# NORTH AMERICAN PRODUCT TECHNICAL GUIDE

## Volume 2 : Anchor Fastening Technical Guide, Edition 22



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# ASK HILTI COMMUNITY

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# ASK HILTI

## Online Specifier Community




# ASK HILTI COMMUNITY

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| | |
|---|---|
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All our continuing education courses for both on-demand and live webinars is available through our online specifier community, Ask Hilti.

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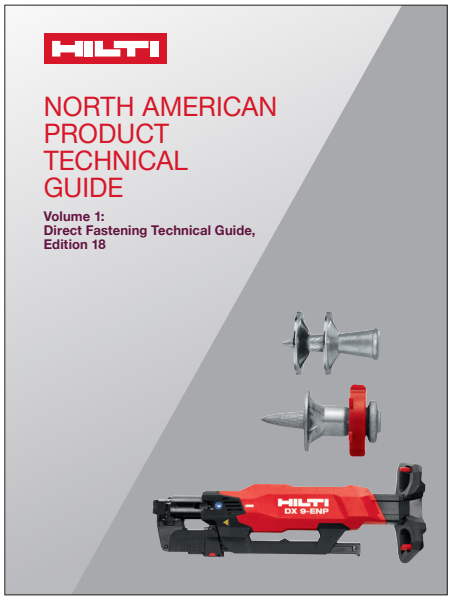
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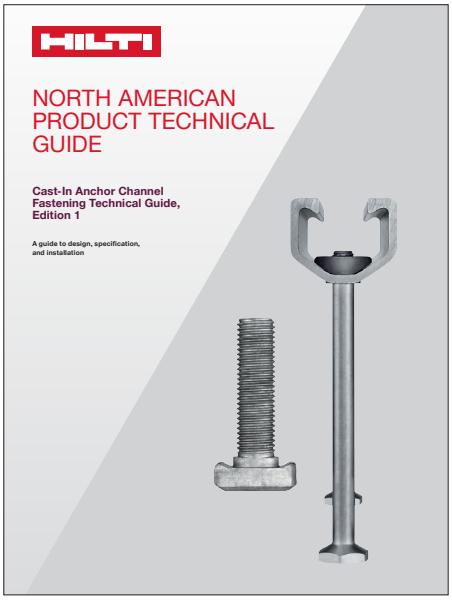
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**Hilti North American Product Technical Guide Volume 1, Installation Technical Manual and Cast-In Anchor Channel Fastening Technical Guide. Contact your Hilti Field Engineer about them today.**









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HDV Drop-inAnchor
HCA Coil Anchor
Metal Hit Anchor
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HSH Split Bolt
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# Anchor selection guide

| | | Base material*, [1, 2] | | | | | | | | Installation* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| | Section number | Uncracked concrete | Cracked concrete[3] | Lightweight concrete | Hollow-core concrete | Grout-filled concrete block | Hollow concrete block | Hollow clay brick | Unreinforced Multi-wythe brick | Approx. gel/cure time at 68°F (20°C) | Compatibility with SafeSet™ Technology | Diamond-cored holes[4] | Water-saturated concrete | Water-filled holes | Submerged (underwater) | Overhead |
| HIT-HY 200 A/R V3 adhesive  | 3.2.2 | ■ | ■ | ■ | | ■ | | | | A: 7/45 min R: 15/90 min | ■ w/HDB only | ■ | ■ | ■ | | ■ |
| HIT-HY 200 A/R V3 adhesive with HIT-Z(-R)  | 3.2.2 | ■ | ■ | ■ | | ■ | | | | A: 7/45 min R: 15/90 min | ■ | ■ | ■ | ■ | | ■ |
| HIT-RE 500 V3 Epoxy  | 3.2.3 | ■ | ■ | ■ | | | | | | 40min/ 6.5 hrs | ■ w/ HDB or TE-YRT | ■ | ■ | ■ | ■ | ■ |
| HIT-HY 100 Adhesive  | online | ■ | ■ | ■ | | ■ | | | | 8 min/ 60 min | ■ w/HDB only | | ■ | | | ■ |
| HIT-RE 100 Epoxy  | online | ■ | ■ | ■ | | | | | | 30 min/ 12 hrs | | | ■ | ■ | ■ | ■ |
| HIT-HY 270  | 3.2.4 | | | | ■ | ■ | ■ | ■ | ■ | 5 min/ 1.5 hrs | ■ w/HDB only | | | | | □ |
| HIT-ICE Adhesive  | 3.2.5 | ■ | ■ | ■ | | ■ | | | | 5 min/ 1 hrs | ■ w/HDB only | | ■ | | | ■ |
| HVU2 Capsule  | 3.2.6 | ■ | ■ | ■ | | | | | | 5 min | ■ w/HDB only | ■ | ■ | | | ■[5] |
| HIT-HY 10 PLUS  | online | ■ | | □ | | ■ | ■ | ■ | | 5 min/ 45 min | | | □ | | | ■ |
| HIT-1  | online | ■ | | ■ | | ■ | ■ | ■ | | 5 min/ 40 min | | | | | | ■ |
| HIT-RE 10 Transportation Epoxy  | online | ■ | | □ | | | | | | 2 hr/ 36 hr | | | ■ | □ | | ■ |

■ Suitable. Technical data is available for this application. Refer to related sections within this technical guide.

□ May be suitable. Anchor system may function properly for this application. However, no substantiating data is available.

∗ Indicates suitability for the stated condition alone. If multiple conditions apply simultaneously, see product specific details within this technical guide or contact Hilti Technical Services.

1 Base material may vary widely. Site specific anchor testing may be required.
2 Unless otherwise stated, testing is performed in normal weight concrete. Lightweight concrete may be available. See product specific details within this technical guide or consult the relevant building codes (ACI 318, IBC, etc.).
3 Refer to Section 2.1.2 for definition of cracked concrete.
4 Diamond coring is applicable where noted, however, it can be restricted to certain base materials, installation conditions and applications, certain Hilti tools, or have associated load reduction. See product specific details within this technical guide.
5 Except 1-1/4-in. diameter rod.

# Anchor selection guide

| | Approvals | | | | | Features* | | | | | Element Type | | | Corrosion resistance[2] | | | Size[3] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ICC-ES/IAPMO UES | ACI 355.4 | COLA / LABC Supplement | FLORIDA BUILDING CODE | NSF 61 | Seismic | In-place (through) fastening | High cycle fatigue[1] | Shock / impact load[1] | High temperature resistance | Threaded rod | Internally threaded insert | Rebar | Electro / mechanically zinc plated | Hot dip galvanized | Stainless steel | Minimum size (diameter) | Maximum size (diameter) |
| HIT-HY 200 V3 Adhesive (Type A or R)  | AC308 AC58 | ■ | ■ | ■ w/ HVHZ | ■ | ■ | ■ | □ | | □ | ■ | ■ | ■ | ■ | ■ | 304/ 316 | 3/8" | 1-1/4" |
| HIT-HY 200 V3 Adhesive (Type A or R) HIT-Z(-R)  | AC308 AC58 | ■ | ■ | ■ w/ HVHZ | ■ | ■ | ■ | □ | | □ | ■ | | | ■ | | 316 | 3/8" | 3/4" |
| HIT-RE 500 V3 Epoxy  | AC308 | ■ | ■ | ■ w/ HVHZ | ■ | ■ | ■ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | 304/ 316 | 3/8" | 1-1/4" |
| HIT-HY 100 Adhesive  | AC308 AC 58 | ■ | ■ | ■ w/ HVHZ | ■ | ■ | ■ | | | □ | ■ | ■ | ■ | ■ | ■ | 304/ 316 | 3/8" | 1-1/4" |
| HIT-RE 100 Epoxy  | AC308 | ■ | ■ | ■ w/ HVHZ | ■ | ■ | ■ | □ | □ | □ | ■ | | ■ | ■ | ■ | 304/ 316 | 3/8" | 1-1/4" |
| HIT-HY 270  | AC58 AC60 | | ■ | ■ | | ■ | □ | | | | ■ | ■ | ■ | ■ | | 304/ 316 | 1/4" | 3/4" |
| HIT-ICE Adhesive  | | ■ | | | | | ■ | | | □ | ■ | ■ | ■ | ■ | ■ | 304/ 316 | 3/8" | 1-1/4" |
| HVU2 Capsule  | AC308 | ■ | ■ | ■ w/ HVHZ | ■ | ■ | ■ | | | □ | ■ | ■ | | ■ | ■ | 304/ 316 | 3/8" | 1-1/4" |
| HIT-HY 10 PLUS  | | | | | | □ | ■ | | | | ■ | | ■ | ■ | | | 3/8" | 3/4" |
| HIT-1  | | | | | | | ■ | | | | ■ | ■ | | ■ | | 304/ 316 | 1/4" | 5/8" |
| HIT-RE 10 Transportation Epoxy  | | | | | | □ | ■ | | | | ■ | | ■ | ■ | ■ | 304/ 316 | 3/8" | 1-1/4" |

■ Suitable. Technical data is available for this application. Refer to related sections within this technical guide.

□ May be suitable. Anchor system may function properly for this application. However, no substantiating data is available.

* Indicates suitability for the stated condition alone. If multiple conditions apply simultaneously, see product specific details within this technical guide or contact Hilti Technical Services.

1 High cycle fatigue and shock/impact loading reference data is only available based on European testing and guidelines.

2 Refer to Section 2.3 for a more detailed discussion on corrosion and corrosion resistance.

3 Listed diameters are those with published load data. Larger diameter elements may be used with some adhesive anchor systems. Contact Hilti for more information.

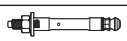
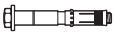
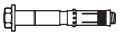
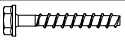
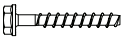
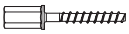
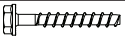
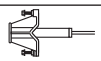
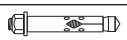
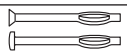
# Anchor selection guide

| | | Base material[1,2] | | | | | | | | | Features | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Section number | Uncracked concrete | Cracked concrete[3] | Lightweight concrete | Concrete over metal deck | Hollow-core concrete | Grout-filled concrete block | Hollow concrete block | Hollow clay brick | Unreinforced Multi-wythe brick | Seismic | In-place (through) fastening | High cycle –fatigue[4] | Shock / impact load[4] |
| HDA Undercut Anchor | 3.3.1 | ■ | ■ | ■ | | | | | | | ■ | ■ | □ | □ |
| HSL4 Heavy Duty Carbon Steel Anchor | 3.3.2 | ■ | ■ | ■ | | | | | | | ■ | ■ | □ | □ |
| HSL-3-R Heavy-duty Expansion Anchor | 3.3.3 | ■ | ■ | ■ | | | | | | | ■* | ■ | □ | □ |
| HSL-GR Heavy-duty Expansion Anchor | 3.3.4 | ■ | | □ | | | | | | | □ | ■ | □ | □ |
| HSL4-I Internally Threaded Exp. Anchor | online | ■ | | □ | | | | | | | □ | ■ | □ | □ |
| KWIK BOLT TZ2 Expansion Anchor | 3.3.5 | ■ | ■ | ■ | ■ | | ■ | | | | ■ | ■ | | |
| KWIK HUS-EZ Screw Anchor | 3.3.6 | ■ | ■ | ■ | ■ | ■ | ■ | | | | ■ | ■ | | |
| KH-EZ SS316 Screw Anchor | 3.3.7 | ■ | ■ | ■ | | | ■ | | | | ■ | ■ | | |
| KWIK HUS-EZ I Screw Anchor w/coupler | 3.3.8 | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ | | |
| KWIK Bolt 1 Expansion Anchor | 3.3.9 | ■ | ■ | ■ | ■ | | ■ | | | | ■ | ■ | | |
| KWIK HUS Screw Anchor | 3.3.10 | ■ | | ■ | ■ | | ■ | | | | | ■ | | |
| KWIK Bolt 3 Expansion Anchor | 3.3.11 | ■ | | ■ | ■ | | | | | | | ■ | | |
| HCA Coil Anchor | online | ■ | | | | | | | | | | ■ | | |
| HDI+/HDI-L+/HDI/HDI-L Drop-In Anchor | 3.3.12 | ■ | | ■ | ■ | | □ | | | | | | | |
| HDI-P TZ Drop-in Anchor | 3.3.13 | ■ | ■ | ■ | | □ | | | | | ■ | | | |
| HDV Drop-In Anchor | online | ■ | | ■ | ■ | | □ | | | | | | | |
| HDI-P Drop-In Anchor | 3.3.14 | ■ | | □ | | ■ | □ | | | | | | | |
| KCM-WF/PD Cast-in Anchor | 3.3.15 | ■ | ■ | ■ | | | | | | | ■ | | | |
| KCM-MD Cast-in Anchor | 3.3.16 | ■ | ■ | ■ | ■ | | | | | | ■ | | | |
| KCC-WF Cast-in-Anchor | 3.3.17 | ■ | ■ | ■ | ■ | | | | | | ■ | | | |
| KCC-MD Cast-in-Anchor | 3.3.17 | ■ | ■ | ■ | ■ | | | | | | ■ | | | |
| KCS-WF | online | ■ | ■ | ■ | ■ | | | | | | ■ | | | |
| HLC Sleeve Anchor | 3.3.18 | ■ | | □ | □ | □ | ■ | ■ | □ | ■ | | ■ | | |
| KWIK CON II+ Screw Anchor KWIK CON+ Screw Anchor | 3.3.19 | ■ | | □ | □ | □ | ■ | ■ | ■ | □ | | ■ | | |
| HMH Metal Hit Anchor | online | ■ | | □ | □ | □ | □ | ■ | ■ | ■ | | ■ | | |
| HPS-1 Impact Anchor | online | ■ | | □ | | □ | □ | ■ | □ | ■ | | ■ | | |
| HTB-2 | online | | | | | | | ■ | | | | □ | | |
| HSH Split Bolt | online | ■ | | | | | | | | | | ■ | | |
| HLD KWIK-Tog | online | □ | | □ | | □ | □ | ■ | □ | □ | | | | |
| IDP Insulation Anchor | online | ■ | | ■ | | ■ | □ | ■ | □ | ■ | | ■ | | |

■ Suitable. Technical data is available for this application. Refer to related sections within this technical guide.
□ May be suitable. Anchor system may function properly for this application. However, no substantiating data is available.
∗ No diamond cored holes

1 Base material may vary widely. Site specific anchor testing may be required.
2 Unless otherwise stated, testing is performed in normal weight concrete. Lightweight concrete may be available. See product specific details within this technical guide or consult the relevant building codes (ACI 318, IBC, etc.).
3 Refer to Section 2.1.2 for definition of cracked concrete.
4 High cycle fatigue and shock/impact loading reference data is only available based on European testing and guidelines.

## Anchor selection guide

| | | Approvals | | | | | | Head type | | | | Corrosion resistance[1] | | | | Size[2] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ICC-ES/IAPMO UES | ACI 355.2 | FM | UL | COLA/LABC Supplement | Florida Building Code High Velocity Hurricane Zone | Stud (Externally threaded) | Internally threaded | Hex bolt | Countersunk/pan head | Electro / mechanically zinc plated | Hot dip galvanized | Sheradized carbo steel | Stainless steel | Minimum size (diameter) | Maximum size (diameter) |
| HDA Undercut Anchor |  | AC193 | ■ | | | ■ | | ■ | | | | ■ | | ■ | 316 | M10 | M20 |
| HSL4 Heavy duty Expansion Anchor |  | AC193 | ■ | | | ■ | | ■ | ■ | ■ | ■ | ■ | | | | M8 | M24 |
| HSL-3 Heavy duty Expansion Anchor |  | AC193 | ■ | | | ■ | | ■ | ■ | ■ | | ■ | | | | M8 | M24 |
| HSL-GR Heavy duty Expansion Anchor |  | | | | | | | ■ | | | | | | | 316 | M10 | M20 |
| HSL-I Internally Threaded Exp. Anchor |  | | | | | | | ■ | ■ | | | ■ | | | | M12 | M12 |
| KWIK Bolt TZ2 Expansion Anchor |  | AC01 AC193 | ■ | ■ | ■ | ■ | ■ | ■ | | | | ■ | | | 304/ 316 | 1/4" | 3/4" |
| KWIK HUS-EZ Screw Anchor |  | AC193 AC106 | ■ | | | ■ | ■ | | | ■ | ■ | ■ | | | | 1/4" | 3/4" |
| KH-EZ SS316 Screw Anchor |  | AC193 AC106 | ■ | | | ■ | ■ | | | ■ | ■ | | | | 316 | 1/4" | 1/2" |
| KWIK HUS-EZ I Screw Anchor w/coupler |  | AC193 | ■ | ■ | | ■ | ■ | | ■ | | | ■ | | | | 1/4" | 3/8" |
| KWIK Bolt 1 Expansion Anchor |  | AC01 AC193 | ■ | ■ | ■ | ■ | ■ | ■ | | | | ■ | | | 304/ 316 | 3/8" | 3/4" |
| KWIK HUS Screw Anchor |  | | ■ | | | | | | | ■ | | ■ | | | | 1/4" | 3/4" |
| KWIK Bolt 3 Expansion Anchor |  | AC193 | ■ | ■ | ■ | ■ | ■ | ■ | | | ■ | | ■ | | 304/ 316 | 1/4" | 1" |
| | | | | | | | | | | | | | | | | | |
| HCA Coil Anchor |  | | | | | | | | | ■ | | ■ | | | | 1/4" | 3/4" |
| HDI+/HDI-L+/HDI/HDI-L Drop-In Anchor |  | | | ■ | ■ | | | | ■ | | | ■ | | | 303 | 1/4" | 3/4" |
| HDI-P TZ Drop-in Anchor |  | AC193 | ■ | ■ | ■ | ■ | ■ | | ■ | | | ■ | | | | 3/8" | 3/8" |
| HDV Drop-In Anchor |  | | | ■ | ■ | | | | ■ | | | ■ | | | 303 | 1/4" | 1/2" |
| HDI-P Drop-In Anchor |  | | | ■ | | | | | ■ | | | ■ | | | | 1/4" | 1/2" |
| KCM-WF/PD Cast-in Anchor |  | AC446 | | ■ | ■ | ■ | ■ | | ■ | | | ■ | | | | 1/4" | 3/4" |
| KCM-MD Cast-in Anchor |  | AC446 | | ■ | ■ | ■ | ■ | | ■ | | | ■ | | | | 1/4" | 3/4" |
| KCC-WF Cast-in-Anchor |  | AC446 | | ■ | ■ | ■ | | | ■ | | | ■ | | | | 3/8" | 1/2" |
| KCC-MD Cast-in-Anchor |  | AC446 | | ■ | ■ | ■ | ■ | | ■ | | | ■ | | | | 3/8" | 1/2" |
| KCS-WF |  | AC446 | | ■ | ■ | ■ | | | ■ | | | ■ | | | | 1/4" | 3/4" |
| HLC Sleeve Anchor |  | | | | ■ | | | | | ■ | ■ | ■ | | | 304 | 1/4" | 3/4" |
| KWIK CON+ Screw Anchor |  | | | | | | | | | | | ■ | | | 410 | 3/16" | 1/4" |
| Metal HIT Anchor |  | | | | | | | | | | | ■ | | | 304 | 3/16" | 1/4" |
| HPS-1 Impact Anchor |  | | | | | | | | | | | ■ | | | 304 | 3/16" | 5/16" |
| HTB-2 |  | | | | | | | | | | | ■ | | | | 3/16" | 1/2" |
| HSH Split Bolt |  | | | | | | | | | | ■ | ■ | | | | 1/4" | 1/4" |
| HLD KWIK-Tog |  | | | | | | | | | | | | | | | #8 | #10 |
| IDP Insulation Anchor |  | | | | | | | | | | | | | | | | |

■ Suitable. Technical data is available for this application. Refer to related sections within this technical guide.
□ May be suitable. Anchor system may function properly for this application. However, no substantiating data is available.
∗ No diamond cored holes

1 Refer to Section 2.3 for a more detailed discussion on corrosion and corrosion resistance.
2 Listed diameters are those with published load data.

# ANCHOR FASTENING TECHNICAL GUIDE

# 1.0 INTRODUCTION

## 1.1 ABOUT PUBLISHED LOAD VALUES

The Anchor Fastening Technical Guide is intended to supplement the Hilti Product and Services catalog with technical information for the designer or specifier. Technical data presented herein was current as of the date of publication (see back cover). Load values are based on testing and analytical calculations by Hilti or by contracted testing laboratories using testing procedures and construction materials representative of current practice in North America. Variations in base materials such as concrete and local site conditions require on-site testing to determine actual performance at any specific site. Data may also be based on national standards or professional research and analysis.

**Note that design values published in reports issued by approval agencies (e.g., ICC-ES, COLA, etc.) may differ from those contained in this publication.**

For information regarding updates and changes, please contact Hilti,Inc. (US) Technical Support at **1-800-879-8000** or Hilti (Canada) Corporation at **1-800-363-4458**.

## 1.2 APPROVALS/LISTINGS

Many Hilti anchoring products have listings or approvals such as International Code Council Evaluation Services Reports (ICC-ES ESR's) or Underwriters Laboratory (UL) listings. Listings and approvals are provided by independent third parties who evaluate products based on model building codes or various jurisdictional requirements. Product listings and approvals indicate that a product has been tested and evaluated based on a specific acceptance or test criteria.

Not all technical data contained in this document is based on a published approval or listing. Hilti may publish additional data beyond that contained in a report, i.e. for applications outside the scope of an available test criteria.

Approvals and listings have been indicated in the Anchor Fastening Technical Guide for reference. Acceptance of the product listings or approvals is subject to the authority having jurisdiction over the project. It is important to review the approval or listing to determine if the application or conditions expected for the project are included in the scope of the approval or listing.

## 1.3 UNITS

Technical data is provided in both fractional (imperial) and metric units. Metric values are provided using the International System of units (SI) in observance of the **Metric Conversion Act of 1975** as amended by the **Omnibus Trade and Competitiveness Act of 1988.** Data for metric products, such as the HSL and HDA anchors, is provided in SI units with conversions to imperial engineering units (inches, pounds, and so forth) given in parentheses. Data for fractional products (e.g. the KWIK Bolt 3) is provided in imperial engineering units with the SI metric conversions shown in parentheses. Additional information may be found in section 4.3.1 Metric Conversions and Equivalents, provided in this product technical guide.

## 1.4 OUR PURPOSE

We passionately create enthusiastic customers and build a better future!



### Enthusiastic customers

We create success for our customers by identifying their needs and providing innovative and value-added solutions.

### Build a better future

We embrace our responsibility towards society and environment.

## 1.5 OUR QUALITY SYSTEM

Certified Quality and Environmental Systems
SQS
ISO 9001 / ISO 14001*
Reg. No. 12455
*ISO 14001 US Only

Hilti is one of a select group of North American companies to receive the ISO 9001 and ISO 14001 Certifications. This recognition of our commitment to quality ensures our customers that Hilti has the systems and procedures in place to maintain our position as the world market leader, and to continually evaluate and improve our performance.

### That's total customer satisfaction!

For technical support, contact Hilti,Inc. (US) at 1-800-879-8000 or Hilti (Canada) Corporation at 1-800-363-4458.

# 2.0 ANCHOR FASTENING TECHNOLOGY

## 2.1 BASE MATERIALS

### 2.1.1 BASE MATERIALS FOR FASTENING

The wide variety of building materials used today provides different anchoring conditions for anchors. There is hardly a base material in or to which a fastening cannot be made with a Hilti product. However, the properties of the base material play a decisive role when selecting a suitable fastener/anchor and determining the load it can hold. It is the responsibility of the designer to carefully match the type of fastener with the base material to obtain the desired results. For base materials not listed, contact Hilti,Inc. (US) at 1-800-879-8000 or Hilti (Canada) Corporation at 1-800-363-4458.

### 2.1.2 CONCRETE

Concrete is a synthetic stone consisting of a mixture of cement, aggregates, and water. In many cases, special additives are used to influence or change certain properties. Concrete has a relatively high compressive strength compared to its tensile strength. Thus, steel reinforcing bars are frequently cast in concrete to carry tensile forces, and this combination is referred to as reinforced concrete.

Cement is a binding agent which combines with water and aggregates and hardens through the process of hydration to form concrete. Portland cement is the most commonly used cement and is available in several different types to meet specific design requirements (ASTM C150).

The aggregates used in concrete consist of both fine aggregate (usually sand) and coarse aggregate graded by particle size. Different types of aggregates can be used to obtain concrete with specific characteristics. Normal-weight concrete is generally made from crushed stone or gravel, while lightweight concrete is obtained using expanded clay, shale, slate, or blast-furnace slag. Lightweight concrete is used when it is desirable to reduce the dead load on a structure or to achieve a superior fire rating for a floor structure. When thermal insulating properties are a prime consideration, lightweight aggregates are manufactured from perlite, vermiculite, blast-furnace slag, clay or shale. Finally, sand lightweight concrete is obtained using lightweight aggregate and natural sand. In general, all concretes with a unit weight between 85 and 115 pcf are considered to be structural lightweight concretes. The ASTM specifications related to concrete type and weight can be summarized
as follows:

| ASTM | | |
|---|---|---|
| **Concrete Type** | **Aggregate Grading Specification** | **Concrete Unit Weight pcf** |
| Normal Weight | ASTM C33 | 145-155 |
| Sand Lightweight | ASTM C330 | 105-115 |
| All Lightweight | ASTM C 330 | 85-110 |
| Lightweight Insulating Concrete | ASTM C 332 | 15-90 |

The type and mechanical properties of concrete aggregate have a major influence on the behavior of drill bits used to drill anchor holes. Harder aggregates, in fact, cause higher bit wear and reduced drilling performance.

The hardness of concrete aggregate can also affect the load capacity of power-actuated fasteners and anchors. Driven fasteners or studs can generally penetrate “soft” aggregates (shale or limestone), but hard aggregates (like granite) near the surface of the concrete can adversely affect the penetration of a fastener or stud and reduce its load capacity. The effect of aggregate mechanical properties on anchor performance is less well understood. In general, harder/denser aggregates (i.e. granite) tend to result in higher concrete cone breakout loads, whereas lightweight aggregates produce lower tension and shear capacities.

Concrete is typically assumed to crack under normal service load conditions or, more specifically, when tensile stresses imposed by loads or restraint conditions exceed its tensile strength. Crack width and distribution are generally controlled through the use of reinforcement. With consideration for the protection of the reinforcing steel, crack widths, per ACI 318, are assumed to be less than approximately 0.012 in (0.3 mm). Under seismic loading, flexural crack widths corresponding to the onset of reinforcing yield are assumed to be approximately 1-1/2 x static crack width = 0.02” (0.5 mm). Both ACI 318 and the International Building Code conservatively assume cracked concrete as the baseline condition for the design of cast-in-place and post-installed anchors since the existence of cracks in the vicinity of the anchor can result in a reduced ultimate load capacity and increased displacement at ultimate load compared to uncracked concrete conditions. Design for uncracked concrete conditions is permitted by the model Building Codes only for cases where it can be shown that cracking of the concrete at service load levels will not occur over the anchor service life. For cases involving design for seismic actions, post-installed anchors must be demonstrated as being suitable for use in cracked concrete as well as for seismic loading.

Values for the ultimate strength of fasteners in concrete are traditionally given in relation to the 28-day uniaxial compressive strength of the concrete (actual, not specified). Concrete that has cured for less than 28 days is referred to as green concrete. Aggregate type, cement replacements such as fly ash, and admixtures can affect the capacity of some fasteners, and this may not be reflected in the concrete strength as measured in a standard uniaxial compression test. In general, Hilti data reflects testing with common aggregates and cement types in plain, unreinforced concrete. In questionable cases, consult with Hilti Technical Services.

In view of the significantly lower strength of green concrete (less than 28-day cure), it is recommended that mechanical anchors not be placed/installed in concretes cured for less than 7 days, unless site testing is performed to verify the fastening capacity. If an anchor is installed in green concrete, but not loaded until the concrete has achieved full cure, the capacity of the anchor can be based on the strength of the concrete at the time of loading.

ACI 318 Section 17.1.2 and CSA A23.3 Section D.1.2 require adhesive anchors to be installed in concrete having a minimum age of 21 days at the time of anchor installation.
For adhesive anchors installed in concrete aged less than 21 days, it is recommended that the design engineer evaluate the anchor design based on the concrete strength at the time of installation and use a bond strength value for water saturated concrete. Site testing is recommended to verify the fastening capacity.

Cutting through concrete reinforcement when drilling holes for anchors should be avoided. If this is not possible, the responsible design engineer should be consulted first.

## 2.1.3 MASONRY MATERIALS

Masonry is a heterogeneous building material consisting of clay brick, concrete block or clay tile bonded together using joint mortar. The primary application for masonry is the construction of walls which are built by placing masonry components in horizontal rows (courses) and/or vertical rows (wythes). Masonry components can be manufactured in a wide variety of shapes, sizes, materials and both hollow and solid configurations. These variations require that the selection of an anchoring or fastening system be carefully matched to the application and type of masonry material being used. As a base material, masonry typically has a much lower strength than concrete. The behavior of the masonry components, as well as the geometry of their cavities and webs, has a considerable influence on the ultimate load capacity of the fastening.

When drilling holes for anchors in masonry with hollow cavities, care must be taken to avoid spalling on the inside of the face shell. This could greatly affect the performance of “toggle” type mechanical anchors whose length must be matched to the face shell thickness. To reduce the potential for spalling, unless otherwise specified, holes should be drilled with hammer drills set in rotation only mode (i.e. hammering action of the drill turned off).

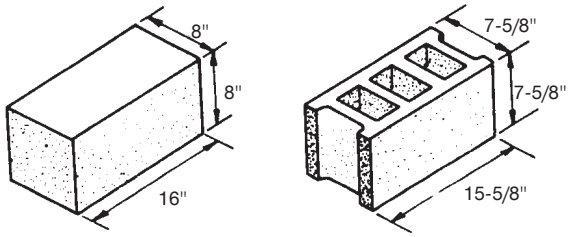
### CONCRETE BLOCK

Concrete block is the term commonly used to refer to concrete masonry units (CMU) made from Portland cement, water and mineral aggregates. CMU blocks are manufactured in a variety of shapes and sizes using light-, medium-, and normal-weight aggregates. Both hollow and solid load bearing CMUs are manufactured in accordance with ASTM C90.

| Nominal width of unit in. (mm) | Minimum face-shell thickness in. (mm) | Minimum web thickness in. (mm) |
|---|---|---|
| 3 (76) and 4 (102) | 3/4 (19) | 3/4 (19) |
| 6 (152) | 1 (25) | 3/4 (19) |
| 8 (203) and greater | 1-1/4 (32) | 3/4 (19) |

Adapted from ASTM C90 - 14 Table 1.

1 Average of measurements on three units when measured as described in Test Methods C140.

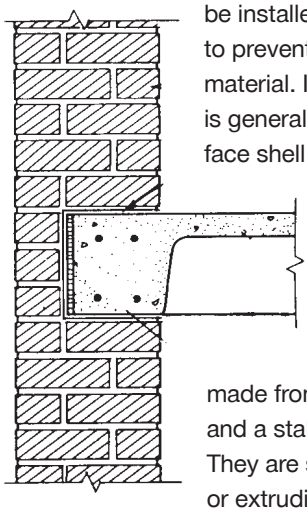



**Nominal size** (usually fictitious)

**Modular size** (actual)

CMU sizes generally refer to the nominal width of the unit (6", 8", 10" etc.). Actual dimensions are nominal dimensions reduced by the thickness of the mortar joint.

CMU construction can be reinforced, whereby reinforcing bars are placed vertically in cells filled with grout to create a composite section analogous to reinforced concrete. If all cells, both unreinforced and reinforced, are filled with grout, the construction is referred to as fully grouted. If only the reinforced cells are grouted, the construction is referred to as partially grouted. Horizontal reinforcement may be placed in a wall via a bond beam, which is always grouted. Ladder reinforcement may also be placed in the mortar bed between courses. Grout typically conforms to ASTM C476 and has a minimum compressive strength of 2,000 psi. Concrete masonry units have a compressive strength which may range from 1,250 to over 4,800 psi, although the maximum specified compressive strength of the assembled masonry will generally not exceed 3,000 psi. Both chemical and mechanical anchors may be used in grouted CMU. If voids are present or suspected, mechanical anchors should not be used, and chemical anchors should only



**12" Brick Bearing Walls**

be installed in conjunction with a screen tube to prevent uncontrolled flow of the bonding material. In hollow masonry, anchor strength is generally assumed to be based on the face shell thickness, which can be variable.

## CLAY BRICK

Clay brick is the most extensively used type of masonry unit throughout the world. Bricks are prismatic masonry units made from a suitable mixture of soil, clay and a stabilizing agent (emulsified asphalt). They are shaped by molding, pressing, or extruding, and are fired at elevated temperature to meet the strength and durability requirements of ASTM C62 (solid brick) and C652 (hollow brick).

Depending upon the grade, clay masonry bricks can have a compressive strength ranging from 1,250 to over 25,000 psi. Grouted multi-wythe masonry construction typically consists of two wythes, each one unit masonry in thickness, separated by a space (collar joint) 1/2" to 4-1/2" wide, generally filled with grout. The wythes are connected with wall ties. This space may also be reinforced with vertical reinforcing bars. Solid brick masonry consists of abutting wythes interlaced with header courses. In general, chemical anchors are recommended for use in brick. In older unreinforced construction (URM), or where the condition of the masonry is unknown, it is advisable to use a screen tube to prevent unrestricted flow of the bonding material into voids.

## MORTAR

Mortar is used to provide uniform bearing between masonry units and to bond individual units into a composite assemblage that will withstand the imposed loading conditions. Mortar consists of a mixture of cementitious material, aggregate and water proportionally combined in accordance with ASTM C270. Cement/lime mortar or masonry mortar (each in four types) are typically used under this Standard.

| Mortar | Type | Average compressive strength at 28 days, minimum psi (MPa) | |
|---|---|---|---|
| Cement-lime | M | 2500 | (17.2) |
| | S | 1800 | (12.4) |
| | N | 750 | (5.2) |
| | O | 350 | (2.4) |
| Masonry cement | M | 2500 | (17.2) |
| | S | 1800 | (12.4) |
| | N | 750 | (5.2) |
| | O | 350 | (2.4) |

Since mortar plays a significant role in the structural integrity of a masonry wall, it is important to understand how post installed anchors interact with the structure. Within a masonry structure there are designated joint locations, and the proximity of a post-installed anchor or power-actuated fastener to one of these locations must be considered in the design of the anchorage. Product specific guidelines are provided within this technical guide.

## GROUT

ACI defines grout as “a mixture of cementitious material and water, with or without aggregate, proportioned to produce a pourable consistency without segregation of the constituents”. The terms grout and mortar are frequently used interchangeably but are, in actuality, not the same. Grout need not contain aggregate (mortar contains fine aggregate), is supplied in a pourable consistency (mortar is not), and fills voids (mortar only bonds elements together).

In summary, grout is used to fill spaces or cavities and provide continuity between building elements. In some applications, grout will act in a structural capacity, such as in unreinforced masonry construction.

Grout, with respect to post-installed anchorages, is specified by the design official. When post-installed anchors are tested for the development of design values, the grout is specified according to applicable ASTM standards. Design engineers are encouraged to become familiar with the characteristics of the grout used in performance testing to better understand the applicability of the design loads published in this guide.

# 2.1.4 ADMIXTURES

Chemical admixtures are ingredients added to the basic components of concrete or mortar (cement, water, and aggregates) immediately before or during mixing. Chemical admixtures are used to enhance the properties of concrete and mortar in the plastic and hardened state. These properties may be modified to increase compressive and flexural strength, decrease permeability and improve durability, inhibit corrosion, reduce shrinkage, accelerate or retard initial set, increase slump and working properties, increase cement efficiency, improve the economy of the mixture, etc.

Testing of post-installed anchors is performed in concrete without admixtures. Designers should take into consideration the effects produced by admixtures on concrete when considering the use of post-installed anchors.

# 2.2 EVALUATION OF TEST DATA

### 2.2.1 Developing fastener performance data

State-of-the-art anchor design uses what is known as the Strength Design Method. By using the Strength Design Method, nominal strengths are first calculated for all the possible anchor failure modes. Subsequently, strength reduction factors are applied to each nominal strength to obtain a design strength. The controlling design strength is finally compared to a factored load. The provisions of ACI 318 Chapter 17 are the basis used for Strength Design.

Strength Design data for Hilti mechanical anchors in concrete is derived from testing as per the provisions of ACI 355.2 and ICC-ES AC193. Strength Design data for Hilti adhesive anchors in concrete is derived from testing as per the provisions of ACI 355.4 and ICC-ES AC308.

Beginning with IBC 2003, the IBC Building Codes have adopted the Strength Design Method for anchorage into concrete of both cast-in-place and post-installed anchors.

Another anchor design method known as "Allowable Stress Design" is still used as an alternative to the Strength Design provisions especially when used for anchoring into masonry base materials. Section 2.2.2 provides detailed explanations of the Allowable Stress Design provisions used by Hilti. Allowable Stress Design data for Hilti mechanical anchors is derived from testing based on ASTM E488, ICC-ES AC01 and AC106. Allowable Stress Design data for Hilti adhesive anchors is derived from testing based on ASTM E1512, ASTM E488, ICC-ES AC58 and AC60.

There are two methods of developing allowable loads; (1) apply an appropriate safety factor to the mean ultimate load as determined from a given number of individual tests, or (2) apply a statistical method to the test data which relates the allowable working load to the performance variability of the fastening.

## 2.2.2 ALLOWABLE LOADS

Historically, allowable loads for anchors have been derived by applying a global safety factor to the average ultimate value of test results as shown in Eq. (2.2.1).

$$F_{all} = \frac{\overline{F}}{v} \qquad (2.2.1)$$

Where:

$\overline{F}$ = mean ultimate value of test data (population sample)

v = global safety factor

Global safety factors of 4 to 8 for post-installed anchors have been industry practice for nearly three decades. The global safety factor is assumed to cover expected variations in field installation conditions and in anchor performance from laboratory tests.

Note that global safety factors applied to the mean do not explicitly account for the coefficient of variation, i.e., all anchors are considered equal with respect to variability in the test data.

## 2.2.3 STATISTICAL EVALUATION OF DATA

Experience from a large number of tests on anchors has shown that ultimate loads generally approximate a normal Gaussian probability density function as shown in Fig. 2.2.1. This allows for the use of statistical evaluation techniques that relate the resistance to the system performance variability associated with a particular anchor.

The 5% fractile characteristic value has been adopted by the IBC as the basis for determining published design loads based on anchor testing results for Strength Design. There is a 90% probability that 95% of the test loads will exceed a 5% fractile value. The 5% fractile value is calculated by subtracting a certain number of standard deviations of the test results from the mean based on the number of trials. See Eq. (2.2.2) and the referenced statistical table by D. B. Owen. For a series of 5 trials, the 5% fractile value is calculated by multiplying the standard deviations by k = 3.401 and subtracting from the mean.

Owen, D.B., (1962) Handbook of Statistical Tables, Section 5.3. Reading: Addison-Wesley Publishing.

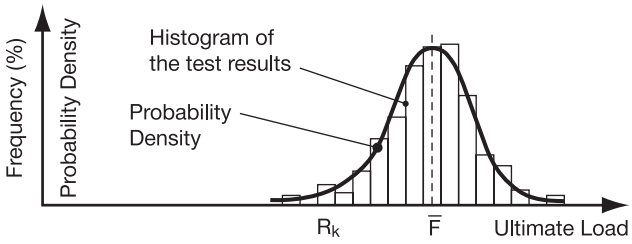



Fig. 2.2.1 Frequency distribution of anchor ultimate loads, demonstrating the significance of the 5% fractile

$$R_k = \overline{F} - k \cdot s = \overline{F}(1 - k \cdot cv) \qquad (2.2.2)$$

Where:

$R_k$ = characteristic resistance of the tested anchor system

$\overline{F}$ = mean ultimate resistance of the tested anchor system

k = distribution value for test sample size n

s = standard deviation of the test data

cv = coefficient of variation = $\frac{s}{\overline{F}}$

Thus, test series with low standard deviations are rewarded with higher 5% fractile characteristic design values. This is typical of ductile steel failure modes.

Characteristic Strength Design loads may be converted to allowable loads. See Section 3.1.6.

# 3.0 ANCHORING SYSTEMS

## 3.1 ANCHOR PRINCIPLES AND DESIGN

### 3.1.1 DEFINITIONS

**Adhesive anchor** is a post-installed anchor that is inserted into a drilled hole in hardened concrete, masonry or stone. Loads are transferred to the base material by the bond between the anchor and the adhesive and the adhesive and the base material.

**Anchor category** is an assigned rating that corresponds to a specific strength reduction factor for concrete failure modes associated with anchors in tension. The anchor category is established based on the performance of the anchor in reliability tests.

**Anchor group** is a group of anchors of approximately equal effective embedment and stiffness where the maximum anchor spacing is less than the critical spacing.

**Anchor reinforcement** is reinforcement used to transfer the full design load from the anchors into the structural member.

**Anchor spacing** is centerline-to-centerline distance between loaded anchors.

**Attachment** is the structural assembly, external to the surface of the concrete, that transmits loads to or receives loads from the anchor.

**Cast-in-place anchor** is traditionally a headed bolt, headed stud or hooked bolt installed before placing concrete. Additionally, cast-in-place internally threaded inserts are a form of cast-in-place anchors.

**Characteristic capacity** is a statistical term indicating 90 percent confidence that there is 95 percent probability of the actual strength exceeding the nominal strength. This is also called the 5% fractile capacity.

**Concrete breakout** is a concrete failure mode that develops a cone or edge failure of the test member due to setting of the anchor or applied loads.

**Concrete splitting failure** is a concrete failure mode in which the concrete fractures along a plane passing through the axis of the anchor or anchors.

**Cracked concrete** is condition of concrete in which the anchor is located. See Section 2.1.2.

**Critical spacing** is minimum required spacing between loaded anchors to achieve full capacity.

**Critical edge distance** is minimum required edge distance to achieve full capacity.

**Cure time** is the elapsed time after mixing of the adhesive material components to achieve a state of hardening of the adhesive material in the drilled hole corresponding to the design mechanical properties and resistances. After the full cure time has elapsed, loads can be applied.

**Displacement controlled expansion anchor** is a post-installed anchor that is set by expansion against the side of the drilled hole through movement of an internal plug in the sleeve or through movement of the sleeve over an expansion element (plug). Once set, no further expansion can occur.

**Ductile steel element** are anchors designed to be governed by ductile yielding of the steel. This is determined by performing tension testing on coupons machined from the finished anchors. The minimum requirements are 14% elongation and 30% reduction of area.

**Expansion anchor** is a post-installed anchor that is inserted into a drilled hole in hardened concrete or masonry. Loads are transferred to and from the base material by bearing, friction or both.

**Edge distance** is distance from centerline of anchor to the free edge of base material in which the anchor is installed.

**Effective embedment depth** is the overall depth through which the anchor transfers force to or from the surrounding concrete. The effective embedment depth will normally be the depth of the concrete failure surface in tension applications. For cast-in headed anchor bolts and headed studs, the effective embedment depth is measured from the bearing contact surface of the head. For expansion anchors, it is taken as the distance from surface of base material to tip of expansion element(s).

**Gel time** is the elapsed time after mixing of the adhesive material components to onset of significant chemical reaction as characterized by an increase in viscosity. After the gel time has elapsed, the anchors must not be disturbed.

**Minimum edge distance** is the spacing from the centerline of the anchor to the edge of the base material required to minimize the likelihood of splitting of the base material during anchor installation.

**Minimum spacing** is distance between the centerlines of adjacent loaded anchors to minimize the likelihood of splitting of the base material during anchor installation.

**Minimum member thickness** is minimum required thickness of member in which anchor is embedded to minimize the likelihood of splitting of the base material.

**Post-installed anchor** is an anchor installed in hardened concrete and masonry. Expansion, undercut, and adhesive anchors are examples of post-installed anchors.

**Projected area** is the area on the free surface of the concrete member that is used to represent the larger base of the assumed rectilinear failure surface.

**Pryout failure** is a failure mode where anchors having limited embedment depth and loaded in shear exhibit sufficient rotation to produce a pryout fracture whereby the primary fracture surface develops behind the point of load application. This failure mode does not depend on the presence of free edges.

**Pullout failure** is a failure mode in which the anchor pulls out of the concrete without development of the full steel or concrete capacity.

**Pull-through failure** is a failure mode in which the anchor body pulls through the expansion mechanism without development of the full steel or concrete capacity.

**Side face blowout strength** is the strength of anchors with deeper embedment but thinner side cover corresponding to concrete spalling on the side face around the embedded head while no major breakout occurs at the top concrete surface.

**Steel failure** is a failure mode in which the steel anchor parts fracture.

**Supplementary reinforcement** is reinforcement that acts to restrain the potential concrete breakout area but is not designed to transfer the full design load from the anchors into the structural member.

**Torque controlled expansion anchor** is a post-installed expansion anchor that is set by the expansion of one or more sleeves or other elements against the sides of the drilled hole through the application of torque, which pulls the cone(s) into the expansion sleeve(s). After setting, tensile loading can cause additional expansion (follow-up expansion).

**Undercut anchor** is a post-installed anchor that derives tensile holding strength by the mechanical interlock provided by undercutting the concrete, achieved either by a special tool or by the anchor itself during installation.

## 3.1.2 ANCHORS IN CONCRETE AND MASONRY

Post-installed anchor bolts are used for a variety of construction anchoring applications including column baseplates, supporting mechanical and electric services, fixation of building facades and anchoring guardrails. Critical connections, i.e., those that are either safety-related or whose failure could result in significant financial loss, require robust anchor solutions capable of providing a verifiable and durable load path. In turn, the selection of a suitable anchor system and its incorporation in connection design requires a thorough understanding of the fundamental principles of anchoring. While a general overview is provided here, additional references can be found at the conclusion of this section.

## 3.1.3 ANCHOR WORKING PRINCIPLES

Anchors designed for use in concrete and masonry develop resistance to tension loading on the basis of one or more of the following mechanisms:

**Friction:** This is the mechanism used by most post-installed mechanical expansion anchors to resist tension loads, including the KWIK Bolt TZ, HSL-3 and HDI anchors. The frictional resistance resulting from expansion forces generated between the anchor and the wall of the drilled hole during setting of the anchor may also be supplemented by local deformation of the concrete. The frictional force is proportional to the magnitude of the expansion stresses generated by the anchor. Torque-controlled expansion anchors like the KWIK Bolt TZ and HSL-3 anchors use follow-up expansion to increase the expansion force in response to increases in tension loading beyond the service load level (preload) or to adjust for changes in the state of the base material (cracking).

**Keying:** Undercut anchors and, to a lesser degree, certain types of expansion anchors, rely on the interlock of the anchor with deformations in the hole wall to resist the applied tension loading. The (bearing) stresses developed in the base material at the interface with the anchor bearing surfaces can reach relatively high levels without crushing due to the triaxial nature of the state of stress. Undercut anchors like the Hilti HDA offer much greater resilience to variations in the base material conditions and represent the most robust solution for most anchoring needs.

**Bonding (adhesion):** Adhesive anchor systems utilize the bonding mechanism that takes place between the adhesive and the anchor element, and the adhesive and the concrete, to transfer the applied load from the anchor element into the concrete. The degree of bonding available is influenced by the condition of the hole wall at the time of anchor installation. Injection anchor systems like Hilti's HIT-HY 200 V3 offer unparalleled flexibility and high bond resistance for a wide variety of anchoring applications.

Hybrid anchor elements like the Hilti HIT-Z threaded rod combine the functionality of an adhesive anchor system with the working principle of a torque-controlled expansion anchor for increased reliability under adverse job-site conditions.

**Shear resistance:** Most anchors develop resistance to shear loading via bearing of the anchor element against the hole wall close to the surface of the base material. Shear loading may cause surface spalling resulting in significant flexural stresses and secondary tension in the anchor element.

## 3.1.4 ANCHOR BEHAVIOR UNDER LOAD

When loaded in tension to failure, anchors may exhibit one or more identifiable failure modes. These include:

- steel failure in tension
- anchor pullout or pull-through failure
- adhesive bond failure
- concrete breakout failure
- concrete splitting failure
- side-face blowout failure

Failure modes associated with anchors loaded to failure in shear may be characterized as follows:

- steel failure in shear/tension
- concrete edge breakout failure
- pryout failure

### PRESTRESSING OF ANCHORS

In general, properly installed anchors do not exhibit noticeable deflection at the expected service load levels due to the application of the prescribed installation torque. External tension loading results in a reduction of the clamping force in the connection with little increase in the corresponding bolt tension force. Shear loads are resisted by a combination of bearing and friction resulting from the anchor preload forces.

At load levels beyond the clamping load, anchor deflections increase and the response of the anchor varies according to the anchor force-resisting mechanism. Expansion anchors capable of follow-up expansion show increased deflections corresponding to relative movement of the cone and expansion elements. Adhesive anchors exhibit a change in stiffness corresponding to loss of adhesion between the adhesive and the base material whereby tension resistance at increasing displacement levels is provided by friction between the uneven hole wall and the adhesive plug. In all cases, increasing stress levels in the anchor bolt/element result in increased anchor displacements.

### LONG TERM BEHAVIOR

Following are some factors that can influence the long-term behavior of post-installed anchoring systems.

Adhesive anchoring systems:

- Pretensioning relaxation
- Chemical resistance/durability
- Creep
- Freeze/thaw conditions
- High temperature
- Fatigue
- Concrete cracking
- Corrosion
- Fire
- Seismic loading

Mechanical anchoring systems:

- Pretensioning relaxation
- Fatigue
- Concrete cracking
- Corrosion
- Fire
- Seismic Loading

All Hilti adhesive anchor systems suitable for use with the Strength Design Method have been tested for sustained loading conditions as per ACI 355.4 and ICC-ES Acceptance Criteria AC308.

## 3.1.5 ANCHOR DESIGN

The design of anchors is based on an assessment of the loading conditions and anchorage capacity. Strength design (SD), limit state design (LSD), and allowable stress design (ASD) methods are currently in use in North America for the design of anchors.

**Strength Design:** The Strength Design Method for anchor design has been incorporated into several codes such as IBC and ACI 318. The method assigns specific strength reduction factors to each of several possible failure modes, provides predictions for the strength associated with each failure mode, and compares the controlling strength with factored loads. The Strength Design Method is a more accurate estimate of anchor resistance as compared to the ASD approach. The Strength Design Method, as incorporated in ACI 318 Chapter 17, is discussed in Section 3.1.6. Strength Design is state-of-the-art and Hilti recommends its use where applicable.

**Limit State Design:** The limit state design method for anchor design is described and included in the CSA A23.3 Annex D. In principle, the method follows the strength design concept with the application of different strength reduction factors. The limit states design method generally results in a more accurate estimate of anchor resistance as compared to the ASD approach. This approach is discussed further in 3.1.7.

**Allowable loads:** Under the Allowable Stress Design Method, the allowable load, or resistance, is based on the application of a safety factor to the mean result of laboratory testing to failure, regardless of the controlling failure mode observed in the tests. The safety factor is intended to account for reasonably expected variations in loading. Adjustments for anchor spacing and edge distance are developed as individual factors based on testing of two- and four-anchor groups and single anchors near free edges. These factors are multiplied together for specific anchor layouts. This approach is discussed further in section 3.1.9. Allowable Stress Design is typically used today for masonry applications.

## 3.1.6 ACI 318 Chapter 17 Strength Design — SD (LRFD)

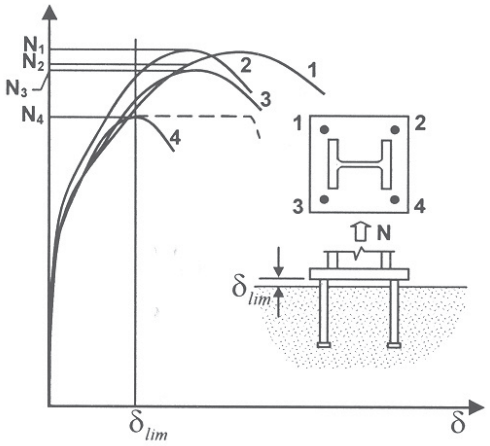
Strength Design of anchors is referenced in the provisions of ACI 355.2, ACI 355.4, ACI 318 Chapter 17 and the ICC-ES Acceptance Criteria AC193 for mechanical anchors and AC308 for adhesive anchors.

### STRENGTH DESIGN (SD) TERMINOLOGY

Terminology used in the strength design provisions is consistent with the terminology of ACI 318 Chapter 2.

## LOAD DISTRIBUTION

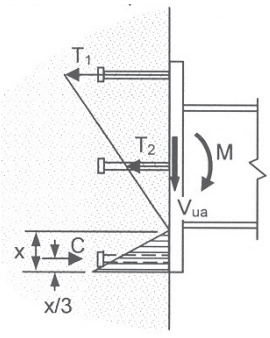
As per ACI 318 Section 17.2, load distribution should be determined on the basis of elastic analysis unless it can be shown that the nominal anchor strength is controlled by ductile steel elements. Where plastic analysis (assumption of fully yielded anchors) is used, compatibility of deformations must be checked.




Example of incompatibility of deformations (displacements)

In most cases, elastic analysis yields satisfactory results and is recommended. It should be noted, however, that the assumption of anchor load linearly proportional to the magnitude of the applied load and the distance from the neutral axis of the group is valid only if the attachment (e.g. baseplate) is sufficiently stiff in comparison to the axial stiffness of the anchors. For additional information on elastic load distribution in typical column baseplate assemblies, the reader is referred to Blodgett, O., Design of Welded Structures, The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

Note: Assuming a rigid base plate condition, Hilti's PROFIS Anchor analysis and design software performs a simplified finite element analysis to establish anchor load distribution on an elastic basis.




Example of elastic load distribution in a beam-wall connection

## BOLT BENDING — STRENGTH DESIGN

ACI 318 does not consider the possibility of bolt bending in detail as part of the design criteria. When stand-off is not grouted, it is recommended to consider bolt bending as a possible failure mode in shear because it could be a controlling shear failure mode. Per the ETAG 001 Annex C Part 4.2.2.4, an additional check for shear load resulting from stand-off conditions can be performed when calculating nominal shear strengths.

$$V_s^M = \frac{\alpha_M \cdot M_s}{\ell}$$

whereby:

$\alpha_M$ = adjustment of bending moment associated with rotational restraint, where $1 \le \alpha_M \le 2$

$M_S$ = resultant flexural resistance of single anchor

$$= M_s^0 \left(1 - \left(\frac{N_{ua}}{\Phi N_{sa}}\right)\right)$$

$M_s^0$ = characteristic flexural resistance of single anchor

$$= 1.2 \cdot S \cdot f_{u,min}$$

$f_{u,min}$ = minimum nominal ultimate tensile strength of anchor element

S = elastic section modulus of anchor bolt at concrete surface (a uniform cross section is assumed)

$$= (\pi * d^3) / 32$$

$\ell$ = internal lever arm adjusted for spalling of the concrete surface as follows:

$$= z + (n \cdot d_o)$$

z = distance from center of base plate to surface of concrete (standoff distance)

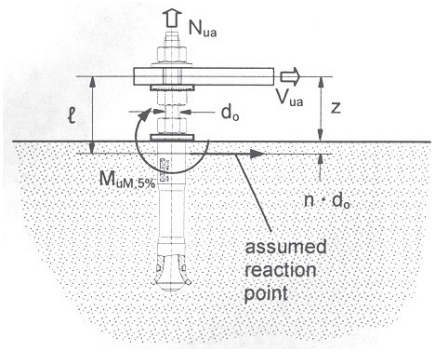
$d_o$ = anchor outside diameter at concrete surface

n = 0, for loading with clamping at the concrete surface as provided by a nut and washer assembly (required for mechanical anchors)

= 0.5, for loading without clamping at the concrete surface, e.g., adhesive anchor without nut and washer at concrete surface

Note that stand-off installations of post-installed mechanical anchors require a nut and bearing washer at the concrete

surface as shown below for proper anchor function and to properly resist compression loads.




Determination of bolt bending — Strength Design

## 3.1.7 CSA A23.3 ANNEX D LIMIT STATE DESIGN

Limit State Design of anchors is referenced in the provisions of CSA A23.3 Annex D, which cover headed studs and bolts, hooked bolts and post-installed anchors that meet the assessment of ACI 355.2 and ACI 355.4. Furthermore, the suitability of post-installed anchors for use in concrete must be demonstrated by the ACI 355.2 and ACI 355.4 prequalification tests.

### LOAD DISTRIBUTION

The provisions of CSA A23.3 Annex D and ACI 318 Chapter 17 are based on identical assumptions. Refer to Section 3.1.6.2 for more details.

## 3.1.8 HILTI SIMPLIFIED DESIGN TABLES

The Hilti Simplified Design Tables is not a new “method” of designing an anchor that is different than the provisions of ACI 318 Chapter 17 or CSA A23.3 Annex D. Rather, it is a series of pre-calculated tables and reduction factors meant to help the designer create a quick calculation of the capacity of the Hilti anchor system, and still be compliant with the codes and criteria of ACI and CSA.

The Hilti Simplified Design Tables are formatted similar to the Allowable Stress Design (ASD) tables and reduction factors which was a standard of practice for design of post-installed anchors.

The Hilti Simplified Design Tables combine the simplicity of performing a calculation according to the ASD method with the code-required testing, evaluation criteria and technical data in ACI 318 Chapter 17 and CSA Annex D.

### SIMPLIFIED TABLES DATA DEVELOPMENT

The Simplified Tables have two table types. The single anchor capacity table and the reduction factor table.

Single anchor capacity tables show the design strength (for ACI) or factored resistance (for CSA) in tension and shear for a single anchor. This is the capacity of a single anchor with no edge distance or concrete thickness influences and is based on the assumptions outlined in the footnotes below each table.

Reduction factor tables are created by comparing the single anchor capacity to the capacity that includes the influence of a specific edge distance, spacing, or concrete thickness, using the equations of ACI 318 Chapter 17.

### HILTI MECHANICAL ANCHORS OR HILTI HIT-Z(-R) ANCHOR RODS

The single anchor tension capacity is based on the lesser of concrete breakout strength or pullout strength:

ACI/AC308: $\Phi N_n = \min | \Phi N_{cb} ; \Phi N_{pn} |$

CSA: $N_r = \min | N_{cbr} ; N_{cpr} |$

$\Phi N_n = N_r$

The shear value is based on the pryout strength.

ACI/AC308: $\Phi V_n = \Phi V_{cp}$

CSA: $V_r = V_{cpr}$

$\Phi V_n = V_r$

Concrete breakout and pryout are calculated according to ACI 318 Chapter 17 and CSA A23.3 Annex D using the variables from product specific ICC-ES Evaluation Service Reports (ESR's). These values are equivalent.

Pullout for torque controlled adhesive anchors is not recognized in ACI or CSA, so this is determined from AC308 Section 3.3 and the value of $N_{p,uncr}$ or $N_{p,cr}$ from ESR-4868. This is a similar approach to mechanical anchor pullout strength. ACI and CSA values are equivalent.

### HILTI ADHESIVE ANCHORS WITH STANDARD THREADED RODS, REBAR, AND HILTI HIS-(R)N INTERNALLY THREADED INSERTS

The single anchor tension capacity is based on the lesser of concrete breakout strength or bond strength:

ACI: $\Phi N_n = \min | \Phi N_{cb} ; \Phi N_a |$

CSA/ACI: $N_r = \min | N_{cbr} ; N_a |$

$\Phi N_n = N_r$

The shear value is based on the pryout strength.

ACI: $\Phi V_n = \Phi V_{cp}$

CSA/ACI: $V_r = V_{cpr}$

$\Phi V_n = V_r$

Concrete breakout, bond, and pryout are calculated according to ACI 318 Chapter 17 and CSA A23.3 Annex D using the variables from product specific ICC-ES Evaluation Service Reports (ESR's). These values are equivalent, however, the values will be calculated based on standard concrete compressive strengths specified in the US or Canada.

## STEEL STRENGTH FOR ALL ELEMENTS

The steel strength is provided on a separate table and is based on calculations from ACI 318 Chapter 17 and CSA A23.3 Annex D. ACI and CSA have different reduction factors for steel strength, thus the values for both ACI and CSA are published.

**How to calculate anchor capacity using simplified tables**

The process for calculating the capacity of a single anchor or anchor group is similar to the ASD calculation process currently outlined in section 3.1.9 of this document.

The design strength (factored resistance) of an anchor is obtained as follows:

Tension:

ACI: $N_{des} = n \bullet \min | \Phi N_n \bullet f_{AN} \bullet f_{RN} ; \Phi N_{sa} |$

CSA: $N_{des} = n \bullet \min | N_r \bullet f_{AN} \bullet f_{RN} ; N_{sr} |$

Shear:

ACI: $V_{des} = n \bullet \min | \Phi V_n \bullet f_{AV} \bullet f_{RV} \bullet f_{HV} ; \Phi V_{sa} |$

CSA: $V_{des} = n \bullet \min | V_r \bullet f_{AV} \bullet f_{RV} \bullet f_{HV} ; V_{sr} |$

where:

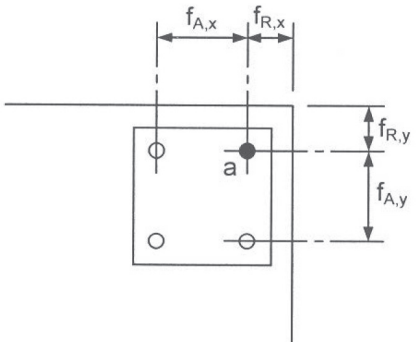
- $n$ = number of anchors
- $N_{des}$ = design resistance in tension
- $\Phi N_n$ = design strength in tension considering concrete breakout, pullout, or bond failure (ACI)
- $\Phi N_{sa}$ = design strength in tension considering steel failure (ACI)
- $N_r$ = factored resistance in tension considering concrete breakout, pullout, or bond failure (CSA)
- $N_{sr}$ = factored resistance in tension considering steel failure (CSA)
- $V_{des}$ = design resistance in shear
- $\Phi V_n$ = design strength in shear considering concrete failure (ACI)
- $\Phi V_{sa}$ = design strength in shear considering steel failure (ACI)
- $V_r$ = factored resistance in shear considering concrete failure (CSA)
- $V_{sr}$ = factored resistance in shear considering steel failure (CSA)
- $f_{AN}$ = adjustment factor for spacing in tension
- $f_{RN}$ = adjustment factor for edge distance in tension
- $f_{AV}$ = adjustment factor for spacing in shear
- $f_{RV}$ = adjustment factor for edge distance in shear
- $f_{HV}$ = adjustment factor for concrete thickness in shear (this is a new factor that ASD did not use previously)

Adjustment factors are applied for all applicable near edge and spacing conditions.

For example, the capacity in tension corresponding to the anchor group based on worst case anchor “a” in the figure below is evaluated as follows:

ACI: $N_{des} = 4 \bullet \Phi N_n \bullet f_{A,x} \bullet f_{A,y} \bullet f_{R,x} \bullet f_{R,y}$

CSA: $N_{des} = 4 \bullet N_r \bullet f_{A,x} \bullet f_{A,y} \bullet f_{R,x} \bullet f_{R,y}$




Note: designs are for orthogonal anchor bolt patterns and no reduction factor for the diagonally located adjacent anchor is required.

Where anchors are loaded simultaneously in tension and shear, interaction must be considered. The interaction equation is as follows:

ACI: $$\frac{N_{ua}}{N_{des}} + \frac{V_{ua}}{V_{des}} \leq 1.2$$

CSA: $$\frac{N_f}{N_{des}} + \frac{V_f}{V_{des}} \leq 1.2$$

where:

- $N_{ua}$ = Required strength in tension based on factored load combinations of ACI 318 Chapter 5.
- $V_{ua}$ = Required strength in shear based on factored load combinations of ACI 318 Chapter 5.
- $N_f$ = Required strength in tension based on factored load combinations of CSA A23.3 Chapter 8.
- $V_f$ = Required strength in shear based on factored load combinations of CSA A23.3 Chapter 8.

The full tension strength can be permitted if:

$$\text{ACI:} \quad \frac{V_{ua}}{V_{des}} \leq 0.2$$

$$\text{CSA:} \quad \frac{V_{f}}{V_{des}} \leq 0.2$$

The full shear strength can be permitted if:

$$\text{ACI:} \quad \frac{N_{ua}}{N_{des}} \leq 0.2$$

$$\text{CSA:} \quad \frac{N_{f}}{N_{des}} \leq 0.2$$

## ALLOWABLE STRESS DESIGN (ASD)

The values of $N_{des}$ and $V_{des}$ developed from Section 3.1.6 are design strengths (factored resistances) and are to be compared to the required strength in tension and shear from factored load combinations of ACI 318 Chapter 5 or CSA A23.3 Chapter 8.

The design strength (factored resistance) can be converted to an ASD value as follows:

$$N_{des,ASD} = \frac{N_{des}}{\alpha_{ASD}}$$

$$V_{des,ASD} = \frac{V_{des}}{\alpha_{ASD}}$$

where:

$\alpha_{ASD}$ = Conversion factor calculated as a weighted average of the load factors for the controlling load combination.

An example for the calculation of $\alpha_{ASD}$ for ACI is as follows:

Strength design with controlling load combination:
$1.2D + 1.6L < \phi N_n$

Allowable stress design (ASD):
$1.0D + 1.0L < \phi N_n / \alpha_{ASD}$

Therefore, for an equivalent level of safety:
$\alpha_{ASD} = (1.2D + 1.6L) / (1.0D + 1.0L)$

If the dead load contribution is 40% and live load contribution is 60%, you will get:

$\alpha_{ASD} = (1.2 \times 0.4 + 1.6 \times 0.6) / (1.0 \times 0.4 + 1.0 \times 0.6)$

$\alpha_{ASD} = 1.44$

## SEISMIC DESIGN

To determine the seismic design strength (factored resistance) a reduction factor, $\alpha_{seis}$, is applied to the applicable table values. This value of $\alpha_{seis}$ will be in the footnotes of the relevant design tables.

The value of $\alpha_{N,seis}$ for tension is based on 0.75 times a reduction factor determined from testing. The total reduction is footnoted in the tables.

The value of $\alpha_{V,seis}$ for steel failure is based on testing and is typically only applied for shear. There is no additional 0.75 factor. The reduction is footnoted in the tables.

The factored load and associated seismic load combinations that will be compared to the design strength (factored resistance) can be determined from ACI or CSA provisions and national or local code requirements. An additional value for $\phi_{non\text{-}ductile}$ may be needed based on failure mode or ductility of the attached components.

## SUSTAINED LOADS AND OVERHEAD USE

For adhesive anchors only, sustained loading is calculated by multiplying the value of $\Phi N_n$ or $N_r$ by 0.55 and comparing the value to the tension dead load contribution (and any sustained live loads or other loads) of the factored load. Edge, spacing, and concrete thickness influences do not need to be accounted for when evaluating sustained loads.

## ACCURACY OF THE SIMPLIFIED TABLES

Calculations using the Simplified Tables have the potential of providing a design strength (factored resistance) that is exactly what would be calculated using equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

The tables for the single anchor design strength (factored resistance) for concrete / bond / pullout failure or steel failure have the same values that will be computed using the provisions of ACI and CSA.

The load adjustment factors for edge distance influences are based on a single anchor near an edge. The load adjustment factors for spacing are determined from the influence of two adjacent anchors. Each reduction factor is calculated for the minimum value of either concrete or bond failure. When more than one edge distance and/or spacing condition exists, the load adjustment factors are multiplied together. This will result in a conservative design when compared to a full calculation based on ACI or CSA. Additionally, if the failure mode in the single anchor tables is controlled by concrete failure, and the reduction factor is controlled by bond failure, this will also give a conservative value (and vice versa).

The following is a general summary of the accuracy of the simplified tables:

- Single anchor tables have values equivalent to a calculation according to ACI or CSA.
- Since the table values, including load adjustment factors, are calculated using equations that are not linear, linear interpolation is not permitted. Use the smaller of the two table values listed. This provides a conservative value if the application falls between concrete compressive strengths, embedment depths, or spacing, edge distance, and concrete thickness.
- For one anchor near one edge, applying the edge distance factor typically provides accurate values provided the failure mode of the table values is the same. If the failure mode is not the same, the values are conservative.
- For two to four anchors in tension with no edge reductions, applying the spacing factors provides a value that is equivalent to the ACI and CSA calculated values, provided the controlling failure modes of the table values are the same. If the failure mode is not the same, the values are conservative.
- The spacing factor in shear is conservative when compared to two anchors with no edge distance considerations. This factor is based on spacing near an edge and can be conservative for installations away from the edge of the concrete member. Note: for less conservative results, it is possible to use the spacing factor in tension for this application if there is no edge distance to consider.
- The concrete thickness factor in shear is conservative when compared to an anchor with no edge influences. This factor is based on applications near an edge. In the middle of a concrete member this is conservative. Note: for less conservative results, this factor can be ignored if the application is not near an edge.

## IMPORTANT NOTE:

For applications such as a four bolt or six bolt anchor pattern in a corner in a thin slab, the calculation can be up to 80% conservative when compared to a calculation according to ACI or CSA, and when using the PROFIS Engineering. It is always suggested to use the PROFIS Engineering or perform a calculation by hand using the provisions of ACI and CSA to optimize the design. This is especially true when the Simplified Table calculation does not provide a value that satisfies the design requirements. The fact that a Simplified Table calculation does not exceed a design load does not mean the Hilti anchor system will not fulfill the design requirements. Additional assistance can be given by your local Hilti representative.

## LIMITATIONS USING SIMPLIFIED TABLES

There are additional limitations that the Simplified Tables do not consider:

- Load Combinations: Table values are meant to be used with the load combinations of ACI 318 Section 5.3 and CSA A23.3 Chapter 8. Other load combinations from other code sections are not considered.
- Supplementary Reinforcement: Table values, including reduction factors, are based on Condition B which does not consider the effects of supplementary reinforcement, nor is there an influence factor that can be applied to account for supplementary reinforcement.
- Eccentric loading: Currently, there is not a method for applying a factor to the tables to account for eccentric loading.
- Moments or Torsion: While a designer can apply a moment or torsion to the anchor system and obtain a specific load per anchor, the tables themselves do not have specific factors to account for moments or torsion applied to the anchor system.
- Standoff: Standoff is not considered in the steel design tables.
- Anchor layout: The Simplified Tables assume an orthogonal layout with no more than 2 nearby edges.

As stated above, while the Simplified Tables are limited in application, the designer can use the PROFIS Engineering which does account for the conditions noted above.

There may be additional applications not noted above. Contact Hilti with any questions for specific applications.

# 3.1.9 ALLOWABLE STRESS DESIGN (ASD)

## ALLOWABLE STRESS DESIGN (ASD) TERMINOLOGY

$A_{nom}$ = nominal bolt cross sectional area, in.$^2$ (mm$^2$)

$A_{sl}$ = cross sectional area of anchor sleeve, in.$^2$ (mm$^2$)

$A_{st}$ = tensile stress area of threaded part, in.$^2$ (mm$^2$)

c = distance from anchor centerline to the closest free edge of base material, in. (mm)

$c_{cr}$ = critical edge distance, in. (mm)

$c_{min}$ = minimum edge distance, in. (mm)

d = anchor bolt diameter (shank diameter), in. (mm)

$d_{bit}$ = nominal drill bit diameter, in. (mm)

$d_h$ = diameter of clearance hole in attachment (e.g. baseplate), in. (mm)

$d_{nom}$ = nominal anchor diameter, in. (mm)

$d_o$ = anchor outside diameter (O.D.), in. (mm)

$d_w$ = washer diameter, in. (mm)

$f_A$ = adjustment factor for anchor spacing

$f_c$ = concrete compressive strength as measured by testing of cylinders, psi (MPa)

$f'_c$ = specified concrete compressive strength, psi (MPa)

$f_{RN}$ = adjustment factor for edge distance, tension loading

$f_{RV1}$ = adjustment factor for edge distance, shear loading perpendicular and towards free edge

$f_{RV2}$ = adjustment factor for edge distance, shear loading parallel to free edge

$f_{RV3}$ = adjustment factor for edge distance, shear loading perpendicular and away from free edge

$f_y$ = specified reinforcing bar yield strength, psi (MPa)

$F_y$ = specified bolt minimum yield strength, psi (MPa)

$F_u$ = specified bolt minimum ultimate strength, psi (MPa)

h = thickness of member in which anchor is embedded as measured parallel to anchor axis, in. (mm)

$h_{ef}$ = effective anchor embedment depth, in. (mm)

$h_{min}$ = minimum member thickness, in. (mm)

$h_{nom}$ = distance between base material surface and bottom of anchor (prior to setting is applicable), in. (mm)

$h_o$ = depth of full diameter hole in base material, in. (mm)

$\ell$ = anchor embedded length, in. (mm)

$\ell_{th}$ = anchor useable thread length, in. (mm)

$M_{uM,5\%}$ = characteristic flexural resistance of anchor bolt (5% fractile) , in-lb (N·m)

$N_{allow}$ = allowable tension load, lb (kN)

$N_d$ = design tension load (unfactored), lb (kN)

$N_{rec}$ = recommended tension load, lb (kN)

s = anchor axial spacing, in. (mm)

$s_{cr}$ = critical spacing between adjacent loaded anchors, in. (mm)

$s_{min}$ = minimum spacing between adjacent loaded anchors, in. (mm)

S = elastic section modulus of anchor bolt, in.$^3$ (mm$^3$)

$s_W$ = width of anchor nut across flats, in. (mm)

$t_{fix}$ = maximum thickness of attachment (e.g. baseplate) to be fastened, in. (mm)

$T_{inst}$ = recommended anchor installation torque, ft-lb (N·m)

$T_{max}$ = maximum tightening torque, ft-lb (N·m)

$V_{allow}$ = allowable shear load (based on mean value from tests and a global safety factor), lb (kN)

$V_d$ = design shear load (unfactored), lb (kN)

$V_{rec}$ = recommended shear load, lb (kN)

## GENERAL REQUIREMENTS AND RECOMMENDED LOADS

In accordance with the general ASD principles, the design of anchors must satisfy the following conditions:

$N_{service} \leq N_{rec}$
$V_{service} \leq V_{rec}$

whereby $N_{service}$ and $V_{service}$ are the service tension and shear loads resulting from the governing load combinations (i.e. ASCE 7-10) and $N_{rec}$ and $V_{rec}$ are the recommended allowable loads for an anchor or a group of anchors.

The ASD method is currently referenced in masonry-related ICC-ES AC01, AC58, AC60, and AC106.

The recommended allowable loads for an anchor or a group of anchors are obtained as follows:

Tension: $N_{rec} = N_{allow} \cdot f_{RN} \cdot f_A$

Shear: $V_{rec} = V_{allow} \cdot f_{RV} \cdot f_A$

where:

$N_{rec}$ = recommended tension load

$N_{allow}$ = allowable load (based on the mean value from laboratory testing to failure and a global safety factor)

$V_{rec}$ = recommended shear load

$V_{allow}$ = allowable shear load

$f_A$ = adjustment factor for anchor spacing

$f_{RN}$ = adjustment factor for edge distance, tension loading

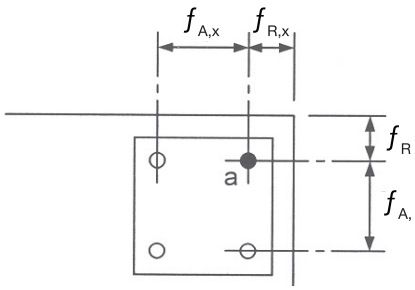
$f_{RV1}$ = adjustment factor for edge distance, shear loading perpendicular and toward free edge

$f_{RV2}$ = adjustment factor for edge distance, shear loading parallel to free edge

$f_{RV3}$ = adjustment factor for edge distance, shear loading perpendicular and away from free edge

Adjustment factors are multiplicative and are applied for all edge and spacing conditions that are less than $c_{cr}$ and $s_{cr}$, respectively.

For example, the recommended tension load corresponding to anchor “a” in the figure below is evaluated as follows:




$F_{rec,a} = F_{allow,a} \cdot f_{Rx} \cdot f_{Ry} \cdot f_{Ax} \cdot f_{Ay}$

Note that no reduction factor for the diagonally located adjacent anchor is required.

## CRITICAL AND MINIMUM SPACING AND EDGE DISTANCE

Spacing adjustment factors are applicable for cases where the anchor spacing is such that:

$s_{min} \le s < s_{cr}$

where:

$s_{min}$ = minimum spacing between loaded anchors; and

$s_{cr}$ = critical spacing between loaded anchors (anchor spacing equal to or greater than the one requiring a reduction factor)

Similarly, for near-edge anchors, the edge distance adjustment factor(s) are applicable for cases where the anchor edge distance is such that:

$$c_{min} \le c < c_{cr}$$

where:

$c_{min}$ = minimum edge distance; and

$c_{cr}$ = critical edge distance (anchor edge distance equal to or greater than the one requiring a reduction factor)

## INTERACTION — ASD

Where anchors are loaded simultaneously in tension and shear, interaction must be considered. The usual form of the interaction equation for anchors is as follows:

$$V_{rec} = \left[\frac{N_d}{N_{rec}}\right]^{\alpha} + \left[\frac{V_d}{V_{rec}}\right]^{\alpha} \le 1.0$$

where:

$N_d$ = design tension load (ASD);

$V_d$ = design shear load (ASD); and

$\alpha$ = exponent, $1 \le \alpha \le 2$

The value used for $\alpha$ corresponds to the type of interaction equation being considered. A value of $\alpha = 1.0$ corresponds to a straight line interaction equation, while a value of $\alpha = 5/3$ corresponds to a parabolic interaction equation.

## SHEAR LOAD WITH LEVER ARM (BOLT BENDING) — ASD

When shear load is applied to a stand-off connection, the anchor bolt is subjected to combined shear and bending, and a separate assessment of the standoff condition is appropriate. In the absence of other guidance, the recommended shear load associated with bolt bending for anchors subjected to shear loads applied at a standoff distance z may be evaluated as follows:

$$V_{rec} = \frac{\alpha_M \cdot M_{uM,5\%}}{1.7 \cdot \ell}$$

where:

$\alpha_M$ = adjustment of bending moment associated with rotational restraint, where $1 \le \alpha_M \le 2$

$V_{rec}$ = recommended shear load corresponding to bending

$M_{uM,5\%}$ = characteristic flexural resistance of a single anchor corresponding to approximately 1/2 degree rotation

$$= 1.2 * S * f_{u,min}\left(1 - \frac{N_d}{N_{rec}}\right)$$

$f_{uta}$ = minimum ultimate tensile strength of anchor

S = elastic section modulus of anchor bolt at concrete surface (a uniform cross section is assumed)

$\ell$ = internal lever arm adjusted for spalling of the surface concrete as follows:

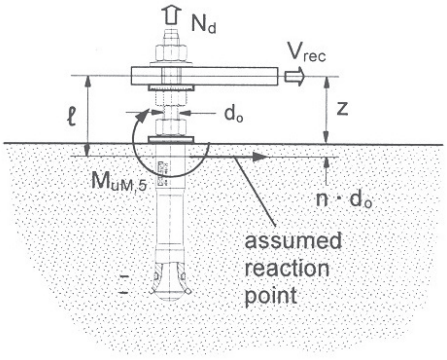
= $z + (n \cdot d_o)$

z = distance from center of base plate to surface of concrete (standoff distance)

$d_0$ = anchor outside diameter at concrete surface

n = 0, for static loading with clamping at the concrete surface as provided by a nut and washer assembly (required for mechanical anchors);

= 0.5, for static loading without clamping at the concrete surface, e.g., adhesive anchor without nut and washer at concrete surface




Determination of bolt bending — ASD

Note that stand-off installations of post-installed mechanical anchors require a nut and bearing washer at the concrete surface as shown above for proper anchor function.

## INCREASE IN CAPACITY FOR SHORT-TERM LOADING — ASD

Some building codes allow a capacity (stress) increase of 1/3 when designing for short-term loading such as wind or seismic. The origin of the 1/3 increase is unclear as it relates to anchor design, but it is generally assumed to address two separate issues: 1) strain-rate effects, whereby the resistance of some materials is increased for transitory stress peaks, and 2) the lower probability of permanent and transitory loads occurring simultaneously.

While Hilti does not include the 1/3 increase in published capacities for anchors in concrete, it is the responsibility of the designer to determine the appropriateness of such a capacity increase under the applicable code.

## 3.1.10 TORQUING AND PRETENSIONING OF ANCHORS

Application of torque is intended to induce a tension force in the anchor bolt. It is therefore important that the torque-tension relationship associated with the anchor nut, washer and threaded anchor element be maintained as close to factory conditions as possible during anchor installation. This is best accomplished by keeping the anchor assembly in its packaging to prevent undue contamination with dust, oil, etc. prior to anchor installation. Note that damage to anchor threads as caused by attempts to re-straighten an anchor after installation, hammer impacts, etc., can significantly alter the torque-tension relationship and result in improper anchor function under load, including failure. Likewise, application of lubricants to the threads may generate excessive pretension loads in the anchor during torquing, which can also result in failure.

There are three possible reasons to apply torque to an anchor bolt in concrete or masonry:

1. To produce a clamping force, therefore eliminating gaps and play within the connected parts. Note that this clamping force is not assumed to be sufficient to permit the shear resistance of the anchorage to be determined on the basis of baseplate friction (i.e., as a slip-critical condition) owing to the relaxation of clamping forces over time.
2. To produce a pretension force in the anchor bolt which is resisted by a corresponding pre-compression in the base material (concrete or masonry). Pretension force serves to reduce anchor displacements under service load and may also serve to reduce the fatigue effects of cyclic loading.
3. To verify the anchorage will hold the tensile preload generated by the recommended torque. This helps reduce the likelihood of a grossly misinstalled anchor and/or completely unsuitable base material.

Anchor pretensioning forces dissipate over time due to relaxation in the concrete and, to a lesser degree, in the bolt threads. Re-torquing anchors can result in a higher level of residual prestress.

Anchor pretensioning should not be counted on for cases where cracking of the concrete may occur (i.e., earthquake loading).

## 3.1.11 DESIGN OF ANCHORS FOR FATIGUE

The design of structural elements to resist fatigue loading can have a significant effect on the connection design. The reader is referred to relevant standards for additional information on this subject. Design of anchors for fatigue should consider the following points:

1. The application of preload to prevent stress fluctuations in the anchor rod element may be complicated by gradual loss of preload over time, particularly in cases where cracking in the base material may occur, and the fact that many anchor designs do not provide sufficient gauge length to permit the development of a meaningful degree of preload strain.
2. Design of anchor groups for fatigue is often far more critical than the design of a single anchor due to the unequal distribution of loads. Load distribution is affected by anchor slip as well as by the degree of annular gap between the anchor and the baseplate and the specific location of the anchor with respect to the hole in the baseplate. It is therefore recommended that where anchor groups are to be subjected to significant fatigue loading, the annular gap between the anchors and the baseplate be eliminated through the use of weld washers, grout, or other means.
3. Secondary flexural stresses as generated by eccentricities or gaps in the connection may be critical to the fatigue behavior of the anchor.

## 3.1.12 DESIGN OF ANCHORS FOR FIRE

Building codes are generally silent on the need to design anchors specifically for fire conditions. It may be assumed, however, that structural connections to concrete or masonry involving sustained dead and live loads should be protected for fire exposure in the same manner as other structural steel elements, i.e., through the use of appropriate fireproofing materials, concrete cover, etc.

In some cases, it may be necessary to ascertain the length of time over which unprotected anchorages will survive fire exposure. The design of anchors for fire conditions is predicated on the availability of test data for the performance of anchors subjected to a standardized time-temperature curve (e.g., ASTM E 119, ISO 834) while under load.

## 3.1.13 DESIGN OF POST-INSTALLED REINFORCING BAR CONNECTIONS

Previous to this section, design of post-installed threaded rod and rebar have followed the anchoring provisions of ACI 318 Chapter 17 and CSA A23.3 Annex D. Another common and long-standing application of anchoring adhesives is the installation of deformed reinforcing bars in holes drilled in concrete to emulate the behavior of cast-in-place reinforcing bars.

This section is a supplement to the Hilti North America Post-Installed Reinforcing Bar Guide and is an alternative to considering the post-installed rebar as an "anchor". Refer to the Guide for a comprehensive description of post-installed reinforcing bar design with Hilti adhesive anchor systems. Contact Hilti Technical Services with questions.

Adhesive anchor systems are qualified in accordance with ICC-ES Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements (AC308). Hilti HIT-RE 500 V3 and HIT-HY 200 V3 adhesives are recognized for use with post-installed reinforcing bars in ICC-ES Evaluation Service Reports ESR-3814 and ESR-4868. Based on these recognitions, reinforcing bars installed with HIT-RE 500 V3 and HIT-HY 200 V3 may now be designed using two methods:

1. Development and splice length provisions in ACI 318 (Chapters 18 and 25) and CSA A23.3 (Chapters 12 and 21)
2. Anchoring to concrete provisions in ACI 318 Chapter 17 and CSA A23.3 Annex D.

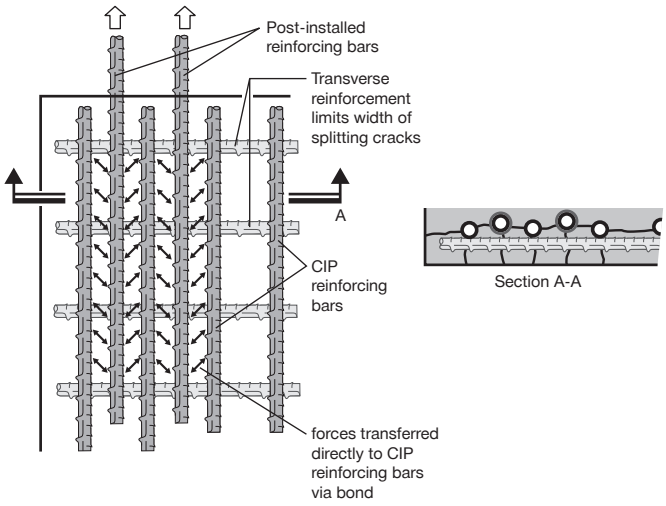
Within this section, development and splice lengths are provided according to ACI 318 Chapter 25 and CSA A23.3 Chapter 12 calculations (see item 1 above). In addition, embedment depths provided for anchorage calculations correspond to development of reinforcing bars following an approach outlined in a paper published in the ACI Structural Journal (see item 2 above).

Post-installed reinforcing bar installations in accordance with ACI 318 and CSA A23.3 can also be designed using Hilti's PROFIS Anchor and PROFIS Rebar software. You can access PROFIS Anchor and PROFIS Rebar at www.hilti.com.

### DEVELOPMENT AND SPLICING USING ACI 318 CHAPTER 25 PROVISIONS

ACI 318 Chapter 25 contains provisions for reinforcing bar development and splice lengths in non-seismic applications. Development lengths are assumed to preclude concrete

concrete splitting and reinforcing bar pullout failure prior to "development" (attainment) of bar yield stress. Although the term "lap splice" implies direct transfer of stress from bar to bar, forces between bars are transferred via struts and hoop stresses in the concrete. The ICC-ES acceptance criteria for adhesive anchors in concrete, AC308, now includes procedures and requirements for the recognition of post-installed designed reinforcing using the development length provisions of ACI 318 Chapters 18 and 25. Hilti HIT-RE 500 V3 and HIT-HY 200 V3 are recognized in ICC-ES ESR-3814 and ESR-4868, respectively, for this purpose.




Splicing of post-installed reinforcing bars

### Tension development length: ACI 318 25.4.2.3

Under the conditions given in ESR-3814 and ESR-4868 as revised in July 2015, design of post-installed reinforcing bars with HIT-RE 500 V3 and HIT-HY 200 V3, respectively, may be performed using the applicable provisions of ACI 318 Chapters 18 and 25. The basic expression for tension development length in Chapter 25 is provided in the following equation as:

$$\ell_d = \left[ \frac{3}{40\lambda} \frac{f_y}{\sqrt{f'_c}} \frac{\psi_t \psi_e \psi_s}{\frac{c_b + K_{tr}}{d_b}} \right] d_b$$

where the confinement term $(c_b + K_{tr})/d_b$ shall not be taken as greater than 2.5 and the design value of $\ell_d$ shall not be less than 12 inches per 25.4.2.1.

**Note:** Because the "top bar" factor, $\psi_t$, accounts for bar position effects in freshly poured concrete, it may be neglected for the drilled-in portion of post-installed bars. $\psi_t$ must be applied where applicable for the freshly cast-in portion of new bars and for the spliced portions of existing cast-in-place bars.

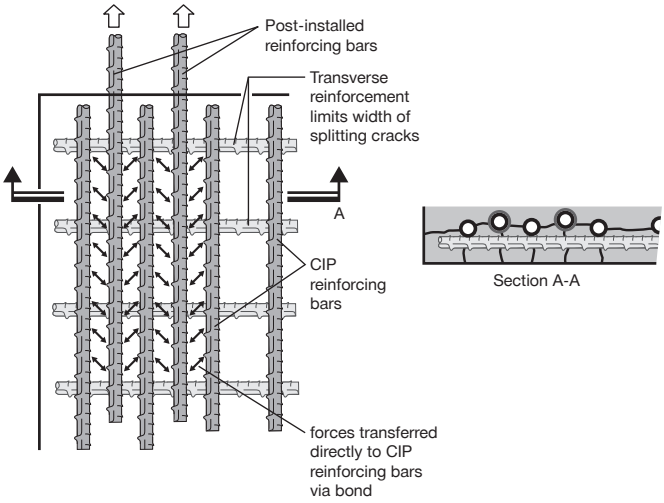
### Tension lap splices: ACI 318 25.5.2

A Class B splice taken as the greater of $1.3\ell_d$ and 12 inches is required in all cases unless 1) the area of reinforcement provided is at least twice that determined by analysis over the entire length of the splice and 2) one-half or less of the total reinforcement is spliced within the lap length. Where 1) and 2) are satisfied, a Class A splice taken as the greater of $1.0\ell$ and 12 inches may be used.

Table 89 in Sec. 3.2.3, and Table 83 in Sec. 3.2.4 provide a summary of calculated development and splice lengths for a range of concrete strengths for HIT-HY 200 V3 and HIT-RE 500 V3 for the specific case where the confinement term $(c_b + K_{tr})/d_b$ has been taken as the maximum value of 2.5. Refer to Chapter 6 of the Post-Installed Reinforcing Bar Guide and ESRs for additional design information relating to development length and lap splices.

## DEVELOPMENT AND SPLICING USING CSA A23.3 CHAPTER 12 PROVISIONS

CSA A23.3 Chapter 12 contains provisions for reinforcing bar development and splice lengths in non-seismic applications analogous to those of ACI 318. While not formally recognized in ICC-ES ESRs, Hilti HIT-RE 500 V3
and HIT-HY 200 V3 is commonly used with the provisions of CSA A23.3 based on the testing performed in accordance with ICC-ES AC308. As with the design for ACI 318 Chapter 25, design of post-installed reinforcing bars with HIT-RE 500 V3 and HIT-HY 200 V3 may be performed equivalently to cast-in reinforcing bars using the applicable equations in CSA A23.3. The basic expression for tension development length is provided in the equation as follows:




Splicing of post-installed reinforcing bars

### Tension development length: CSA A23.3 12.2.2 EQ 12-1

$$\ell_d = 1.15 \frac{k_1 k_2 k_3 k_4}{(d_{cs} + k_{tr})} \frac{f_y}{\sqrt{f'_c}} A_b$$

where the confinement term $(d_{cs} + K_{tr})$ shall not be taken greater than 2.5 and the design value of $\ell_d$ shall not be less than 300 mm per 12.2.1.

**Note:** Because the "top bar" factor, $k_1$, accounts for bar position effects in freshly poured concrete, it may be neglected for the drilled-in portion of post-installed bars. $k_1$ must be applied where applicable for the freshly cast-in portion of new bars and for the spliced portions of existing cast-in-place reinforcement.

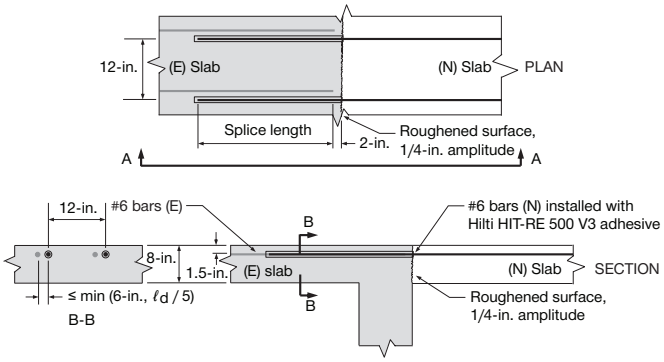
### Tension lap splices: CSA A23.3 12.15.1

A Class B splice taken as the greater of $1.3\ell_d$ and 300 mm is required in all cases unless 1) the area of reinforcement provided is at least twice that determined by analysis over the entire length of the splice and 2) one-half or less of the total reinforcement is spliced within the lap length. Where 1) and 2) are satisfied, a Class A splice taken as the greater of $1.0\ell_d$ and 300 mm may be used.

Table 94 in Sec. 3.2.3, and Table 88 in Sec. 3.2.4 provides a summary of development and splice lengths for a range of concrete strengths for HIT-HY 200 V3 and HIT-RE 500 V3 according to CSA provisions for the specific case where the confinement term ($d_{cs}$ +$K_{tr}$) has been taken as the maximum value of 2.5$d_b$. Refer to Chapter 6 of the Post- Installed Reinforcing Bar Guide and ESRs for additional design information relating to development length and lap splices.

### Design example — development lengths for negative reinforcement slab extension

Requirement: Establish the embedment for post-installed reinforcing bars for a slab extension as shown in the figure below.




New-to-existing slab connection

**Step 1: Parameters**

| | |
|---|---|
| Existing construction | (E) slab, 8-inch thick, 4000 psi normal weight concrete, Gr. 60 reinforcement, #6 bars at 12-inch on-center spacing. Note: other detailing not shown. |
| New construction | (N) slab, 8-inch thick, 5000 psi normal weight concrete, Gr. 60 reinforcement, #6 bars at 12-inch on-center spacing. |

**Step 2: Determine the development length for a Class B splice**

Assuming $K_{tr}$ is equal to zero (i.e., no transverse reinforcing present to restrain splitting), with 12−inch spacing and 1.5−inch cover, $c_b$ = (1.5 + 0.625/2) = 1.875 inches and ($c_b$ + $K_{tr}$)/$d_b$ = (1.875 + 0)/0.625 = 2.5. With ($c_b$ + $K_{tr}$)/$d_b$ ≥ 2.5 and less than 12 inches of concrete in the slab member installed below existing bars, Table 89 in Sec. 3.2.4, applies to both existing and new reinforcement. From Table 83 in Sec. 3.2.4, the Class B splice length of a #6 bar in 4000 psi concrete is 22 inches.

Per ACI 318 25.5.1.3, the distance between a post-installed reinforcing bar and an existing cast-in-place reinforcing bar to which the post-installed bar is spliced shall be no greater than the lesser of 6 in. and one-fifth of the development length. For this example 22/5 = 4.5 in.

**Step 3: Specification**

Install #6 Gr. 60 reinforcing bars at 12 inches on center with a minimum 24-inch embedment (22-inch splice plus 2-inch end cover) using Hilti HIT-RE 500 V3 as shown in the figure above. Locate post-installed bars within 4-1/2 in. of existing bars to be spliced. Install in accordance with Hilti Instructions for Use. Do not damage existing reinforcing. Roughen interface to 1/4-inch amplitude prior to placement of post-installed bars.

**Note:** ACI 318 and ICC Evaluation Service Reports refer to the manufacturer instructions for use as the Manufacturer's Published Installation Instructions (MPII).

## DEVELOPMENT OF POST-INSTALLED REINFORCING BARS BASED ON ACI 318 CHAPTER 17 AND CSA A23.3 ANNEX D ANCHORAGE PROVISIONS

ACI 318 Chapter 17 and CSA A23.3 Annex D contain design provisions for the determination of the tensile strength of post-installed adhesive anchors in concrete, whereby the strength is taken as the minimum of the resistances corresponding to steel rupture, concrete breakout, and bond failure at the adhesive-to-concrete interface. Since the establishment of development length is based on the assumption of the attainment of a minimum strength corresponding to yield of the bar, the design equations for anchorage can also be applied to this problem. Within the May-June 2013 issue of the ACI Structural Journal, “Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures” by Charney, Pal and Silva provides a methodology for establishing the bar embedment to develop the bar using the concepts of anchorage contained in ACI 318 Chapter 17. This methodology is similarly applicable to CSA A23.3 Annex D.

**Note:** This procedure is not addressed in ACI 318 or in CSA A23.3. As stated in Charney, et al., the assumptions made to ensure bar yield are a matter of judgment and may require unique determination for specific applications and conditions. For specific cases, contact Hilti.

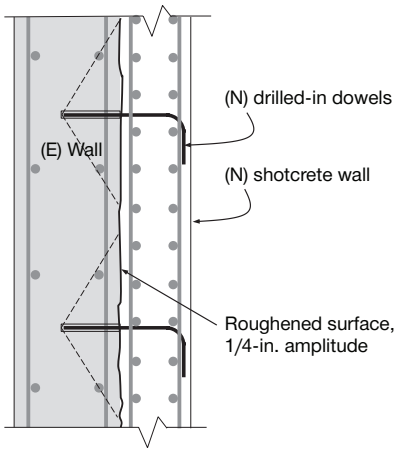
The use of bond values corresponding to the assumption of uncracked vs. cracked concrete for the design of reinforcing bar embedment is a matter of judgment. The ACI 318 Chapter 25 development length provisions do not explicitly consider reduction of bond corresponding to cracking of the concrete that may arise in conjunction with structure loading, shrinkage, etc. Furthermore, while the development length provisions of the code appear to consider only the nominal yield strength of the bar, it may be prudent to provide sufficient embedment to develop the actual bar yield, generally assumed to be 125% of the nominal value. Tables 90 and 95 in Sec. 3.2.3, and Tables 84 and 89 in Sec. 3.2.4 provide calculated embedments to develop Gr. 60 rebar based on the application of anchor

theory. For the development of these Tables, the strengths corresponding to the applicable limit states for single bars in tension for non-seismic applications (i.e., SDC A and B) in ACI 318 Chapter 17 are taken as follows:

$N_{steel} = A_b\,(1.25\,f_y)$

$N_{breakout} = \phi_c k_{c,uncr} \sqrt{f'_c}\, h_{ef,breakout}^{1.5}$

$N_{bond} = \phi_b \tau_{k,cr/uncr}\, \pi d_b h_{ef,bond}$




Section through a shotcrete onlay wall with post-installed dowels designed using anchor provisions whereby the concrete breakout and bond strengths with reduction factors applied are each set equal to the assumed bar yield strength. In CSA calculations, R for breakout and bond calculations is conservatively assumed to equal 1.0. The resulting expressions are solved for $h_{ef}$ as follows:

As governed by single-bar concrete breakout strength:

$A_b 1.25 f_y = \phi_c k_{c,uncr} \sqrt{f'_c}\, h_{ef,breakout}^{1.5}$ yields

$$h_{ef,breakout} = \left( \frac{A_b\,(1.25\,f_y)}{\phi_c k_{c,uncr} \sqrt{f'_c}} \right)^{2/3}$$

with minimum $c_a$ and s intended to preclude edge and spacing effects.

As governed by single-bar bond strength:

$A_{se,N} 1.25 f_y = \phi_b \tau_{k,uncr} \pi d_b h_{ef,bond}$ yields

$$h_{ef,bond} = \frac{A_b\,(1.25\,f_y)}{\phi_b \tau_{k,uncr} \pi d_a}$$

with minimum $c_a$ and s intended to preclude edge and spacing effects.

The controlling embedment (in this case, the larger value of $h_{ef,breakout}$ and $h_{ef,bond}$), is reported in the table together with the accompanying edge distances and spacing values.

**Note:** ACI 318 17.3.2.3 states: "For adhesive anchors with embedment depths $4d_a \le h_{ef} \le 20d_a$ the bond strength requirements shall be considered satisfied by the design procedure of 17.4.5." In accordance with 17.3.2.3, ESR-3814 and ESR-4868 limit anchorage embedment depths to this range of values. These requirements recognize the limits of the uniform bond model adopted by ACI. Anchorage embedments published in the Hilti North American Product Technical Guide are based on assumptions that are intended to achieve development of the nominal yield stress in reinforcing bars. In some cases, the recommended bar embedment exceeds, by an acceptable margin, the 20 bar diameter limit established in ACI 318 Chapter 17 for the applicability of the uniform bond model. It is Hilti's view that the conservatism of the underlying assumptions, taken in aggregate, is sufficient to offset any reduction in the effective bond stress associated with these bond lengths. The designer may elect to employ alternate design assumptions for bar development based on the specific conditions for a given design.

**Spacing:** To account for the influence of nearby bars on the concrete resistance (breakout/bond failure), minimum spacing is calculated as the greater of $20d_b\,(\tau_{k,uncr}/1100\text{ psi})^{0.5}$ and $3h_{ef,breakout}$

**Edge distance:** To account for the effect of edge distance on the concrete resistance, minimum edge distance is calculated as the greater of $10d_b\,(\tau_{k,uncr}/1100\text{ psi})^{0.5}$ and $1.5h_{ef,breakout}$.

In addition, for uncracked concrete, the minimum edge distance may be governed by the value of $c_{ac}$, the critical edge distance for splitting failure where the design assumes uncracked concrete and where there is no reinforcing to control splitting cracks.

In this case, the value of $c_{ac}$ is taken as:

$$c_{ac} = h_{ef} \left( \frac{\tau_{k,uncr}}{1160} \right)^{0.4} \quad 3.1 - 0.7 \frac{h}{h_{ef}}$$

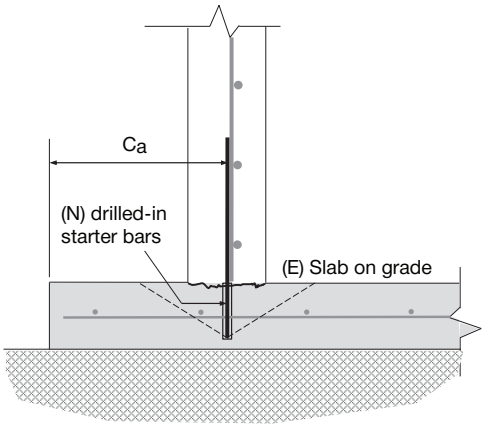
where $\frac{h}{h_{ef}} \le 2.4$ and

$\tau_{k,uncr}$ is the characteristic bond strength stated in the Evaluation Service Report and cannot be taken as larger than:

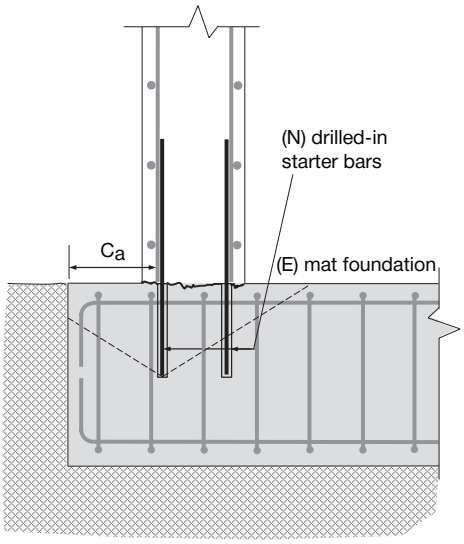
$$\tau_{k,uncr} = \frac{k_{c,uncr} \sqrt{h_{ef}\, f'_c}}{\pi \cdot d}$$

The application of $c_{ac}$ to post-installed reinforcing bars in uncracked concrete is advisable where the EOR determines that splitting will be critical for the behavior of the connection at ultimate loads. The figure below represents two possible extremes for the calculation of edge distance. Condition I illustrates a bar anchored in a relatively thin and lightly reinforced slab. In this case, splitting is likely to be critical and the application of $c_{ac}$ as calculated in the equation above is advisable. At the other extreme, Condition II is represented by bars embedded in a heavily reinforced foundation where the ratio of h to $h_{ef}$ is large as judged by the EOR. In Condition II, splitting is unlikely to control the behavior and the $c_{ac}$ term may be neglected. In all cases, proper judgment based on the loading and geometry of the connection should be applied.

**Note:** Tables 90 and 95 in Sec. 3.2.3, and Tables 84 and 89 in Sec. 3.2.4 provide suggested embedment depths, edge distances, and spacing values for the development of Grade 60 reinforcing bars. Bond strengths have not been reduced for seismic loading and a bar overstrength factor of 125% of nominal yield has been applied in the determination of the values provided. Bond strengths include reductions for sustained tension loading as provided in the applicable evaluation reports; however, no additional reduction in accordance with ACI 318 17.3.1.2 has been included. Where bars are used to resist sustained tension loading, increases in the tabulated embedment values may be appropriate. Consult Hilti Technical Services for further information.




Condition I: thin member, light or no reinforcing




Condition II: thick member, heavily reinforcing
Considerations for determination of minimum edge distance

## DEVELOPMENT OF POST-INSTALLED WALL/ COLUMN STARTER BARS IN A LINEAR ARRAY BASED ON ACI 318 CHAPTER 17 AND CSA A23.3 ANNEX D ANCHORAGE PROVISIONS

**Note:** This procedure is not addressed in ACI 318 or in CSA A23.3. For additional information see May-June 2013 issue of the ACI Structural Journal, "Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures" by Charney, Pal and Silva. As addressed in this study, the assumptions made to ensure bar yield are a matter of judgment and may require unique determination for specific applications and conditions. For specific cases, contact Hilti.

In Tables 91 through 93 and 96 through 98 in Sec. 3.2.3, and Tables 85 through 87 and 90 through 92 in Sec. 3.2.4, the expressions presented in the study have been expanded to include the effects of set spacing of starter bars in a linear array at set spacings. To produce these tables $A_{Nc}$ is defined by ACI 318, 17.4.2.1 and Fig. R17.4.2.1 (CSA A23.3 D.6.2.1 and Fig. D.7). $A_{Na}$ is defined by ACI 318, 17.4.5.1 and Fig. R17.4.5.1 (CSA A23.3 D.6.5.1 and Fig. D.11). $A_{Nco}$ and $A_{Nao}$ are defined by Equations (17.4.2.1c) and (17.4.5.1c) (CSA Equations (D.5) and (D.22)), respectively. Inclusion of these terms permits the effects of edge distance to be considered on the concrete breakout and bond strengths. Using the relationships above, the equations below for $h_{ef}$ for both breakout and bond can be found, the larger of which is taken as the final embedment depth.

$$N_{steel,m} = n_{bars} A_b (1.25 f_y)$$

$$N_{breakout,m} = \left(\frac{A_{Nc}}{A_{Nco}}\right) \phi_c k_{c,uncr} \sqrt{f'_c}\ h_{ef,breakout}^{1.5}$$

$$N_{bond,m} = \frac{A_{Na}}{A_{Nao}}\ \phi_b \tau_{k,uncr}\ \pi d_b h_{ef,bond}$$

whereby the concrete breakout and bond strengths with reduction factors applied are each set equal to the assumed bar yield strength and the resulting expressions are solved for $h_{ef}$ as follows: As governed by multiple-bar breakout strength:

$$h_{ef,breakout} = \left( \frac{1}{\phi_c} \frac{A_{Nco}}{A_{Nc}} \frac{n_{bars} A_b (1.25 f_y)}{k_{c,uncr} f'_c} \right)^{2/3}$$

with minimum $c_a$ intended to preclude edge effects.

**Note:** The term ($A_{Nco}$ / $A_{Nc}$) depends on $h_{ef}$. For this reason, the calculation of $h_{ef}$ using the equation above may require iteration.

As governed by multiple-bar bond strength:

$$h_{ef,bond,m} = \frac{1}{\phi_b} \frac{A_{Nao}}{A_{Na}} \frac{n_{bars} A_b (1.25 f_y)}{\tau_{k,uncr} \pi d_a}$$

with minimum $c_a$ intended to preclude edge effects.

In Equations (6) and (7), $\left(\frac{A_{Nco} \cdot n_{bars}}{A_{Nc}}\right)$ and $\left(\frac{A_{Nao} \cdot n_{bars}}{A_{Na}}\right)$ shall not be taken as less than 1.0.

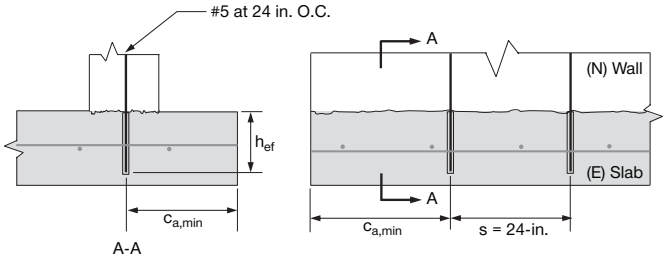
**Note:** Anchorage embedments published in the Hilti North American Product Technical Guide are based on assumptions that are intended to achieve development of 125% of the nominal yield stress in reinforcing bars. In some cases, the recommended bar embedment exceeds the 20 bar diameter limit established in ACI 318 Chapter 17 for the applicability of the uniform bond model. It is Hilti's view that the conservatism of the underlying assumptions, taken in aggregate, is sufficient to offset any reduction in the effective bond stress associated with these bond lengths. The designer may elect to employ alternate design assumptions for bar development based on the specific conditions for a given design.

**Edge distance:** To account for the effect of edge distance on the concrete resistance, minimum edge distance is calculated as the greater of $10d_b (\tau_{k,uncr} / 1100 \text{ psi})^{0.5}$ and $1.5h_{ef,breakout}$. In addition, for uncracked concrete, the minimum edge distance may be governed by the value of $c_{ac}$, the critical edge distance for splitting failure, where the design assumes uncracked concrete and there is no reinforcing to control splitting cracks.

**General assumptions:** Embedment depths in Tables 91 through 93 and 96 through 98 in Sec. 3.2.3, and Tables 85 through 87 and 90 through 92 in Sec. 3.2.4,are predicated on the assumptions that 1) edge distances are no less than $c_{Na}$ and $c_{ac}$ as defined by ACI 318 Chapter 17 and AC308, respectively, 2) all bars in the group are loaded equally, 3) uncracked concrete conditions apply, 4) that orthogonal bars are spaced far enough way to preclude edge and spacing effects, 5) bars are NOT subject to sustained tension, and 6) that the number of bars in a linear array, $n_{bars}$, is equal to 10.

**Note:** Tables 91 through 93 and 96 through 98 in Sec. 3.2.3, and Tables 85 through 87 and 90 through 92 in Sec. 3.2.4, provide calculated embedment depths, edge distances, and spacing values corresponding to the stated assumptions that are intended to develop 125% of nominal yield in Grade 60 reinforcing bars under non-earthquake conditions (i.e., SDC A and B). The use of other assumptions (e.g., bond values corresponding to cracked concrete or seismic loading, omission of the bar overstrength multiplier, etc.) will result in different embedment depths, spacings, and edge distances that may be appropriate for specific design conditions. Consult Hilti Technical Services for further information.

**Design example —** development of wall-to-slab starter bars in linear 24-inch-on-center array using anchor theory Requirement: Provide post-installed starter bars for a new wall on an existing lightly reinforced slab-on-grade as shown in the figure below installed with HIT-RE 500-V3. Analysis indicates that there will be no cracking during service loading and no sustained tensile loads on the reinforcing bars.




Section views of wall-to-slab starter bars

**Step 1: Establish requirements for the new bars**

| | |
|---|---|
| Existing construction | (E) 12-inch thick foundation,6000 psi normal weight concrete, Gr. 60 reinforcement. |
| New construction | (N) 10-inch wide wall as shown, 5000 psi normal weight concrete, Gr. 60 reinforcement, #5 bars at 24−inch on-center spacing. |

**Step 2: Determine the development length for the wall starter bars using anchor theory**

From Table 85 in Sec. 3.2.4, a #5 bar with $f'_c$ = 6000 psi produces $h_{ef}$ = 9 inches with $c_a \geq 25$ inches.

**Step 3: Specification**

Gr. 60 #5 reinforcing bars installed at an 9-inch embedment with Hilti HIT-RE 500 V3 at 24-inch O.C. no less than 25 inches from all edges. Install per Hilti Instructions for Use. Do not damage existing reinforcing. Roughen interface to 1/4-inch amplitude prior to placement of post-installed bars.

**Note:** ACI 318 and ICC Evaluation Service Reports refer to the manufacturer instructions for use as the Manufacturer's Published Installation Instructions (MPII).

# 3.2 ADHESIVE ANCHORING SYSTEMS

## 3.2.1 ADHESIVE ANCHORING SYSTEMS OVERVIEW

### HILTI LEADS THE WAY WITH PRODUCTS AND EDUCATION

Hilti leads the way in sharing knowledge and experience by educating users on various aspects of Hilti adhesive anchoring systems. We know the importance of selecting the right adhesive anchor system for a specific application.

When comparing two adhesive anchor systems, users should give special consideration to the following key parameters:

- Moisture condition of the base material
- Allowable or preferred drilling method
- Base material condition (e.g. cracked concrete)
- Cure time
- Installation procedure
- Bond strength
- Temperature sensitivity
- Creep resistance
- Inspection requirements

### FREQUENTLY ASKED QUESTIONS

**What is creep?**

Creep is the slow and continuous deformation of a material over time. All materials experience some sort of creep - concrete, steel, stone and adhesive anchor systems. In general, small deformations due to a constant sustained load are typical and creep is only problematic when excessive deformations occur.

- All current Hilti adhesive anchor systems passed the creep test requirements of either ICC-ES AC308 or ICC-ES AC58.

**Does temperature have an effect on adhesive anchor performance?**

Yes, temperature affects an adhesive anchor system throughout its lifetime - from storage to installation and throughout the life cycle of an anchor.

- Temperature is an important factor which influences an adhesive anchor system's strength, cure time, ease of installation and creep performance. Some adhesive anchoring systems are engineered for colder climates and others for warmer climates. High temperatures tend to soften adhesive materials, while cold temperatures might prevent a full cure of the adhesive. Both situations might lead to a reduction in bond strength. Each product will have a different low and high temperature threshold at installation and throughout the service life of the anchor.

**How does installation affect adhesive anchors?**

Proper installation is the single most user-influenced factor when it comes to an adhesive anchor system's bond strength and performance.

- Hilti is the only manufacturer that provides the entire solution from drilling and cleaning the hole to injecting adhesive into boreholes as deep as 125-in.

**What are ICC-ES AC58 and ICC-ES AC308?**

ICC-ES AC58 is an acceptance criteria published in 1995 used for evaluating adhesive anchor systems in concrete and masonry base materials. In 2005, ICC-ES AC308 was published for adhesive anchors in concrete, and ICC-ES AC58 was changed to only address masonry base materials. In general, AC308 improved the testing and assessment of adhesive anchor systems in concrete based on research on the behavior of these systems. AC58 is still the state-of-the-art with respect to adhesive anchor systems in masonry.

Hilti has maintained their focus on evaluating adhesive anchor systems to the highest standards. As such, Hilti maintains ICC-ES evaluation reports for adhesive anchors in concrete according to AC308 and in masonry according to AC58.

## HILTI ADHESIVE ANCHORING SYSTEMS

To address the various conditions found on today's construction projects, Hilti offers the most complete selection of adhesive anchoring products. We call it the HIT Portfolio. No matter what application you have on the jobsite, Hilti has a product for you.

Every product in the HIT Portfolio was developed using the same stringent standards and is backed by the experience of the company that brought cartridge adhesive anchor systems to the world...Hilti.

| Adhesive anchors | Approved base materials | | Drilling Method |
|---|---|---|---|
| **HIT-HY 200 A/R V3 FAST CURE**<br>**Ultimate performance hybrid mortar for rebar connections and heavy anchoring**<br>  | Uncracked concrete<br>Cracked concrete<br>Grout filled masonry | Seismic, ICC ES, NSF | SAFE-SET<br>  |
| **HIT-RE 500 V3 SLOW CURE**<br>**Ultimate performance epoxy mortar for rebar connections and heavy anchoring**<br>  | Uncracked concrete<br>Cracked concrete | Seismic, ICC ES, NSF | SAFE-SET<br>  |
| **HIT-HY 100 FAST CURE**<br>**Premium hybrid mortar for anchoring in concrete and rebar connections**<br>  | Uncracked concrete<br>Cracked concrete<br>Grout filled masonry | Seismic, ICC ES, IAPMO MEMBER, NSF | SAFE-SET<br>  |
| **HIT-RE 100 SLOW CURE**<br>**Premium epoxy mortar for anchoring and rebar connections in concrete**<br>  | Uncracked concrete<br>Cracked concrete | Seismic, ICC ES, NSF | SAFE-SET<br>  |
| **HIT-HY 270 FAST CURE**<br>**The ideal adhesive anchor designed for virtually all masonry**<br>  | Grout filled block<br>Hollow block<br>Brick<br>Multi-wythe brick | Seismic[1], ICC ES | SAFE-SET<br>  |
| **HIT-HY 10+ FAST CURE**<br>**Economical injectable hybrid mortar for medium-duty fastenings in uncracked concrete and masonry**<br>  | Concrete<br>Grout filled block<br>Hollow block<br>Brick | |  |
| **HIT-ICE ADHESIVE**<br>**Special mortar for low temperature fastening in concrete**<br>  | Uncracked concrete<br>Cracked concrete<br>Grout filled block | | SAFE-SET<br>  |

1 Seismic approval only for grout filled block and multi-wythe brick
2 Must be used with HIT-Z Anchor Rod
3 Approved for diamond drilling in cracked concrete with the use of a TE-YRT roughening tool and in uncracked concrete without the roughening tool
4 Diamond drilling in cracked concrete requires the use of a TE-YRT roughening tool

# INTRODUCING HILTI SAFESET™ TECHNOLOGY

**Reliably set anchors and rebar in cracked and uncracked concrete and grout filled masonry**

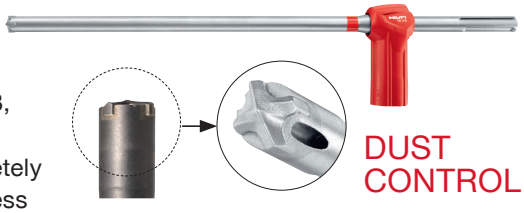
## NO CLEANING REQUIRED



**HIT-Z Anchor Rods**

The new Hilti HIT-Z Anchor Rod with its cone-shaped helix works as a torque-controlled bonded anchor. This means that because of their shape, HIT-Z Anchor Rods are not affected by uncleaned, hammer-drilled holes in dry or water saturated concrete in base materials above 41°F (5°C) when used with HIT-HY 200 A/R V3. The benefits are clear: fewer steps and extremely high reliability in anchoring applications.

## HOLES THAT CLEAN THEMSELVES




**Hollow Drill Bits**

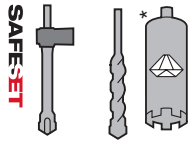
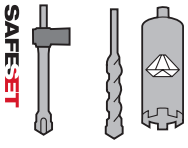
Hilti TE-CD and TE-YD Hollow Drill Bits, in conjunction with HIT-HY 200 A/R V3, HIT-RE 500 V3, HIT-HY 100, HIT-RE 100, HIT-HY 270, and HIT-ICE and the Hilti VC 150 series or the VC 300 vacuums, make subsequent hole cleaning completely unnecessary. Dust is removed by the Vacuum System while drilling is in progress for more reliability and a virtually dustless working environment.

## CORE DRILLED HOLES IN CRACKED CONCRETE



**Roughening Tool**

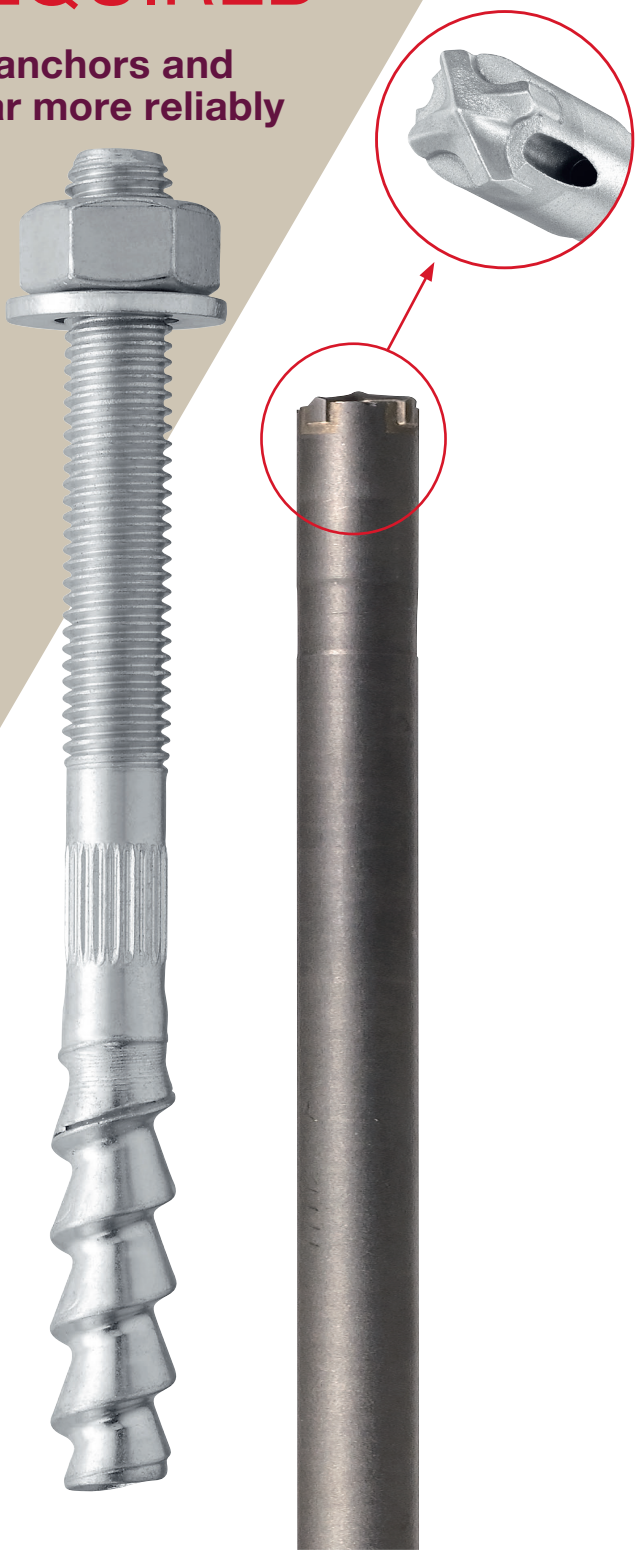
Hilti HIT-RE 500 V3 with the TE-YRT roughening tool in addition to the HIT-HY 200 A/R V3 adhesive with the HIT-Z rod are the only ICC-ES approved systems in cracked concrete to make installation in core drilled holes easier, more productive, and greater reliability.

| | Fast cure portfolio | | | Slow cure portfolio | | Masonry |
|---|---|---|---|---|---|---|
| | HIT-HY 200 A/R V3 | HIT-HY 100 | HIT-ICE | HIT-RE 500 V3 | HIT-RE 100 | HIT-HY 270 |
| |  |  |  |  |  |  |
| **Proven performance** | | | | | | |
| **ICC-ES/IAMPO Evaluation Report** | ESR-4868, ESR-4878 | ESR-3574 ES 547 | N/A | ESR-3814 | ESR-3829 | ESR 4143, ESR 4144 |
| **Base material** | Uncracked concrete, cracked concrete, Grout-filled CMU | Uncracked concrete, cracked concrete, Grout-filled CMU | Uncracked concrete, cracked concrete, Grout-filled CMU | Uncracked concrete, cracked concrete | Uncracked concrete, cracked concrete | All masonry |
| **Recommended application** | Anchor and rebar | Day-to-day anchor and rebar | Low temperature applications | Anchor and rebar | Day-to-day anchor and rebar | All anchoring and rebar in masonry |
| **Gel time at 72˚F** | HY-200-A V3: 4 min<br>HY-200-R V3: 9 min | 5 min | 2.5 min | 25 min | 30 min | 2 min |
| **Cure time at 72˚F** | HY-200-A V3: 30 min<br>HY-200-R V3: 60 min | 30 min | 45 min | 6.5 hours | 12 hours | 30 min |
| **Drilling method** |  |  |  |  |  |  |

*Diamond coring is an approved drilling method when used with the HIT-Z rod.

# NO MANUAL HOLE CLEANING REQUIRED

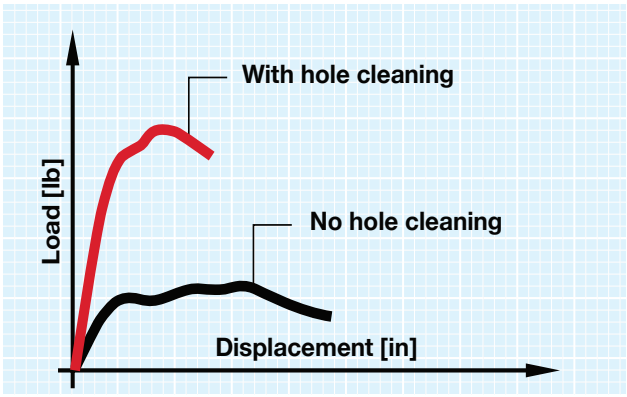
## Set anchors and rebar more reliably



It's no secret that adhesive anchors encounter varying jobsite conditions. Hilti Injection Technology (HIT) is featured in our lineup of quality products to combat this issue. With Hilti SafeSet™ Technology, which includes either Hollow Drill Bits with the VC 150 or VC 300 vacuum cleaner or HIT-Z anchor rods, we are taking another giant leap forward by removing a step of the installation process entirely: there is no manual hole cleaning required.

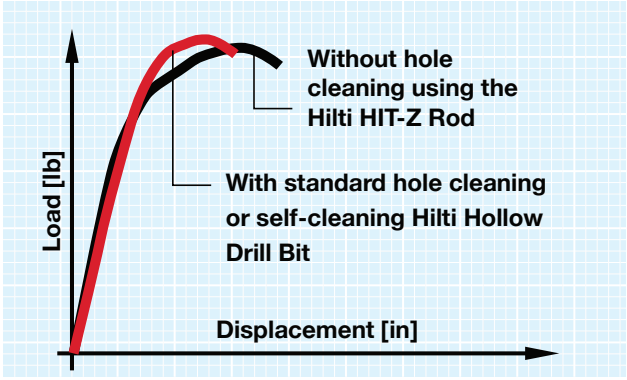
### Potential effects of no hole cleaning

When a threaded rod or rebar is set with conventional injection adhesive, the load it's capable of taking may be very low if the hole is inadequately cleaned after drilling. The Hilti SafeSet™ system helps elminate a cleaning step while still providing excellent load values.




### Hilti HIT-HY 200 V3 Injectable Adhesive with SafeSet™ Technology

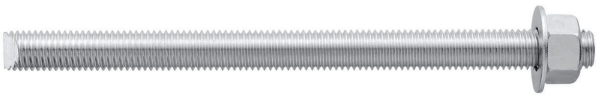
The new SafeSet™ System featuring HIT-HY 200 V3 allows a fastening point to take higher loads, as though the hole were cleaned using traditional installation methods.

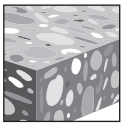


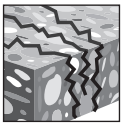
# 3.2.2 HIT-HY 200 A/R V3 ADHESIVE ANCHORING SYSTEM

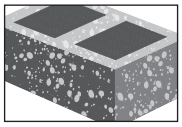
## PRODUCT DESCRIPTION

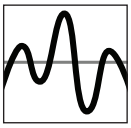
**HIT-HY 200 A/R V3 with HIT-Z rods, Threaded Rod, Rebar, and HIS-N/RN Inserts**

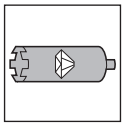
| Anchor System | Features and Benefits |
|---|---|
|  Hilti HIT-HY 200-R V3 Cartridge<br>  Hilti HIT-HY 200-A V3 Cartridge<br>  Hilti HIT-Z Anchor Rod<br>  Hilti HAS Threaded Rod<br>  Rebar<br>  Hilti HIS-N/RN | • Two great products with equal performance data<br>• User can select product gel time suitability based on temperature of the base material and jobsite time requirements<br>• No hole cleaning requirement when installed with SafeSet™ hollow drill bit and vacuum technology<br>• No hole cleaning requirement when installing HIT-Z anchor rods in dry or wet conditions with hammer-drilled holes<br>• ICC-ES approved for cracked concrete and seismic service<br>• May be installed in diamond cored holes with HIT-Z anchor rod only when addition cleaning steps are employed<br>• ICC-ES approved for grout-filled concrete masonry |


Uncracked concrete


Cracked concrete


Grout-filled concrete masonry


Seismic Design Categories A-F


Diamond cored holes for Cracked and Uncracked Concrete



Hollow Drill Bit



Profis Anchor design software

| Approvals/Listings | |
|---|---|
| **ICC-ES (International Code Council)** | ESR-4868 in concrete per ACI 318 Ch. 17 / ACI 355.4/ ICC-ES AC308<br>ESR-4878 in grout-filled CMU per ICC-ES AC58<br>ELC-4868 in concrete per CSA A23.3/ ACI 355.4 |
| **NSF/ANSI Std 61** | Certification for use in potable water |
| **European Technical Approval** | ETA-11/0492, ETA-11/0493<br>ETA-12/0006, ETA-12/0028<br>ETA-12/0083, ETA-12/0084 |
| **City of Los Angeles** | City of Los Angeles 2020 LABC Supplement (within ESR-4868 for Concrete)<br>Research Report No. 26077 for Masonry |
| **Florida Building Code** | 2020 Florida Building Code Supplement (within ESR-4868) |
| **U.S. Green Building Council** | LEED® Credit 4.1-Low Emitting Materials |
| **Department of Transportation** | Contact Hilti for various states |

# MATERIAL SPECIFICATIONS

For material specifications for anchor rods and inserts, please refer to section 3.2.8.



# DESIGN DATA IN CONCRETE PER ACI 318

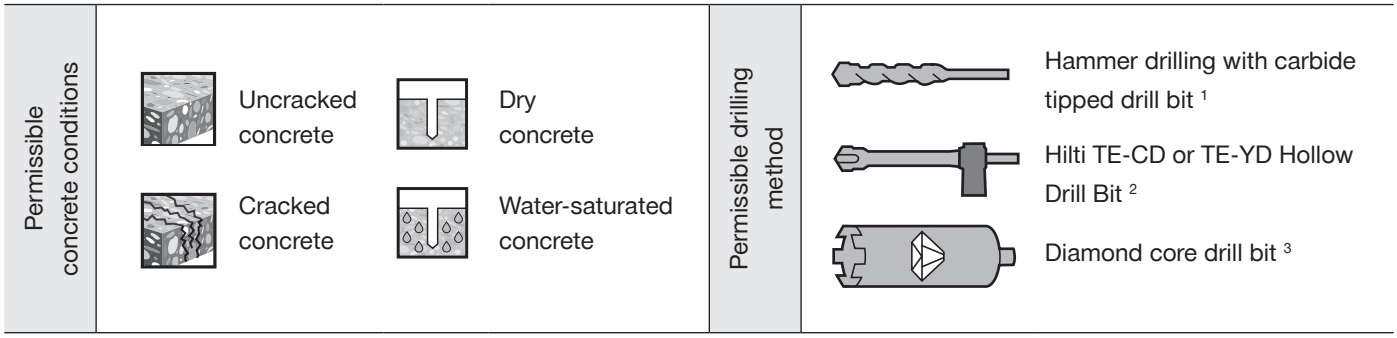
**ACI 318 Chapter 17 design**

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-4868 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-4868 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

**HIT-HY 200 V3 adhesive with HIT-Z and HIT-Z-R anchor rods**



**Figure 1 — Hilti HIT-Z and HIT-Z-R installation conditions**




1 Anchor may be installed in a hole drilled with a carbide-tipped bit without cleaning the drilling dust from the hole. Temperature must be 41° F or higher. Drilling dust must be removed from the hole if the temperature is below 41° F. See Manufacturer's Published Installation Instructions (MPII).
2 When temperatures are below 41° F, TE-CD or TE-YD Hollow Drill Bits used with a Hilti vacuum cleaner are viable methods for removing drilling dust from the hole.
3 Holes drilled by diamond coring require cleaning with a water hose and compressed air. See MPII.

**Table 1 — Specifications for Hilti HIT-Z and HIT-Z-R installed with Hilti HIT-HY 200 A/R V3 adhesive**

| Setting information | | Symbol | Units | Nominal anchor diameter | | | |
|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 |
| Nominal bit diameter | | $d_o$ | in. | 7/16 | 9/16 | 3/4 | 7/8 |
| Effective embedment | minimum | $h_{ef,min}$ | in. | 2-3/8 | 2-3/4 | 3-3/4 | 4 |
| | | | (mm) | (60) | (70) | (95) | (102) |
| | maximum | $h_{ef,max}$ | in. | 4-1/2 | 6 | 7-1/2 | 8-1/2 |
| | | | (mm) | (114) | (152) | (190) | (216) |
| Diameter of fixture hole | through-set |  | in. | 1/2 | 5/8 | 13/16[1] | 15/16[1] |
| | preset |  | in. | 7/16 | 9/16 | 11/16 | 13/16 |
| Installation torque | HIT-Z | $T_{inst}$ | ft-lb | 15 | 30 | 60 | 110 |
| | | | (Nm) | (20) | (40) | (80) | (150) |
| | HIT-Z-R | $T_{inst}$ | ft-lb | 30 | 65 | 125 | 165 |
| | | | (Nm) | (40) | (90) | (170) | (220) |

1 Install using (2) washers. See Figure 3.

**Figure 2 — Hilti HIT-Z and HIT-Z-R specfications**

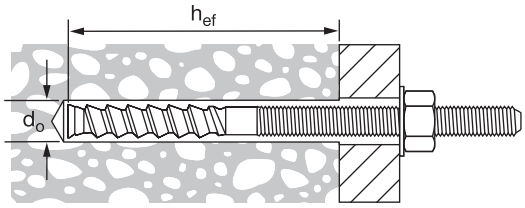



**Figure 3 — Installation with (2) washers**



**Table 2 — Hilti HIT-Z and HIT-Z-R anchor rod length and thread dimension**

| Size | $\ell$ Anchor length | | $\ell_{helix}$ Helix length | | Smooth shank length | | Total thread length | | Usable thread length | | HIT-Z Length Code |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | in. | (mm) | in. | (mm) | in. | (mm) | in. | (mm) | in. | (mm) | |
| 3/8 x 3-3/8 | 3-3/8 | (85) | 2-1/4 | (57) | 3/8 | (6) | 13/16 | (21) | 5/16 | (8) | D |
| 3/8 x 4-3/8 | 4-3/8 | (111) | 2-1/4 | (57) | 5/16 | (8) | 1-13/16 | (46) | 1-5/16 | (33) | F |
| 3/8 x 5-1/8 | 5-1/8 | (130) | 2-1/4 | (57) | 5/16 | (8) | 2-9/16 | (65) | 2-1/16 | (52) | H |
| 3/8 x 6-3/8 | 6-3/8 | (162) | 2-1/4 | (57) | 5/16 | (8) | 3-13/16 | (97) | 3-5/16 | (84) | J |
| 1/2 x 4-1/2 | 4-1/2 | (114) | 2-1/2 | (63) | 5/16 | (8) | 1-11/16 | (43) | 1 | (26) | F |
| 1/2 x 6-1/2 | 6-1/2 | (165) | 2-1/2 | (63) | 5/16 | (8) | 3-11/16 | (94) | 3-1/16 | (77) | J |
| 1/2 x 7-3/4 | 7-3/4 | (197) | 2-1/2 | (63) | 5/16 | (8) | 4-15/16 | (126) | 4-5/16 | (109) | M |
| 5/8 x 6 | 6 | (152) | 3-5/8 | (92) | 7/16 | (11) | 1-15/16 | (49) | 1-1/8 | (28) | I |
| 5/8 x 8 | 8 | (203) | 3-5/8 | (92) | 7/16 | (11) | 3-15/16 | (100) | 3-1/8 | (79) | M |
| 5/8 x 9-1/2 | 9-1/2 | (241) | 3-5/8 | (92) | 1-15/16 | (49) | 3-15/16 | (100) | 3-1/8 | (79) | P |
| 3/4 x 6-1/2 | 6-1/2 | (165) | 4 | (102) | 5/16 | (8) | 2 | (51) | 1 | (26) | K |
| 3/4 x 8-1/2 | 8-1/2 | (216) | 4 | (102) | 7/16 | (12) | 4 | (102) | 3-1/16 | (77) | N |
| 3/4 x 9-3/4 | 9-3/4 | (248) | 4 | (102) | 1-11/16 | (44) | 4 | (102) | 3-1/16 | (77) | Q |

**Figure 4 — Hilti HIT-Z and HIT-Z-R anchor rod length and thread dimension**

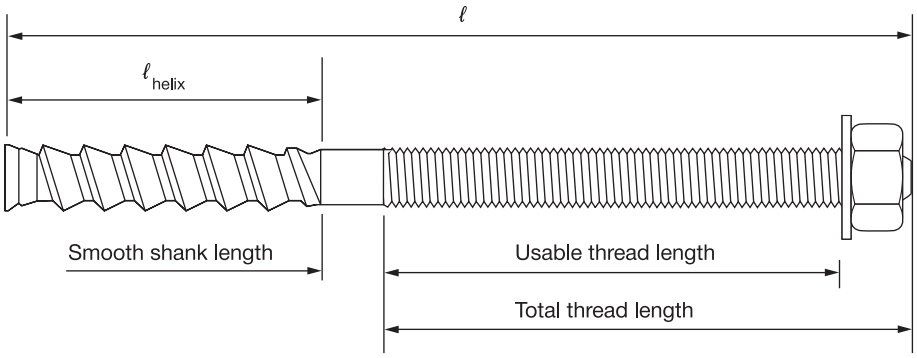


**Table 3 — Hilti HIT-HY 200 A/R V3 design strength with concrete/pullout failure for Hilti HIT-Z(-R) rods in uncracked concrete[1,2,3,4,5,6,7,8,9,10]**

| Nominal anchor diameter in. | Effective embed. in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8 | 2-3/8 (60) | 2,855 (12.7) | 3,125 (13.9) | 3,610 (16.1) | 4,425 (19.7) | 3,075 (13.7) | 3,370 (15.0) | 3,890 (17.3) | 4,765 (21.2) |
| | 3-3/8 (86) | 4,835 (21.5) | 5,170 (23.0) | 5,170 (23.0) | 5,170 (23.0) | 10,415 (46.3) | 11,410 (50.8) | 13,175 (58.6) | 16,135 (71.8) |
| | 4-1/2 (114) | 5,170 (23.0) | 5,170 (23.0) | 5,170 (23.0) | 5,170 (23.0) | 16,035 (71.3) | 17,570 (78.2) | 20,285 (90.2) | 24,845 (110.5) |
| 1/2 | 2-3/4 (70) | 3,555 (15.8) | 3,895 (17.3) | 4,500 (20.0) | 5,510 (24.5) | 7,660 (34.1) | 8,395 (37.3) | 9,690 (43.1) | 11,870 (52.8) |
| | 4-1/2 (114) | 7,445 (33.1) | 7,615 (33.9) | 7,615 (33.9) | 7,615 (33.9) | 16,035 (71.3) | 17,570 (78.2) | 20,285 (90.2) | 24,845 (110.5) |
| | 6 (152) | 7,615 (33.9) | 7,615 (33.9) | 7,615 (33.9) | 7,615 (33.9) | 24,690 (109.8) | 27,045 (120.3) | 31,230 (138.9) | 38,250 (170.1) |
| 5/8 | 3-3/4 (95) | 5,665 (25.2) | 6,205 (27.6) | 7,165 (31.9) | 8,775 (39.0) | 12,200 (54.3) | 13,365 (59.5) | 15,430 (68.6) | 18,900 (84.1) |
| | 5-5/8 (143) | 10,405 (46.3) | 11,400 (50.7) | 13,165 (58.6) | 13,905 (61.9) | 22,415 (99.7) | 24,550 (109.2) | 28,350 (126.1) | 34,720 (154.4) |
| | 7-1/2 (191) | 13,905 (61.9) | 13,905 (61.9) | 13,905 (61.9) | 13,905 (61.9) | 34,505 (153.5) | 37,800 (168.1) | 43,650 (194.2) | 53,455 (237.8) |
| 3/4 | 4 (102) | 6,240 (27.8) | 6,835 (30.4) | 7,895 (35.1) | 9,665 (43.0) | 13,440 (59.8) | 14,725 (65.5) | 17,000 (75.6) | 20,820 (92.6) |
| | 6-3/4 (171) | 13,680 (60.9) | 14,985 (66.7) | 17,305 (77.0) | 18,500 (82.3) | 29,460 (131.0) | 32,275 (143.6) | 37,265 (165.8) | 45,645 (203.0) |
| | 8-1/2 (216) | 18,500 (82.3) | 18,500 (82.3) | 18,500 (82.3) | 18,500 (82.3) | 41,635 (185.2) | 45,605 (202.9) | 52,660 (234.2) | 64,500 (286.9) |

**Table 4 — Hilti HIT-HY 200 A/R V3 design strength with concrete/pullout failure for Hilti HIT-Z(-R) rods in cracked concrete[1,2,3,4,5,6,7,8,9,10]**

| Nominal anchor diameter in. | Effective embed. in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8 | 2-3/8 (60) | 2,020 (9.0) | 2,215 (9.9) | 2,560 (11.4) | 3,135 (13.9) | 2,180 (9.7) | 2,385 (10.6) | 2,755 (12.3) | 3,375 (15.0) |
| | 3-3/8 (86) | 3,425 (15.2) | 3,755 (16.7) | 4,335 (19.3) | 5,170 (23.0) | 7,380 (32.8) | 8,085 (36.0) | 9,335 (41.5) | 11,430 (50.8) |
| | 4-1/2 (114) | 5,170 (23.0) | 5,170 (23.0) | 5,170 (23.0) | 5,170 (23.0) | 11,360 (50.5) | 12,445 (55.4) | 14,370 (63.9) | 17,600 (78.3) |
| 1/2 | 2-3/4 (70) | 2,520 (11.2) | 2,760 (12.3) | 3,185 (14.2) | 3,905 (17.4) | 5,425 (24.1) | 5,945 (26.4) | 6,865 (30.5) | 8,405 (37.4) |
| | 4-1/2 (114) | 5,275 (23.5) | 5,780 (25.7) | 6,670 (29.7) | 7,110 (31.6) | 11,360 (50.5) | 12,445 (55.4) | 14,370 (63.9) | 17,600 (78.3) |
| | 6 (152) | 7,110 (31.6) | 7,110 (31.6) | 7,110 (31.6) | 7,110 (31.6) | 17,490 (77.8) | 19,160 (85.2) | 22,120 (98.4) | 27,095 (120.5) |
| 5/8 | 3-3/4 (95) | 4,010 (17.8) | 4,395 (19.5) | 5,075 (22.6) | 6,215 (27.6) | 8,640 (38.4) | 9,465 (42.1) | 10,930 (48.6) | 13,390 (59.6) |
| | 5-5/8 (143) | 7,370 (32.8) | 8,075 (35.9) | 9,325 (41.5) | 11,420 (50.8) | 15,875 (70.6) | 17,390 (77.4) | 20,080 (89.3) | 24,595 (109.4) |
| | 7-1/2 (191) | 11,350 (50.5) | 12,430 (55.3) | 13,905 (61.9) | 13,905 (61.9) | 24,440 (108.7) | 26,775 (119.1) | 30,915 (137.5) | 37,865 (168.4) |
| 3/4 | 4 (102) | 4,420 (19.7) | 4,840 (21.5) | 5,590 (24.9) | 6,845 (30.4) | 9,520 (42.3) | 10,430 (46.4) | 12,040 (53.6) | 14,750 (65.6) |
| | 6-3/4 (171) | 9,690 (43.1) | 10,615 (47.2) | 12,255 (54.5) | 15,010 (66.8) | 20,870 (92.8) | 22,860 (101.7) | 26,395 (117.4) | 32,330 (143.8) |
| | 8-1/2 (216) | 13,690 (60.9) | 15,000 (66.7) | 17,320 (77.0) | 18,155 (80.8) | 29,490 (131.2) | 32,305 (143.7) | 37,300 (165.9) | 45,685 (203.2) |

1 Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 10 - 17 as necessary to the above values. Compare to the steel values in table 5. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 1.0.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.90.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions.
7 Tabular values are for short-term loads only. For sustained loads, see section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension only by the following reduction factors:
3/8-in diameter - $\alpha_{N,seis}$ = 0.705
1/2-in to 3/4-in diameter - $\alpha_{N,seis}$ = 0.75
See Section 3.1.8 for additional information on seismic applications.
10 Diamond core drilling with Hilti HIT-Z(-R) rods is permitted with no reduction in published data above.

**Table 5 — Steel design strength for Hilti HIT-Z and HIT-Z-R rods [1,2]**

| Nominal anchor diameter in. | ACI 318 Chapter 17 Based Design | | | | | |
|---|---|---|---|---|---|---|
| | HIT-Z carbon steel rod | | | HIT-Z-R stainless steel rod | | |
| | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic Shear[5] $\phi V_{sa,eq}$ lb (kN) | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic Shear[5] $\phi V_{sa,eq}$ lb (kN) |
| 3/8 | 4,750 (21.1) | 1,930 (8.6) | 1,255 (5.6) | 4,750 (21.1) | 2,630 (11.7) | 2,080 (9.3) |
| 1/2 | 8,695 (38.7) | 3,530 (15.7) | 2,295 (10.2) | 8,695 (38.7) | 4,815 (21.4) | 3,610 (16.1) |
| 5/8 | 13,850 (61.6) | 5,625 (25.0) | 3,655 (16.3) | 13,850 (61.6) | 7,670 (34.1) | 4,985 (22.2) |
| 3/4 | 20,455 (91.0) | 8,310 (37.0) | 5,400 (24.0) | 20,455 (91.0) | 11,330 (50.4) | 7,365 (32.8) |

1 See section 3.1.8 to convert design strength value to ASD value.
2 HIT-Z and HIT-Z-R rods are to be considered brittle steel elements.
3 Tensile = $\phi\ A_{se,N}\ f_{uta}$ as noted in ACI 318 Chapter 17.
4 Shear values determined by static shear tests with $\phi V_{sa} \le \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17.
5 Seismic Shear = $\alpha_{V,seis}\ \phi_{Vsa}$ : Reduction for seismic shear only. See section 3.1.8 for additional information on seismic applications.

### Hilti HIT-Z(-R) rod permissible combinations of edge distance, anchor spacing, and concrete thickness

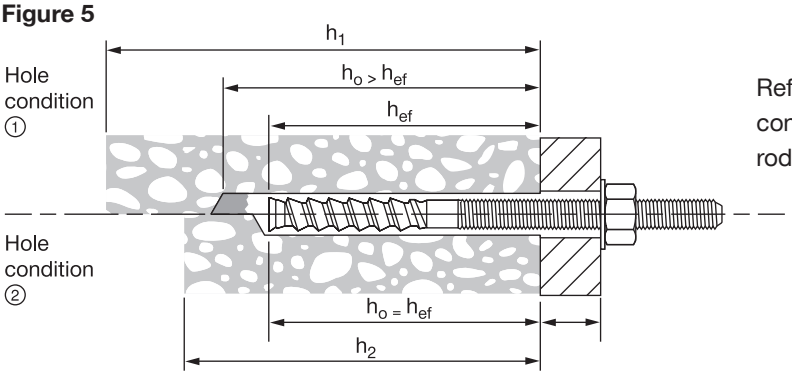
The Hilti HIT-Z and HIT-Z-R anchor rods produce higher expansion forces in the concrete slab when the installation torque is applied. This means that the anchor must be installed with larger edge distances and spacing when compared to standard threaded rod, to minimize the likelihood that the concrete slab will split during installation.

The permissible edge distance is based on the concrete condition (cracked or uncracked), the concrete thickness, and anchor spacing if designing for anchor groups. The permissible concrete thickness is dependent on whether or not the drill dust is removed during the anchor installation process.

### Step 1: Check concrete thickness

When using Hilti HIT-Z and HIT-Z-R anchor rods, drilling dust does not need to be removed for optimum capacity when base material temperatures are greater than 41° F (5° C) and a hammer drill with a carbide tipped drill bit is used. However, concrete thickness can be reduced if the drilling dust is removed. The figure below shows both drilled hole conditions. **Drilled hole condition 1** illustrates the hole depth and concrete thickness when drilling dust is left in the hole. **Drilled hole condition 2** illustrates the corresponding reduction when drill dust is removed by using compressed air, Hilti TE-CD or TE-YD Hollow Drill Bits with a Hilti vacuum.

**Figure 5**

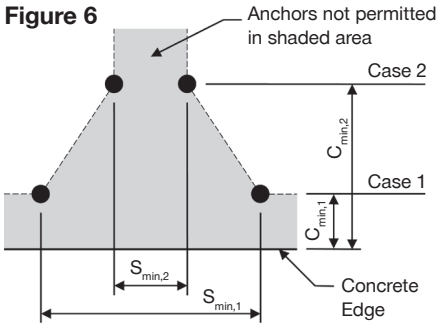



Refer to tables 6 to 9 in this section for the minimum concrete thicknesses associated with the Hilti HIT-Z(-R) rods based on diameter and drilled hole condition.

### Step 2: Check edge distance and anchor spacing

Tables 6 to 9 in this section show the minimum edge distance and anchor spacing based on a specific concrete thickness and whether or not the design is for cracked or uncracked concrete. There are two cases of edge distance and anchor spacing combinations for each embedment and concrete condition (cracked or uncracked). **Case 1** is the minimum edge distance needed for one anchor or for two anchors with large anchor spacing. **Case 2** is the minimum anchor spacing that can be used, but the edge distance is increased to help prevent splitting. Linear interpolation can be used between **Case 1** and **Case 2** for any specific concrete thickness and concrete condition. See the following figure and calculation which can be used to determine specific edge distance and anchor spacing combinations.

**Figure 6**




For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$

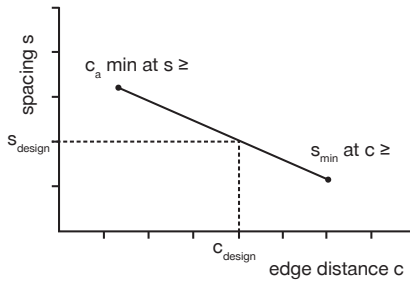



**Table 6 — Minimum edge distance, spacing, and concrete thickness for 3/8-in. diameter Hilti HIT-Z and HIT-Z-R rods[1]**

| Nominal anchor diameter | | d | in. | 3/8 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective embedment | | $h_{ef}$ | in. (mm) | 2-3/8 (60) | | | 3-3/8 (86) | | | 4-1/2 (114) | | |
| Drilled hole condition | | - | - | 2 [2] | 1 or 2 | | 2 [2] | 1 or 2 | | 2 [2] | 1 or 2 | |
| Minimum concrete thickness | | h | in. (mm) | 4 (102) | 4-5/8 (117) | 5-3/4 (146) | 4-5/8 (117) | 5-5/8 (143) | 6-3/8 (162) | 5-3/4 (146) | 6-3/4 (171) | 7-3/8 (187) |
| Uncracked concrete | Minimum edge and spacing **Case 1** | $c_{min,1}$ | in. (mm) | 3-1/8 (79) | 2-3/4 (70) | 2-1/4 (57) | 2-3/4 (70) | 2-1/4 (57) | 2 (51) | 2-1/4 (57) | 1-7/8 (48) | 1-7/8 (48) |
| | | $s_{min,1}$ | in. (mm) | 9-1/8 (232) | 7-3/4 (197) | 6-1/8 (156) | 7-3/4 (197) | 6-1/2 (165) | 5-5/8 (143) | 6-1/8 (156) | 5-3/8 (137) | 4-1/2 (114) |
| | Minimum edge and spacing **Case 2** | $c_{min,2}$ | in. (mm) | 5-5/8 (143) | 4-3/4 (121) | 3-3/4 (95) | 4-3/4 (121) | 3-7/8 (98) | 3-1/4 (83) | 3-3/4 (95) | 3-1/8 (79) | 2-3/4 (70) |
| | | $s_{min,2}$ | in. (mm) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) |
| Cracked concrete | Minimum edge and spacing **Case 1** | $c_{min,1}$ | in. (mm) | 2-1/8 (54) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) |
| | | $s_{min,1}$ | in. (mm) | 6-3/8 (162) | 5-1/2 (140) | 4-1/4 (108) | 5-1/2 (140) | 3-1/2 (89) | 2-5/8 (67) | 3-1/4 (83) | 2 (51) | 1-7/8 (48) |
| | Minimum edge and spacing **Case 2** | $c_{min,2}$ | in. (mm) | 3-5/8 (92) | 3-1/8 (79) | 2-3/8 (60) | 3-1/8 (79) | 2-1/2 (64) | 2-1/8 (54) | 2-3/8 (60) | 2 (51) | 1-7/8 (48) |
| | | $s_{min,2}$ | in. (mm) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) | 1-7/8 (48) |

**Table 7 — Minimum edge distance, spacing, and concrete thickness for 1/2-in. diameter Hilti HIT-Z and HIT-Z-R rods[1]**

| Nominal anchor diameter | | d | in. | 1/2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective embedment | | $h_{ef}$ | in. (mm) | 2-3/4 (70) | | | 4-1/2 (114) | | | 6 (152) | | |
| Drilled hole condition | | - | - | 2 [2] | 1 or 2 | | 2 [2] | 1 or 2 | | 2 [2] | 1 or 2 | |
| Minimum concrete thickness | | h | in. (mm) | 4 (102) | 5 (127) | 7-1/8 (181) | 5-3/4 (146) | 6-3/4 (171) | 8-1/4 (210) | 7-1/4 (184) | 8-1/4 (210) | 9-3/4 (248) |
| Uncracked Concrete | Minimum edge and spacing **Case 1** | $c_{min,1}$ | in. (mm) | 5-1/8 (130) | 4-1/8 (105) | 2-7/8 (73) | 3-5/8 (92) | 3 (76) | 2-1/2 (64) | 2-7/8 (73) | 2-1/2 (64) | 2-1/2 (64) |
| | | $s_{min,1}$ | in. (mm) | 14-7/8 (378) | 11-7/8 (302) | 8-5/8 (219) | 10-1/4 (260) | 9 (229) | 7-1/4 (184) | 8-1/8 (206) | 7-1/4 (184) | 5 (127) |
| | Minimum edge and spacing **Case 2** | $c_{min,2}$ | in. (mm) | 9-1/4 (235) | 7-1/4 (184) | 4-7/8 (124) | 6-1/4 (159) | 5-1/4 (133) | 4-1/8 (105) | 4-3/4 (121) | 4-1/8 (105) | 3-3/8 (86) |
| | | $s_{min,2}$ | in. (mm) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) |
| Cracked Concrete | Minimum edge and spacing **Case 1** | $c_{min,1}$ | in. (mm) | 3-5/8 (92) | 3 (76) | 2-1/2 (64) | 2-5/8 (67) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) |
| | | $s_{min,1}$ | in. (mm) | 10-7/8 (276) | 8-1/2 (216) | 6 (152) | 7-3/8 (187) | 5-1/2 (140) | 3-1/8 (79) | 4-1/2 (114) | 3-1/8 (79) | 2-1/2 (64) |
| | Minimum edge and spacing **Case 2** | $c_{min,2}$ | in. (mm) | 6-1/2 (165) | 5 (127) | 3-1/4 (83) | 4-1/4 (108) | 3-1/2 (89) | 2-3/4 (70) | 3-1/4 (83) | 2-3/4 (70) | 2-1/2 (64) |
| | | $s_{min,2}$ | in. (mm) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) | 2-1/2 (64) |

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2.
Linear interpoloation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$, will determine the permissible spacing s as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$

2 For shaded cells, drilling dust must be removed from drilled hole to justify minimum concrete thickness.

## Table 8 — Minimum edge distance, spacing, and concrete thickness for 5/8-in. diameter Hilti HIT-Z and HIT-Z-R rods[1]

| Nominal anchor diameter | | d | in. | 5/8 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective embedment | | $h_{ef}$ | in. (mm) | 3-3/4 (95) | | | 5-5/8 (143) | | | 7-1/2 (191) | | |
| Drilled hole condition | | - | - | 2 [2] | 1 or 2 | | 2 [2] | 1 or 2 | | 2 [2] | 1 or 2 | |
| Minimum concrete thickness | | h | in. | 5-1/2 | 7-3/4 | 9-3/8 | 7-3/8 | 9-5/8 | 10-1/2 | 9-1/4 | 11-1/2 | 12-1/4 |
| | | | (mm) | (140) | (197) | (238) | (187) | (244) | (267) | (235) | (292) | (311) |
| Uncracked concrete | Minimum edge and spacing **Case 1** | $c_{min,1}$ | in. | 6-1/4 | 4-1/2 | 3-3/4 | 4-5/8 | 3-5/8 | 3-1/4 | 3-3/4 | 3-1/8 | 3-1/8 |
| | | | (mm) | (159) | (114) | (95) | (117) | (92) | (83) | (95) | (79) | (79) |
| | | $s_{min,1}$ | in. | 18-3/8 | 12-7/8 | 10-5/8 | 13-7/8 | 10-3/8 | 9-3/4 | 10-7/8 | 8-3/8 | 7-3/8 |
| | | | (mm) | (467) | (327) | (270) | (352) | (264) | (248) | (276) | (213) | (187) |
| | Minimum edge and spacing **Case 2** | $c_{min,2}$ | in. | 11-3/8 | 7-3/4 | 6-1/4 | 8-1/4 | 6-1/8 | 5-1/2 | 6-3/8 | 4-7/8 | 4-5/8 |
| | | | (mm) | (289) | (197) | (159) | (210) | (156) | (140) | (162) | (124) | (117) |
| | | $s_{min,2}$ | in. | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 |
| | | | (mm) | (79) | (79) | (79) | (79) | (79) | (79) | (79) | (79) | (79) |
| Cracked concrete | Minimum edge and spacing **Case 1** | $c_{min,1}$ | in. | 4-5/8 | 3-3/8 | 3-1/8 | 3-1/2 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 |
| | | | (mm) | (117) | (86) | (79) | (89) | (79) | (79) | (79) | (79) | (79) |
| | | $s_{min,1}$ | in. | 13-7/8 | 9-1/2 | 8-3/4 | 10-1/8 | 6-1/2 | 5-3/8 | 7-1/8 | 3-7/8 | 3-1/8 |
| | | | (mm) | (352) | (241) | (222) | (257) | (165) | (137) | (181) | (98) | (79) |
| | Minimum edge and spacing **Case 2** | $c_{min,2}$ | in. | 8-1/4 | 5-1/2 | 4-3/8 | 5-7/8 | 4-1/4 | 3-7/8 | 4-1/2 | 3-3/8 | 3-1/8 |
| | | | (mm) | (210) | (140) | (111) | (149) | (108) | (98) | (114) | (86) | (79) |
| | | $s_{min,2}$ | in. | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 | 3-1/8 |
| | | | (mm) | (79) | (79) | (79) | (79) | (79) | (79) | (79) | (79) | (79) |

## Table 9 — Minimum edge distance, spacing, and concrete thickness for 3/4-in. diameter Hilti HIT-Z and HIT-Z-R rods[1]

| Nominal anchor diameter | | d | in. | 3/4 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective embedment | | $h_{ef}$ | in. (mm) | 4 (102) | | | 6-3/4 (171) | | | 8-1/2 (216) | | |
| Drilled hole condition | | - | - | 2 [2] | 1 or 2 | | 2 [2] | 1 or 2 | | 2 [2] | 1 or 2 | |
| Minimum concrete thickness | | h | in. | 5-3/4 | 8 | 11-1/2 | 8-1/2 | 10-3/4 | 13-1/8 | 10-1/4 | 12-1/2 | 14-1/2 |
| | | | (mm) | (146) | (203) | (292) | (216) | (273) | (333) | (260) | (318) | (368) |
| Uncracked concrete | Minimum edge and spacing **Case 1** | $c_{min,1}$ | in. | 9-3/4 | 7 | 5 | 6-5/8 | 5-1/4 | 4-1/4 | 5-1/2 | 4-1/2 | 4 |
| | | | (mm) | (248) | (178) | (127) | (168) | (133) | (108) | (140) | (114) | (102) |
| | | $s_{min,1}$ | in. | 28-3/4 | 20-5/8 | 14 | 19-3/8 | 15-1/4 | 12-5/8 | 16 | 13-1/4 | 11 |
| | | | (mm) | (730) | (524) | (356) | (492) | (387) | (321) | (406) | (337) | (279) |
| | Minimum edge and spacing **Case 2** | $c_{min,2}$ | in. | 18-1/8 | 12-5/8 | 8-1/2 | 11-7/8 | 9-1/8 | 7-1/4 | 9-5/8 | 7-3/4 | 6-1/2 |
| | | | (mm) | (460) | (321) | (216) | (302) | (232) | (184) | (244) | (197) | (165) |
| | | $s_{min,2}$ | in. | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 |
| | | | (mm) | (95) | (95) | (95) | (95) | (95) | (95) | (95) | (95) | (95) |
| Cracked concrete | Minimum edge and spacing **Case 1** | $c_{min,1}$ | in. | 7-1/4 | 5-1/4 | 4-1/8 | 5 | 4 | 3-3/4 | 4-1/8 | 3-3/4 | 3-3/4 |
| | | | (mm) | (184) | (133) | (105) | (127) | (102) | (95) | (105) | (95) | (95) |
| | | $s_{min,1}$ | in. | 21-3/4 | 15-1/2 | 12-1/4 | 14-1/2 | 11-3/8 | 9 | 12-1/8 | 8-3/4 | 6-1/2 |
| | | | (mm) | (552) | (394) | (311) | (368) | (289) | (229) | (308) | (222) | (165) |
| | Minimum edge and spacing **Case 2** | $c_{min,2}$ | in. | 13-1/4 | 9-1/4 | 6 | 8-5/8 | 6-5/8 | 5-1/8 | 7 | 5-1/2 | 4-1/2 |
| | | | (mm) | (337) | (235) | (152) | (219) | (168) | (130) | (178) | (140) | (114) |
| | | $s_{min,2}$ | in. | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 | 3-3/4 |
| | | | (mm) | (95) | (95) | (95) | (95) | (95) | (95) | (95) | (95) | (95) |

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2.
Linear interpoloation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$, will determine the permissible spacing s as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$

2 For shaded cells, drilling dust must be removed from drilled hole to justify minimum concrete thickness.

**Table 10 — Load adjustment factors for 3/8-in. diameter Hilti HIT-Z and HIT-Z-R rods in uncracked concrete [1,2]**

| 3/8-in. HIT-Z(-R) uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | |
| 1-7/8 | (48) | 0.63 | 0.59 | 0.57 | n/a | n/a | 0.21 | 0.57 | 0.53 | 0.52 | n/a | n/a | 0.05 | n/a | n/a | 0.10 | n/a | n/a | n/a |
| 2 | (51) | 0.64 | 0.60 | 0.57 | n/a | 0.25 | 0.21 | 0.57 | 0.53 | 0.52 | n/a | 0.09 | 0.06 | n/a | 0.17 | 0.11 | n/a | n/a | n/a |
| 2-1/4 | (57) | 0.66 | 0.61 | 0.58 | 0.38 | 0.26 | 0.22 | 0.58 | 0.54 | 0.53 | 0.33 | 0.10 | 0.07 | 0.38 | 0.21 | 0.13 | n/a | n/a | n/a |
| 3 | (76) | 0.71 | 0.65 | 0.61 | 0.46 | 0.30 | 0.25 | 0.61 | 0.55 | 0.54 | 0.51 | 0.16 | 0.10 | 0.51 | 0.32 | 0.21 | n/a | n/a | n/a |
| 4 | (102) | 0.78 | 0.70 | 0.65 | 0.59 | 0.36 | 0.29 | 0.64 | 0.57 | 0.55 | 0.79 | 0.24 | 0.16 | 0.79 | 0.44 | 0.29 | 0.76 | n/a | n/a |
| 4-5/8 | (117) | 0.82 | 0.73 | 0.67 | 0.69 | 0.40 | 0.31 | 0.66 | 0.58 | 0.56 | 0.98 | 0.30 | 0.20 | 0.98 | 0.49 | 0.31 | 0.81 | 0.55 | n/a |
| 5 | (127) | 0.85 | 0.75 | 0.69 | 0.74 | 0.43 | 0.33 | 0.68 | 0.58 | 0.56 | 1.00 | 0.34 | 0.22 | 1.00 | 0.52 | 0.33 | 0.84 | 0.57 | n/a |
| 5-3/4 | (146) | 0.90 | 0.78 | 0.71 | 0.86 | 0.49 | 0.36 | 0.70 | 0.59 | 0.57 | 1.00 | 0.42 | 0.27 | 1.00 | 0.59 | 0.36 | 0.91 | 0.61 | 0.53 |
| 6 | (152) | 0.92 | 0.80 | 0.72 | 0.89 | 0.51 | 0.38 | 0.71 | 0.60 | 0.57 | 1.00 | 0.45 | 0.29 | 1.00 | 0.62 | 0.38 | 0.92 | 0.63 | 0.54 |
| 7 | (178) | 0.99 | 0.85 | 0.76 | 1.00 | 0.60 | 0.43 | 0.75 | 0.61 | 0.59 | | 0.57 | 0.37 | | 0.72 | 0.43 | 1.00 | 0.68 | 0.58 |
| 8 | (203) | 1.00 | 0.90 | 0.80 | | 0.69 | 0.49 | 0.79 | 0.63 | 0.60 | | 0.69 | 0.45 | | 0.83 | 0.49 | 1.00 | 0.72 | 0.63 |
| 9 | (229) | 1.00 | 0.94 | 0.83 | | 0.77 | 0.55 | 0.82 | 0.65 | 0.61 | | 0.83 | 0.54 | | 0.93 | 0.55 | | 0.77 | 0.66 |
| 10 | (254) | 1.00 | 0.99 | 0.87 | | 0.86 | 0.61 | 0.86 | 0.66 | 0.62 | | 0.97 | 0.63 | | 1.00 | 0.63 | | 0.81 | 0.70 |
| 11 | (279) | | 1.00 | 0.91 | | 0.94 | 0.67 | 0.89 | 0.68 | 0.63 | | 1.00 | 0.72 | | | 0.72 | | 0.85 | 0.73 |
| 12 | (305) | | | 0.94 | | 1.00 | 0.73 | 0.93 | 0.70 | 0.65 | | | 0.83 | | | 0.83 | | 0.88 | 0.77 |
| 14 | (356) | | | 1.00 | | | 0.85 | 1.00 | 0.73 | 0.67 | | | 1.00 | | | 1.00 | | 0.96 | 0.83 |
| 16 | (406) | | | | | | 0.98 | | 0.76 | 0.70 | | | | | | | | 1.00 | 0.88 |
| 18 | (457) | | | | | | 1.00 | | 0.79 | 0.72 | | | | | | | | | 0.94 |
| 24 | (610) | | | | | | | | 0.89 | 0.79 | | | | | | | | | 1.00 |
| 30 | (762) | | | | | | | | 0.99 | 0.87 | | | | | | | | | |
| 36 | (914) | | | | | | | | 1.00 | 0.94 | | | | | | | | | |
| > 48 | (1219) | | | | | | | | | 1.00 | | | | | | | | | |

**Table 11 — Load adjustment factors for 3/8-in. diameter Hilti HIT-Z and HIT-Z-R rods in cracked concrete [1,2]**

| 3/8-in. HIT-Z(-R) cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | |
| 1-7/8 | (48) | 0.63 | 0.59 | 0.57 | n/a | 0.56 | 0.50 | 0.57 | 0.53 | 0.52 | n/a | 0.08 | 0.05 | n/a | 0.16 | 0.10 | n/a | n/a | n/a |
| 2 | (51) | 0.64 | 0.60 | 0.57 | n/a | 0.57 | 0.51 | 0.57 | 0.53 | 0.52 | n/a | 0.09 | 0.06 | n/a | 0.17 | 0.11 | n/a | n/a | n/a |
| 2-1/4 | (57) | 0.66 | 0.61 | 0.58 | 0.73 | 0.60 | 0.53 | 0.58 | 0.54 | 0.53 | 0.34 | 0.10 | 0.07 | 0.67 | 0.21 | 0.14 | n/a | n/a | n/a |
| 3 | (76) | 0.71 | 0.65 | 0.61 | 0.88 | 0.70 | 0.60 | 0.61 | 0.55 | 0.54 | 0.52 | 0.16 | 0.10 | 0.88 | 0.32 | 0.21 | n/a | n/a | n/a |
| 4 | (102) | 0.78 | 0.70 | 0.65 | 1.00 | 0.84 | 0.70 | 0.64 | 0.57 | 0.55 | 0.80 | 0.25 | 0.16 | 1.00 | 0.49 | 0.32 | 0.76 | n/a | n/a |
| 4-5/8 | (117) | 0.82 | 0.73 | 0.67 | | 0.93 | 0.76 | 0.67 | 0.58 | 0.56 | 0.99 | 0.31 | 0.20 | | 0.61 | 0.40 | 0.81 | 0.55 | n/a |
| 5 | (127) | 0.85 | 0.75 | 0.69 | | 0.99 | 0.80 | 0.68 | 0.58 | 0.56 | 1.00 | 0.34 | 0.22 | | 0.69 | 0.45 | 0.85 | 0.57 | n/a |
| 5-3/4 | (146) | 0.90 | 0.78 | 0.71 | | 1.00 | 0.88 | 0.71 | 0.59 | 0.57 | | 0.42 | 0.28 | | 0.85 | 0.55 | 0.91 | 0.61 | 0.53 |
| 6 | (152) | 0.92 | 0.80 | 0.72 | | | 0.91 | 0.71 | 0.60 | 0.57 | | 0.45 | 0.29 | | 0.91 | 0.59 | 0.93 | 0.63 | 0.54 |
| 7 | (178) | 0.99 | 0.85 | 0.76 | | | 1.00 | 0.75 | 0.61 | 0.59 | | 0.57 | 0.37 | | 1.00 | 0.74 | 1.00 | 0.68 | 0.59 |
| 8 | (203) | 1.00 | 0.90 | 0.80 | | | | 0.79 | 0.63 | 0.60 | | 0.70 | 0.45 | | | 0.91 | | 0.72 | 0.63 |
| 9 | (229) | | 0.94 | 0.83 | | | | 0.82 | 0.65 | 0.61 | | 0.83 | 0.54 | | | 1.00 | | 0.77 | 0.67 |
| 10 | (254) | | 0.99 | 0.87 | | | | 0.86 | 0.66 | 0.62 | | 0.97 | 0.63 | | | | | 0.81 | 0.70 |
| 11 | (279) | | 1.00 | 0.91 | | | | 0.89 | 0.68 | 0.64 | | 1.00 | 0.73 | | | | | 0.85 | 0.74 |
| 12 | (305) | | | 0.94 | | | | 0.93 | 0.70 | 0.65 | | | 0.83 | | | | | 0.89 | 0.77 |
| 14 | (356) | | | 1.00 | | | | 1.00 | 0.73 | 0.67 | | | 1.00 | | | | | 0.96 | 0.83 |
| 16 | (406) | | | | | | | | 0.76 | 0.70 | | | | | | | | 1.00 | 0.89 |
| 18 | (457) | | | | | | | | 0.79 | 0.72 | | | | | | | | | 0.94 |
| 24 | (610) | | | | | | | | 0.89 | 0.79 | | | | | | | | | 1.00 |
| 30 | (762) | | | | | | | | 0.99 | 0.87 | | | | | | | | | |
| 36 | (914) | | | | | | | | 1.00 | 0.94 | | | | | | | | | |
| > 48 | (1219) | | | | | | | | | 1.00 | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

If a reduction factor value is in a shaded area, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with figure 6 and table 6 of this section to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 12 — Load adjustment factors for 1/2-in. diameter Hilti HIT-Z and HIT-Z-R rods in uncracked concrete [1,2]

| 1/2-in. HIT-Z(-R) uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 2-1/2 (64) | 0.65 | 0.59 | 0.57 | n/a | 0.23 | 0.20 | 0.55 | 0.53 | 0.53 | n/a | 0.09 | 0.06 | n/a | 0.18 | 0.12 | n/a | n/a | n/a |
| | 2-7/8 (73) | 0.67 | 0.61 | 0.58 | 0.35 | 0.24 | 0.21 | 0.56 | 0.54 | 0.53 | 0.22 | 0.11 | 0.07 | 0.35 | 0.22 | 0.15 | n/a | n/a | n/a |
| | 3 (76) | 0.68 | 0.61 | 0.58 | 0.36 | 0.25 | 0.21 | 0.56 | 0.54 | 0.53 | 0.23 | 0.12 | 0.08 | 0.36 | 0.24 | 0.15 | n/a | n/a | n/a |
| | 3-1/2 (89) | 0.71 | 0.63 | 0.60 | 0.40 | 0.27 | 0.22 | 0.57 | 0.55 | 0.54 | 0.29 | 0.15 | 0.10 | 0.40 | 0.30 | 0.19 | n/a | n/a | n/a |
| | 4 (102) | 0.74 | 0.65 | 0.61 | 0.44 | 0.29 | 0.24 | 0.58 | 0.55 | 0.54 | 0.36 | 0.18 | 0.12 | 0.44 | 0.33 | 0.24 | 0.58 | n/a | n/a |
| | 4-1/2 (114) | 0.77 | 0.67 | 0.63 | 0.50 | 0.31 | 0.25 | 0.59 | 0.56 | 0.55 | 0.42 | 0.22 | 0.14 | 0.50 | 0.35 | 0.25 | 0.61 | n/a | n/a |
| | 5 (127) | 0.80 | 0.69 | 0.64 | 0.55 | 0.33 | 0.27 | 0.60 | 0.57 | 0.55 | 0.50 | 0.26 | 0.17 | 0.55 | 0.38 | 0.27 | 0.65 | n/a | n/a |
| | 5-1/2 (140) | 0.83 | 0.70 | 0.65 | 0.61 | 0.35 | 0.28 | 0.62 | 0.57 | 0.56 | 0.57 | 0.30 | 0.19 | 0.61 | 0.40 | 0.28 | 0.68 | n/a | n/a |
| | 6 (152) | 0.86 | 0.72 | 0.67 | 0.66 | 0.38 | 0.30 | 0.63 | 0.58 | 0.56 | 0.65 | 0.34 | 0.22 | 0.66 | 0.43 | 0.30 | 0.71 | 0.57 | n/a |
| | 7 (178) | 0.92 | 0.76 | 0.69 | 0.77 | 0.43 | 0.33 | 0.65 | 0.59 | 0.57 | 0.82 | 0.42 | 0.28 | 0.82 | 0.49 | 0.33 | 0.77 | 0.61 | n/a |
| | 7-1/4 (184) | 0.94 | 0.77 | 0.70 | 0.80 | 0.44 | 0.34 | 0.65 | 0.60 | 0.57 | 0.87 | 0.45 | 0.29 | 0.87 | 0.50 | 0.34 | 0.78 | 0.62 | 0.54 |
| | 8 (203) | 0.98 | 0.80 | 0.72 | 0.88 | 0.49 | 0.36 | 0.67 | 0.61 | 0.58 | 1.00 | 0.52 | 0.34 | 1.00 | 0.56 | 0.36 | 0.82 | 0.66 | 0.57 |
| | 9 (229) | 1.00 | 0.83 | 0.75 | 0.99 | 0.55 | 0.40 | 0.69 | 0.62 | 0.59 | 1.00 | 0.62 | 0.40 | 1.00 | 0.63 | 0.40 | 0.87 | 0.70 | 0.60 |
| | 10 (254) | 1.00 | 0.87 | 0.78 | 1.00 | 0.61 | 0.44 | 0.71 | 0.63 | 0.60 | 1.00 | 0.72 | 0.47 | 1.00 | 0.72 | 0.47 | 0.92 | 0.73 | 0.64 |
| | 11 (279) | 1.00 | 0.91 | 0.81 | | 0.67 | 0.48 | 0.73 | 0.65 | 0.61 | | 0.84 | 0.54 | | 0.84 | 0.54 | 0.96 | 0.77 | 0.67 |
| | 12 (305) | 1.00 | 0.94 | 0.83 | | 0.73 | 0.53 | 0.75 | 0.66 | 0.62 | | 0.95 | 0.62 | | 0.95 | 0.62 | 1.00 | 0.80 | 0.70 |
| | 14 (356) | 1.00 | 1.00 | 0.89 | | 0.85 | 0.62 | 0.79 | 0.69 | 0.64 | | 1.00 | 0.78 | | 1.00 | 0.78 | | 0.87 | 0.75 |
| | 16 (406) | 1.00 | | 0.94 | | 0.98 | 0.70 | 0.83 | 0.72 | 0.66 | | | 0.95 | | | 0.95 | | 0.93 | 0.80 |
| | 18 (457) | | | 1.00 | | 1.00 | 0.79 | 0.88 | 0.74 | 0.68 | | | 1.00 | | | 1.00 | | 0.98 | 0.85 |
| | 24 (610) | | | | | | 1.00 | 1.00 | 0.82 | 0.74 | | | | | | | | 1.00 | 0.98 |
| | 30 (762) | | | | | | | | 0.90 | 0.80 | | | | | | | | | 1.00 |
| | 36 (914) | | | | | | | | 0.98 | 0.86 | | | | | | | | | |
| | > 48 (1219) | | | | | | | | 1.00 | 0.98 | | | | | | | | | |

## Table 13 — Load adjustment factors for 1/2-in. diameter Hilti HIT-Z and HIT-Z-R rods in Cracked Concrete [1,2]

| 1/2-in. HIT-Z(-R) cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 2-1/2 (64) | 0.65 | 0.59 | 0.57 | 0.71 | 0.56 | 0.50 | 0.55 | 0.53 | 0.53 | 0.18 | 0.09 | 0.06 | 0.35 | 0.18 | 0.12 | n/a | n/a | n/a |
| | 2-7/8 (73) | 0.67 | 0.61 | 0.58 | 0.77 | 0.59 | 0.53 | 0.56 | 0.54 | 0.53 | 0.22 | 0.11 | 0.07 | 0.44 | 0.23 | 0.15 | n/a | n/a | n/a |
| | 3 (76) | 0.68 | 0.61 | 0.58 | 0.79 | 0.60 | 0.53 | 0.56 | 0.54 | 0.53 | 0.23 | 0.12 | 0.08 | 0.47 | 0.24 | 0.16 | n/a | n/a | n/a |
| | 3-1/2 (89) | 0.71 | 0.63 | 0.60 | 0.88 | 0.65 | 0.57 | 0.57 | 0.55 | 0.54 | 0.29 | 0.15 | 0.10 | 0.59 | 0.30 | 0.20 | n/a | n/a | n/a |
| | 4 (102) | 0.74 | 0.65 | 0.61 | 0.98 | 0.70 | 0.60 | 0.58 | 0.55 | 0.54 | 0.36 | 0.18 | 0.12 | 0.72 | 0.37 | 0.24 | 0.58 | n/a | n/a |
| | 4-1/2 (114) | 0.77 | 0.67 | 0.63 | 1.00 | 0.75 | 0.64 | 0.59 | 0.56 | 0.55 | 0.43 | 0.22 | 0.14 | 0.86 | 0.44 | 0.29 | 0.62 | n/a | n/a |
| | 5 (127) | 0.80 | 0.69 | 0.64 | 1.00 | 0.80 | 0.67 | 0.61 | 0.57 | 0.55 | 0.50 | 0.26 | 0.17 | 1.00 | 0.52 | 0.34 | 0.65 | n/a | n/a |
| | 5-1/2 (140) | 0.83 | 0.70 | 0.65 | 1.00 | 0.86 | 0.71 | 0.62 | 0.57 | 0.56 | 0.58 | 0.30 | 0.19 | 1.00 | 0.60 | 0.39 | 0.68 | n/a | n/a |
| | 6 (152) | 0.86 | 0.72 | 0.67 | 1.00 | 0.91 | 0.75 | 0.63 | 0.58 | 0.56 | 0.66 | 0.34 | 0.22 | 1.00 | 0.68 | 0.44 | 0.71 | 0.57 | n/a |
| | 7 (178) | 0.92 | 0.76 | 0.69 | 1.00 | 1.00 | 0.83 | 0.65 | 0.59 | 0.57 | 0.83 | 0.43 | 0.28 | 1.00 | 0.86 | 0.56 | 0.77 | 0.62 | n/a |
| | 7-1/4 (184) | 0.94 | 0.77 | 0.70 | | | 0.85 | 0.65 | 0.60 | 0.57 | 0.88 | 0.45 | 0.29 | | 0.90 | 0.59 | 0.78 | 0.63 | 0.54 |
| | 8 (203) | 0.98 | 0.80 | 0.72 | | | 0.91 | 0.67 | 0.61 | 0.58 | 1.00 | 0.52 | 0.34 | | 1.00 | 0.68 | 0.82 | 0.66 | 0.57 |
| | 9 (229) | 1.00 | 0.83 | 0.75 | | | 1.00 | 0.69 | 0.62 | 0.59 | | 0.62 | 0.41 | | | 0.81 | 0.87 | 0.70 | 0.60 |
| | 10 (254) | 1.00 | 0.87 | 0.78 | | | | 0.71 | 0.64 | 0.60 | | 0.73 | 0.47 | | | 0.95 | 0.92 | 0.74 | 0.64 |
| | 11 (279) | 1.00 | 0.91 | 0.81 | | | | 0.73 | 0.65 | 0.61 | | 0.84 | 0.55 | | | 1.00 | 0.96 | 0.77 | 0.67 |
| | 12 (305) | | 0.94 | 0.83 | | | | 0.75 | 0.66 | 0.62 | | 0.96 | 0.62 | | | | 1.00 | 0.81 | 0.70 |
| | 14 (356) | | 1.00 | 0.89 | | | | 0.79 | 0.69 | 0.64 | | 1.00 | 0.79 | | | | | 0.87 | 0.75 |
| | 16 (406) | | | 0.94 | | | | 0.84 | 0.72 | 0.66 | | | 0.96 | | | | | 0.93 | 0.81 |
| | 18 (457) | | | 1.00 | | | | 0.88 | 0.74 | 0.68 | | | 1.00 | | | | | 0.99 | 0.85 |
| | 24 (610) | | | | | | | 1.00 | 0.82 | 0.74 | | | | | | | | 1.00 | 0.99 |
| | 30 (762) | | | | | | | | 0.91 | 0.80 | | | | | | | | | 1.00 |
| | 36 (914) | | | | | | | | 0.99 | 0.87 | | | | | | | | | |
| | > 48 (1219) | | | | | | | | 1.00 | 0.99 | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded area, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with figure 6 and table 7 of this section to calculate permissible edge distance, spacing and concrete thickness combinations.

**Table 14 — Load adjustment factors for 5/8-in. diameter Hilti HIT-Z and HIT-Z-R rods in uncracked concrete [1,2]**

| 5/8-in. HIT-Z(-R) uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 3-1/8 (79) | 0.64 | 0.59 | 0.57 | n/a | n/a | 0.20 | 0.55 | 0.54 | 0.53 | n/a | n/a | 0.07 | n/a | n/a | 0.13 | n/a | n/a | n/a |
| | 3-1/4 (83) | 0.64 | 0.60 | 0.57 | n/a | 0.24 | 0.20 | 0.55 | 0.54 | 0.53 | n/a | 0.11 | 0.07 | n/a | 0.21 | 0.14 | n/a | n/a | n/a |
| | 3-3/4 (95) | 0.67 | 0.61 | 0.58 | 0.34 | 0.25 | 0.21 | 0.56 | 0.54 | 0.53 | 0.23 | 0.13 | 0.09 | 0.34 | 0.27 | 0.17 | n/a | n/a | n/a |
| | 4 (102) | 0.68 | 0.62 | 0.59 | 0.36 | 0.26 | 0.22 | 0.57 | 0.55 | 0.53 | 0.25 | 0.15 | 0.10 | 0.36 | 0.29 | 0.19 | n/a | n/a | n/a |
| | 5 (127) | 0.72 | 0.65 | 0.61 | 0.42 | 0.29 | 0.24 | 0.58 | 0.56 | 0.54 | 0.36 | 0.21 | 0.13 | 0.42 | 0.38 | 0.24 | n/a | n/a | n/a |
| | 5-1/2 (140) | 0.74 | 0.66 | 0.62 | 0.45 | 0.31 | 0.25 | 0.59 | 0.56 | 0.55 | 0.41 | 0.24 | 0.15 | 0.45 | 0.40 | 0.25 | 0.61 | n/a | n/a |
| | 6 (152) | 0.77 | 0.68 | 0.63 | 0.49 | 0.33 | 0.26 | 0.60 | 0.57 | 0.55 | 0.47 | 0.27 | 0.18 | 0.49 | 0.42 | 0.26 | 0.63 | n/a | n/a |
| | 7 (178) | 0.81 | 0.71 | 0.66 | 0.57 | 0.36 | 0.29 | 0.62 | 0.58 | 0.56 | 0.59 | 0.34 | 0.22 | 0.59 | 0.47 | 0.29 | 0.68 | n/a | n/a |
| | 7-3/8 (187) | 0.83 | 0.72 | 0.66 | 0.60 | 0.38 | 0.30 | 0.62 | 0.59 | 0.56 | 0.64 | 0.37 | 0.24 | 0.64 | 0.49 | 0.30 | 0.70 | 0.58 | n/a |
| | 8 (203) | 0.86 | 0.74 | 0.68 | 0.65 | 0.40 | 0.31 | 0.63 | 0.59 | 0.57 | 0.72 | 0.41 | 0.27 | 0.72 | 0.52 | 0.31 | 0.73 | 0.61 | n/a |
| | 9 (229) | 0.90 | 0.77 | 0.70 | 0.73 | 0.45 | 0.34 | 0.65 | 0.60 | 0.58 | 0.86 | 0.50 | 0.32 | 0.86 | 0.58 | 0.34 | 0.78 | 0.65 | n/a |
| | 9-1/4 (235) | 0.91 | 0.77 | 0.71 | 0.76 | 0.46 | 0.35 | 0.65 | 0.61 | 0.58 | 0.89 | 0.52 | 0.34 | 0.89 | 0.59 | 0.35 | 0.79 | 0.65 | 0.57 |
| | 10 (254) | 0.94 | 0.80 | 0.72 | 0.82 | 0.50 | 0.37 | 0.67 | 0.62 | 0.59 | 1.00 | 0.58 | 0.38 | 1.00 | 0.64 | 0.38 | 0.82 | 0.68 | 0.59 |
| | 11 (279) | 0.99 | 0.83 | 0.74 | 0.90 | 0.55 | 0.39 | 0.68 | 0.63 | 0.60 | 1.00 | 0.67 | 0.43 | 1.00 | 0.70 | 0.43 | 0.86 | 0.71 | 0.62 |
| | 12 (305) | 1.00 | 0.86 | 0.77 | 0.98 | 0.60 | 0.43 | 0.70 | 0.64 | 0.60 | 1.00 | 0.76 | 0.50 | 1.00 | 0.77 | 0.50 | 0.90 | 0.75 | 0.65 |
| | 14 (356) | 1.00 | 0.91 | 0.81 | 1.00 | 0.70 | 0.50 | 0.73 | 0.66 | 0.62 | | 0.96 | 0.62 | | 0.96 | 0.62 | 0.97 | 0.81 | 0.70 |
| | 16 (406) | 1.00 | 0.97 | 0.86 | | 0.80 | 0.57 | 0.77 | 0.69 | 0.64 | | 1.00 | 0.76 | | 1.00 | 0.76 | 1.00 | 0.86 | 0.75 |
| | 18 (457) | 1.00 | 1.00 | 0.90 | | 0.89 | 0.64 | 0.80 | 0.71 | 0.66 | | | 0.91 | | | 0.91 | | 0.91 | 0.79 |
| | 24 (610) | 1.00 | | 1.00 | | 1.00 | 0.86 | 0.90 | 0.78 | 0.71 | | | 1.00 | | | 1.00 | | 1.00 | 0.91 |
| | 30 (762) | | | | | | 1.00 | 1.00 | 0.85 | 0.76 | | | | | | | | | 1.00 |
| | 36 (914) | | | | | | | | 0.92 | 0.81 | | | | | | | | | |
| | > 48 (1219) | | | | | | | | 1.00 | 0.92 | | | | | | | | | |

**Table 15 — Load adjustment factors for 5/8-in. diameter Hilti HIT-Z and HIT-Z-R rods in cracked concrete [1,2]**

| 5/8-in. HIT-Z(-R) cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) | 3-3/4 (95) | 5-5/8 (143) | 7-1/2 (191) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete thickness (h), - in. (mm) | 3-1/8 (79) | 0.64 | 0.59 | 0.57 | 0.67 | 0.56 | 0.50 | 0.55 | 0.54 | 0.53 | 0.18 | 0.10 | 0.07 | 0.35 | 0.20 | 0.13 | n/a | n/a | n/a |
| | 3-1/4 (83) | 0.64 | 0.60 | 0.57 | 0.69 | 0.56 | 0.51 | 0.55 | 0.54 | 0.53 | 0.19 | 0.11 | 0.07 | 0.38 | 0.22 | 0.14 | n/a | n/a | n/a |
| | 3-3/4 (95) | 0.67 | 0.61 | 0.58 | 0.75 | 0.60 | 0.53 | 0.56 | 0.54 | 0.53 | 0.23 | 0.13 | 0.09 | 0.47 | 0.27 | 0.17 | n/a | n/a | n/a |
| | 4 (102) | 0.68 | 0.62 | 0.59 | 0.78 | 0.62 | 0.55 | 0.57 | 0.55 | 0.53 | 0.26 | 0.15 | 0.10 | 0.51 | 0.30 | 0.19 | n/a | n/a | n/a |
| | 5 (127) | 0.72 | 0.65 | 0.61 | 0.91 | 0.70 | 0.60 | 0.58 | 0.56 | 0.54 | 0.36 | 0.21 | 0.13 | 0.72 | 0.41 | 0.27 | n/a | n/a | n/a |
| | 5-1/2 (140) | 0.74 | 0.66 | 0.62 | 0.98 | 0.74 | 0.63 | 0.59 | 0.56 | 0.55 | 0.41 | 0.24 | 0.15 | 0.83 | 0.48 | 0.31 | 0.61 | n/a | n/a |
| | 6 (152) | 0.77 | 0.68 | 0.63 | 1.00 | 0.78 | 0.66 | 0.60 | 0.57 | 0.55 | 0.47 | 0.27 | 0.18 | 0.94 | 0.54 | 0.35 | 0.64 | n/a | n/a |
| | 7 (178) | 0.81 | 0.71 | 0.66 | 1.00 | 0.87 | 0.72 | 0.62 | 0.58 | 0.56 | 0.59 | 0.34 | 0.22 | 1.00 | 0.68 | 0.44 | 0.69 | n/a | n/a |
| | 7-3/8 (187) | 0.83 | 0.72 | 0.66 | 1.00 | 0.90 | 0.74 | 0.62 | 0.59 | 0.56 | 0.64 | 0.37 | 0.24 | 1.00 | 0.74 | 0.48 | 0.70 | 0.59 | n/a |
| | 8 (203) | 0.86 | 0.74 | 0.68 | 1.00 | 0.96 | 0.78 | 0.63 | 0.59 | 0.57 | 0.73 | 0.42 | 0.27 | 1.00 | 0.84 | 0.54 | 0.73 | 0.61 | n/a |
| | 9 (229) | 0.90 | 0.77 | 0.70 | 1.00 | 1.00 | 0.85 | 0.65 | 0.60 | 0.58 | 0.87 | 0.50 | 0.32 | 1.00 | 1.00 | 0.65 | 0.78 | 0.65 | n/a |
| | 9-1/4 (235) | 0.91 | 0.77 | 0.71 | | | 0.86 | 0.66 | 0.61 | 0.58 | 0.90 | 0.52 | 0.34 | | | 0.68 | 0.79 | 0.66 | 0.57 |
| | 10 (254) | 0.94 | 0.80 | 0.72 | | | 0.91 | 0.67 | 0.62 | 0.59 | 1.00 | 0.58 | 0.38 | | | 0.76 | 0.82 | 0.68 | 0.59 |
| | 11 (279) | 0.99 | 0.83 | 0.74 | | | 0.98 | 0.69 | 0.63 | 0.60 | | 0.67 | 0.44 | | | 0.88 | 0.86 | 0.72 | 0.62 |
| | 12 (305) | 1.00 | 0.86 | 0.77 | | | 1.00 | 0.70 | 0.64 | 0.60 | | 0.77 | 0.50 | | | 1.00 | 0.90 | 0.75 | 0.65 |
| | 14 (356) | 1.00 | 0.91 | 0.81 | | | | 0.74 | 0.66 | 0.62 | | 0.97 | 0.63 | | | 1.00 | 0.97 | 0.81 | 0.70 |
| | 16 (406) | | 0.97 | 0.86 | | | | 0.77 | 0.69 | 0.64 | | 1.00 | 0.77 | | | | 1.00 | 0.86 | 0.75 |
| | 18 (457) | | 1.00 | 0.90 | | | | 0.80 | 0.71 | 0.66 | | | 0.92 | | | | | 0.92 | 0.79 |
| | 24 (610) | | | 1.00 | | | | 0.90 | 0.78 | 0.71 | | | 1.00 | | | | | 1.00 | 0.92 |
| | 30 (762) | | | | | | | 1.00 | 0.85 | 0.76 | | | | | | | | | 1.00 |
| | 36 (914) | | | | | | | | 0.92 | 0.81 | | | | | | | | | |
| | > 48 (1219) | | | | | | | | 1.00 | 0.92 | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded area, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with figure 6 and table 8 of this section to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 16 — Load adjustment factors for 3/4-in. diameter Hilti HIT-Z and HIT-Z-R rods in uncracked concrete [1,2]

| 3/4-in. HIT-Z(-R) uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 3-3/4 (95) | 0.66 | 0.59 | 0.57 | n/a | n/a | n/a | 0.56 | 0.54 | 0.53 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.67 | 0.60 | 0.58 | n/a | n/a | 0.21 | 0.57 | 0.54 | 0.53 | n/a | n/a | 0.08 | n/a | n/a | 0.17 | n/a | n/a | n/a |
| | 4-1/8 (105) | 0.67 | 0.60 | 0.58 | n/a | n/a | 0.21 | 0.57 | 0.54 | 0.53 | n/a | n/a | 0.09 | n/a | n/a | 0.18 | n/a | n/a | n/a |
| | 4-1/4 (108) | 0.68 | 0.60 | 0.58 | n/a | 0.24 | 0.21 | 0.57 | 0.54 | 0.53 | n/a | 0.13 | 0.09 | n/a | 0.26 | 0.19 | n/a | n/a | n/a |
| | 5 (127) | 0.71 | 0.62 | 0.60 | 0.39 | 0.26 | 0.23 | 0.58 | 0.55 | 0.54 | 0.35 | 0.17 | 0.12 | 0.39 | 0.32 | 0.23 | n/a | n/a | n/a |
| | 5-3/4 (146) | 0.74 | 0.64 | 0.61 | 0.44 | 0.28 | 0.24 | 0.59 | 0.56 | 0.55 | 0.43 | 0.21 | 0.15 | 0.44 | 0.34 | 0.24 | 0.61 | n/a | n/a |
| | 6 (152) | 0.75 | 0.65 | 0.62 | 0.45 | 0.28 | 0.24 | 0.60 | 0.56 | 0.55 | 0.45 | 0.22 | 0.16 | 0.45 | 0.35 | 0.24 | 0.63 | n/a | n/a |
| | 7 (178) | 0.79 | 0.67 | 0.64 | 0.53 | 0.31 | 0.27 | 0.61 | 0.57 | 0.56 | 0.57 | 0.28 | 0.20 | 0.57 | 0.38 | 0.27 | 0.68 | n/a | n/a |
| | 8 (203) | 0.83 | 0.70 | 0.66 | 0.60 | 0.34 | 0.29 | 0.63 | 0.58 | 0.56 | 0.70 | 0.34 | 0.24 | 0.70 | 0.42 | 0.29 | 0.72 | n/a | n/a |
| | 8-1/2 (216) | 0.85 | 0.71 | 0.67 | 0.64 | 0.36 | 0.30 | 0.64 | 0.59 | 0.57 | 0.77 | 0.37 | 0.26 | 0.77 | 0.44 | 0.30 | 0.75 | 0.59 | n/a |
| | 9 (229) | 0.88 | 0.72 | 0.68 | 0.68 | 0.37 | 0.31 | 0.65 | 0.59 | 0.57 | 0.83 | 0.40 | 0.29 | 0.83 | 0.45 | 0.31 | 0.77 | 0.60 | n/a |
| | 10 (254) | 0.92 | 0.75 | 0.70 | 0.75 | 0.40 | 0.33 | 0.66 | 0.60 | 0.58 | 0.98 | 0.47 | 0.33 | 0.98 | 0.49 | 0.33 | 0.81 | 0.64 | n/a |
| | 10-1/4 (260) | 0.93 | 0.75 | 0.70 | 0.77 | 0.41 | 0.34 | 0.67 | 0.60 | 0.58 | 1.00 | 0.49 | 0.35 | 1.00 | 0.50 | 0.35 | 0.82 | 0.64 | 0.57 |
| | 11 (279) | 0.96 | 0.77 | 0.72 | 0.83 | 0.44 | 0.35 | 0.68 | 0.61 | 0.59 | 1.00 | 0.55 | 0.39 | 1.00 | 0.55 | 0.39 | 0.85 | 0.67 | 0.59 |
| | 12 (305) | 1.00 | 0.80 | 0.74 | 0.90 | 0.48 | 0.38 | 0.70 | 0.62 | 0.60 | 1.00 | 0.62 | 0.44 | 1.00 | 0.62 | 0.44 | 0.89 | 0.70 | 0.62 |
| | 14 (356) | 1.00 | 0.85 | 0.77 | 1.00 | 0.56 | 0.43 | 0.73 | 0.64 | 0.61 | 1.00 | 0.78 | 0.55 | 1.00 | 0.78 | 0.55 | 0.96 | 0.75 | 0.67 |
| | 16 (406) | 1.00 | 0.90 | 0.81 | 1.00 | 0.64 | 0.50 | 0.76 | 0.66 | 0.63 | 1.00 | 0.96 | 0.68 | 1.00 | 0.96 | 0.68 | 1.00 | 0.80 | 0.72 |
| | 18 (457) | 1.00 | 0.94 | 0.85 | 1.00 | 0.72 | 0.56 | 0.80 | 0.68 | 0.64 | 1.00 | 1.00 | 0.81 | 1.00 | 1.00 | 0.81 | | 0.85 | 0.76 |
| | 24 (610) | 1.00 | 1.00 | 0.97 | 1.00 | 0.97 | 0.75 | 0.89 | 0.74 | 0.69 | 1.00 | | 1.00 | 1.00 | | 1.00 | | 0.99 | 0.88 |
| | 30 (762) | 1.00 | | 1.00 | | 1.00 | 0.93 | 0.99 | 0.80 | 0.74 | | | | | | | | 1.00 | 0.98 |
| | 36 (914) | | | | | | 1.00 | 1.00 | 0.86 | 0.79 | | | | | | | | | 1.00 |
| | > 48 (1219) | | | | | | | | 0.99 | 0.89 | | | | | | | | | |

## Table 17 — Load adjustment factors for 3/4-in. diameter Hilti HIT-Z and HIT-Z-R rods in cracked concrete [1,2]

| 3/4-in. HIT-Z(-R) cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) | 4 (102) | 6-3/4 (171) | 8-1/2 (216) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 3-3/4 (95) | 0.66 | 0.59 | 0.57 | n/a | 0.56 | 0.51 | 0.56 | 0.54 | 0.53 | n/a | 0.11 | 0.08 | n/a | 0.22 | 0.16 | n/a | n/a | n/a |
| | 4 (102) | 0.67 | 0.60 | 0.58 | n/a | 0.57 | 0.52 | 0.57 | 0.54 | 0.53 | n/a | 0.12 | 0.09 | n/a | 0.24 | 0.17 | n/a | n/a | n/a |
| | 4-1/8 (105) | 0.67 | 0.60 | 0.58 | 0.76 | 0.58 | 0.53 | 0.57 | 0.54 | 0.53 | 0.26 | 0.13 | 0.09 | 0.52 | 0.25 | 0.18 | n/a | n/a | n/a |
| | 4-1/4 (108) | 0.68 | 0.60 | 0.58 | 0.78 | 0.59 | 0.53 | 0.57 | 0.54 | 0.53 | 0.27 | 0.13 | 0.09 | 0.55 | 0.26 | 0.19 | n/a | n/a | n/a |
| | 5 (127) | 0.71 | 0.62 | 0.60 | 0.87 | 0.63 | 0.57 | 0.58 | 0.55 | 0.54 | 0.35 | 0.17 | 0.12 | 0.70 | 0.34 | 0.24 | n/a | n/a | n/a |
| | 5-3/4 (146) | 0.74 | 0.64 | 0.61 | 0.97 | 0.68 | 0.61 | 0.59 | 0.56 | 0.55 | 0.43 | 0.21 | 0.15 | 0.86 | 0.42 | 0.29 | 0.62 | n/a | n/a |
| | 6 (152) | 0.75 | 0.65 | 0.62 | 1.00 | 0.70 | 0.62 | 0.60 | 0.56 | 0.55 | 0.46 | 0.22 | 0.16 | 0.92 | 0.44 | 0.31 | 0.63 | n/a | n/a |
| | 7 (178) | 0.79 | 0.67 | 0.64 | 1.00 | 0.77 | 0.67 | 0.62 | 0.57 | 0.56 | 0.58 | 0.28 | 0.20 | 1.00 | 0.56 | 0.40 | 0.68 | n/a | n/a |
| | 8 (203) | 0.83 | 0.70 | 0.66 | 1.00 | 0.84 | 0.72 | 0.63 | 0.58 | 0.56 | 0.70 | 0.34 | 0.24 | 1.00 | 0.68 | 0.48 | 0.73 | n/a | n/a |
| | 8-1/2 (216) | 0.85 | 0.71 | 0.67 | 1.00 | 0.88 | 0.75 | 0.64 | 0.59 | 0.57 | 0.77 | 0.37 | 0.26 | 1.00 | 0.75 | 0.53 | 0.75 | 0.59 | n/a |
| | 9 (229) | 0.88 | 0.72 | 0.68 | 1.00 | 0.91 | 0.78 | 0.65 | 0.59 | 0.57 | 0.84 | 0.41 | 0.29 | 1.00 | 0.82 | 0.58 | 0.77 | 0.61 | n/a |
| | 10 (254) | 0.92 | 0.75 | 0.70 | 1.00 | 0.99 | 0.83 | 0.67 | 0.60 | 0.58 | 0.99 | 0.48 | 0.34 | 1.00 | 0.95 | 0.68 | 0.81 | 0.64 | n/a |
| | 10-1/4 (260) | 0.93 | 0.75 | 0.70 | 1.00 | 1.00 | 0.85 | 0.67 | 0.60 | 0.58 | 1.00 | 0.50 | 0.35 | 1.00 | 0.99 | 0.70 | 0.82 | 0.65 | 0.58 |
| | 11 (279) | 0.96 | 0.77 | 0.72 | 1.00 | | 0.89 | 0.68 | 0.61 | 0.59 | 1.00 | 0.55 | 0.39 | 1.00 | 1.00 | 0.78 | 0.85 | 0.67 | 0.60 |
| | 12 (305) | 1.00 | 0.80 | 0.74 | 1.00 | | 0.95 | 0.70 | 0.62 | 0.60 | 1.00 | 0.63 | 0.44 | 1.00 | | 0.89 | 0.89 | 0.70 | 0.62 |
| | 14 (356) | 1.00 | 0.85 | 0.77 | 1.00 | | 1.00 | 0.73 | 0.64 | 0.61 | 1.00 | 0.79 | 0.56 | 1.00 | | 1.00 | 0.96 | 0.76 | 0.67 |
| | 16 (406) | 1.00 | 0.90 | 0.81 | | | | 0.76 | 0.66 | 0.63 | | 0.97 | 0.68 | | | | 1.00 | 0.81 | 0.72 |
| | 18 (457) | 1.00 | 0.94 | 0.85 | | | | 0.80 | 0.68 | 0.65 | | 1.00 | 0.82 | | | | | 0.86 | 0.76 |
| | 24 (610) | 1.00 | 1.00 | 0.97 | | | | 0.90 | 0.74 | 0.69 | | | 1.00 | | | | | 0.99 | 0.88 |
| | 30 (762) | | | 1.00 | | | | 1.00 | 0.81 | 0.74 | | | | | | | | 1.00 | 0.98 |
| | 36 (914) | | | | | | | 1.00 | 0.87 | 0.79 | | | | | | | | | 1.00 |
| | >48 (1219) | | | | | | | | 0.99 | 0.89 | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded area, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with figure 6 and table 9 of this section to calculate permissible edge distance, spacing and concrete thickness combinations.

**Hilti HIT-HY 200 A/R V3 adhesive with deformed reinforcing bars (rebar)**





**Figure 7 — Rebar installation conditions**

| Permissible concrete conditions | | Permissible drilling method | |
|---|---|---|---|
|  Uncracked concrete |  Dry concrete |  | Hammer drilling with carbide tipped drill bit |
|  Cracked concrete |  Water-saturated concrete |  | Hilti TE-CD or TE-YD Hollow Drill Bit |
| |  Water-filled holes | | |

**Figure 8 — Rebar installed with Hilti HIT-HY 200 A/R V3 adhesive**

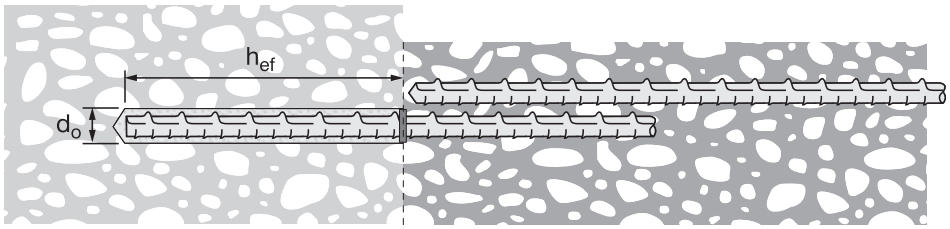



**Table 18 — Specifications for rebar installed with Hilti HIT-HY 200 A/R V3 adhesive**

| Setting information | | Symbol | Units | Rebar size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Nominal bit diameter | | $d_o$ | in. | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/8 | 1-3/8 | 1-1/2 |
| Effective embedment | minimum | $h_{ef,min}$ | in. | 2-3/8 | 2-3/4 | 3-1/8 | 3-1/2 | 3-1/2 | 4 | 4-1/2 | 5 |
| | | | (mm) | (60) | (70) | (79) | (89) | (89) | (102) | (114) | (127) |
| | maximum | $h_{ef,max}$ | in. | 7-1/2 | 10 | 12-1/2 | 15 | 17-1/2 | 20 | 22-1/2 | 25 |
| | | | (mm) | (191) | (254) | (318) | (381) | (445) | (508) | (572) | (635) |
| Minimum concrete member thickness | | $h_{min}$ | in. | $h_{ef}$ + 1-1/4 | | $h_{ef}$ + $2d_o$ | | | | | |
| | | | (mm) | ($h_{ef}$ + 30) | | | | | | | |
| Minimum edge distance[1] | | $c_{min}$ | in. | 1-7/8 | 2-1/2 | 3-1/8 | 3-3/4 | 4-3/8 | 5 | 5-5/8 | 6-1/4 |
| | | | (mm) | (48) | (64) | (79) | (95) | (111) | (127) | (143) | (159) |
| Minimum anchor spacing | | $s_{min}$ | in. | 1-7/8 | 2-1/2 | 3-1/8 | 3-3/4 | 4-3/8 | 5 | 5-5/8 | 6-1/4 |
| | | | (mm) | (48) | (64) | (79) | (95) | (111) | (127) | (143) | (159) |

1 Edge distance of 1-3/4-inch (44mm) is permitted provided the rebar remains un-torqued.

Note: The installation specifications in table 18 above and the data in tables 19 through 37 pertain to the use of Hilti HIT-HY 200 A/R V3 with rebar designed as a post-installed anchor using the provisions of ACI 318 Chapter 17. For the use of Hilti HIT-HY 200 A/R V3 with rebar for typical development calculations according to ACI 318 Chapter 25 (formerly ACI 318-11 Chapter 12), refer to section 3.1.14 for the design method and tables 89 through 93 at the end of this section.

## Table 19 — Hilti HIT-HY 200 A/R V3 adhesive design strength with concrete / bond failure for rebar in uncracked concrete [1,2,3,4,5,6,7,8,9]

| Rebar size | Effective embedment in. (mm) | Tension — $\phi N_n$ | | | | Shear — $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| #3 | 3-3/8 (86) | 4,030 (17.9) | 4,105 (18.3) | 4,225 (18.8) | 4,400 (19.6) | 8,685 (38.6) | 8,845 (39.3) | 9,100 (40.5) | 9,480 (42.2) |
| | 4-1/2 (114) | 5,375 (23.9) | 5,475 (24.4) | 5,635 (25.1) | 5,865 (26.1) | 11,580 (51.5) | 11,790 (52.4) | 12,135 (54.0) | 12,640 (56.2) |
| | 7-1/2 (191) | 8,960 (39.9) | 9,125 (40.6) | 9,390 (41.8) | 9,780 (43.5) | 19,295 (85.8) | 19,650 (87.4) | 20,225 (90.0) | 21,065 (93.7) |
| #4 | 4-1/2 (114) | 7,170 (31.9) | 7,300 (32.5) | 7,510 (33.4) | 7,825 (34.8) | 15,440 (68.7) | 15,720 (69.9) | 16,180 (72.0) | 16,850 (75.0) |
| | 6 (152) | 9,555 (42.5) | 9,735 (43.3) | 10,015 (44.5) | 10,430 (46.4) | 20,585 (91.6) | 20,960 (93.2) | 21,575 (96.0) | 22,465 (99.9) |
| | 10 (254) | 15,930 (70.9) | 16,220 (72.1) | 16,695 (74.3) | 17,385 (77.3) | 34,305 (152.6) | 34,935 (155.4) | 35,955 (159.9) | 37,445 (166.6) |
| #5 | 5-5/8 (143) | 10,405 (46.3) | 11,400 (50.7) | 11,740 (52.2) | 12,225 (54.4) | 22,415 (99.7) | 24,550 (109.2) | 25,280 (112.5) | 26,330 (117.1) |
| | 7-1/2 (191) | 14,930 (66.4) | 15,205 (67.6) | 15,650 (69.6) | 16,300 (72.5) | 32,160 (143.1) | 32,755 (145.7) | 33,710 (149.9) | 35,105 (156.2) |
| | 12-1/2 (318) | 24,885 (110.7) | 25,345 (112.7) | 26,085 (116.0) | 27,165 (120.8) | 53,605 (238.4) | 54,590 (242.8) | 56,185 (249.9) | 58,510 (260.3) |
| #6 | 6-3/4 (171) | 13,680 (60.9) | 14,985 (66.7) | 16,905 (75.2) | 17,600 (78.3) | 29,460 (131.0) | 32,275 (143.6) | 36,405 (161.9) | 37,915 (168.7) |
| | 9 (229) | 21,060 (93.7) | 21,900 (97.4) | 22,535 (100.2) | 23,470 (104.4) | 45,360 (201.8) | 47,165 (209.8) | 48,540 (215.9) | 50,550 (224.9) |
| | 15 (381) | 35,840 (159.4) | 36,495 (162.3) | 37,560 (167.1) | 39,115 (174.0) | 77,190 (343.4) | 78,610 (349.7) | 80,905 (359.9) | 84,250 (374.8) |
| #7 | 7-7/8 (200) | 17,235 (76.7) | 18,885 (84.0) | 21,805 (97.0) | 23,960 (106.6) | 37,125 (165.1) | 40,670 (180.9) | 46,960 (208.9) | 51,605 (229.5) |
| | 10-1/2 (267) | 26,540 (118.1) | 29,070 (129.3) | 30,675 (136.4) | 31,945 (142.1) | 57,160 (254.3) | 62,615 (278.5) | 66,070 (293.9) | 68,805 (306.1) |
| | 17-1/2 (445) | 48,780 (217.0) | 49,675 (221.0) | 51,125 (227.4) | 53,240 (236.8) | 105,065 (467.4) | 106,995 (475.9) | 110,120 (489.8) | 114,675 (510.1) |
| #8 | 9 (229) | 21,060 (93.7) | 23,070 (102.6) | 26,640 (118.5) | 31,295 (139.2) | 45,360 (201.8) | 49,690 (221.0) | 57,375 (255.2) | 67,400 (299.8) |
| | 12 (305) | 32,425 (144.2) | 35,520 (158.0) | 40,065 (178.2) | 41,725 (185.6) | 69,835 (310.6) | 76,500 (340.3) | 86,295 (383.9) | 89,870 (399.8) |
| | 20 (508) | 63,710 (283.4) | 64,885 (288.6) | 66,775 (297.0) | 69,540 (309.3) | 137,225 (610.4) | 139,750 (621.6) | 143,830 (639.8) | 149,780 (666.3) |
| #9 | 10-1/8 (257) | 25,130 (111.8) | 27,530 (122.5) | 31,785 (141.4) | 38,930 (173.2) | 54,125 (240.8) | 59,290 (263.7) | 68,465 (304.5) | 83,850 (373.0) |
| | 13-1/2 (343) | 38,690 (172.1) | 42,380 (188.5) | 48,940 (217.7) | 52,805 (234.9) | 83,330 (370.7) | 91,285 (406.1) | 105,405 (468.9) | 113,740 (505.9) |
| | 22-1/2 (572) | 80,635 (358.7) | 82,120 (365.3) | 84,515 (375.9) | 88,010 (391.5) | 173,675 (772.5) | 176,870 (786.8) | 182,035 (809.7) | 189,565 (843.2) |
| #10 | 11-1/4 (286) | 29,430 (130.9) | 32,240 (143.4) | 37,230 (165.6) | 45,595 (202.8) | 63,395 (282.0) | 69,445 (308.9) | 80,185 (356.7) | 98,205 (436.8) |
| | 15 (381) | 45,315 (201.6) | 49,640 (220.8) | 57,320 (255.0) | 65,195 (290.0) | 97,600 (434.1) | 106,915 (475.6) | 123,455 (549.2) | 140,420 (624.6) |
| | 25 (635) | 97,500 (433.7) | 101,380 (451.0) | 104,340 (464.1) | 108,655 (483.3) | 210,000 (934.1) | 218,360 (971.3) | 224,730 (999.6) | 234,030 (1041.0) |

1 See section 3.1.8 for explanation on development of load values.
2 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 22 - 37 as necessary to the above values. Compare to the steel values in table 21.The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C).
For temperature range C: Max. short term temperature = 248° F (120° C), max. long term temperature = 162° F (72° C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength value by 0.68.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete, multiply design strength (factored resistance) by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 20 — Hilti HIT-HY 200 A/R V3 adhesive design strength with concrete / bond failure for rebar in cracked concrete[1,2,3,4,5,6,7,8,9]

| Rebar size | Effective embedment in. (mm) | Tension — $\phi N_n$ | | | | Shear — $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| #3 | 3-3/8 (86) | 2,790 (12.4) | 2,845 (12.7) | 2,925 (13.0) | 3,045 (13.5) | 6,010 (26.7) | 6,120 (27.2) | 6,300 (28.0) | 6,560 (29.2) |
| | 4-1/2 (114) | 3,720 (16.5) | 3,790 (16.9) | 3,900 (17.3) | 4,060 (18.1) | 8,015 (35.7) | 8,165 (36.3) | 8,400 (37.4) | 8,750 (38.9) |
| | 7-1/2 (191) | 6,205 (27.6) | 6,315 (28.1) | 6,500 (28.9) | 6,770 (30.1) | 13,360 (59.4) | 13,605 (60.5) | 14,005 (62.3) | 14,580 (64.9) |
| #4 | 4-1/2 (114) | 4,960 (22.1) | 5,055 (22.5) | 5,200 (23.1) | 5,415 (24.1) | 10,690 (47.6) | 10,885 (48.4) | 11,200 (49.8) | 11,665 (51.9) |
| | 6 (152) | 6,615 (29.4) | 6,740 (30.0) | 6,935 (30.8) | 7,220 (32.1) | 14,250 (63.4) | 14,510 (64.5) | 14,935 (66.4) | 15,555 (69.2) |
| | 10 (254) | 11,025 (49.0) | 11,230 (50.0) | 11,560 (51.4) | 12,035 (53.5) | 23,750 (105.6) | 24,185 (107.6) | 24,895 (110.7) | 25,925 (115.3) |
| #5 | 5-5/8 (143) | 7,370 (32.8) | 7,970 (35.5) | 8,200 (36.5) | 8,540 (38.0) | 15,875 (70.6) | 17,165 (76.4) | 17,665 (78.6) | 18,395 (81.8) |
| | 7-1/2 (191) | 10,435 (46.4) | 10,625 (47.3) | 10,935 (48.6) | 11,390 (50.7) | 22,470 (100.0) | 22,885 (101.8) | 23,555 (104.8) | 24,530 (109.1) |
| | 12-1/2 (318) | 17,390 (77.4) | 17,710 (78.8) | 18,225 (81.1) | 18,980 (84.4) | 37,455 (166.6) | 38,145 (169.7) | 39,255 (174.6) | 40,880 (181.8) |
| #6 | 6-3/4 (171) | 9,690 (43.1) | 10,615 (47.2) | 11,810 (52.5) | 12,300 (54.7) | 20,870 (92.8) | 22,860 (101.7) | 25,440 (113.2) | 26,490 (117.8) |
| | 9 (229) | 14,920 (66.4) | 15,300 (68.1) | 15,745 (70.0) | 16,400 (73.0) | 32,130 (142.9) | 32,955 (146.6) | 33,915 (150.9) | 35,320 (157.1) |
| | 15 (381) | 25,040 (111.4) | 25,500 (113.4) | 26,245 (116.7) | 27,330 (121.6) | 53,935 (239.9) | 54,925 (244.3) | 56,530 (251.5) | 58,870 (261.9) |
| #7 | 7-7/8 (200) | 11,750 (52.3) | 11,965 (53.2) | 12,315 (54.8) | 12,825 (57.0) | 25,305 (112.6) | 25,770 (114.6) | 26,525 (118.0) | 27,620 (122.9) |
| | 10-1/2 (267) | 15,665 (69.7) | 15,955 (71.0) | 16,420 (73.0) | 17,100 (76.1) | 33,740 (150.1) | 34,360 (152.8) | 35,365 (157.3) | 36,830 (163.8) |
| | 17-1/2 (445) | 26,110 (116.1) | 26,590 (118.3) | 27,365 (121.7) | 28,500 (126.8) | 56,235 (250.1) | 57,270 (254.7) | 58,940 (262.2) | 61,380 (273.0) |
| #8 | 9 (229) | 14,920 (66.4) | 15,720 (69.9) | 16,180 (72.0) | 16,850 (75.0) | 32,130 (142.9) | 33,860 (150.6) | 34,850 (155.0) | 36,295 (161.4) |
| | 12 (305) | 20,585 (91.6) | 20,960 (93.2) | 21,575 (96.0) | 22,465 (99.9) | 44,335 (197.2) | 45,150 (200.8) | 46,470 (206.7) | 48,390 (215.2) |
| | 20 (508) | 34,305 (152.6) | 34,935 (155.4) | 35,955 (159.9) | 37,445 (166.6) | 73,890 (328.7) | 75,250 (334.7) | 77,445 (344.5) | 80,650 (358.7) |
| #9 | 10-1/8 (257) | 17,800 (79.2) | 19,500 (86.7) | 20,720 (92.2) | 21,580 (96.0) | 38,340 (170.5) | 42,000 (186.8) | 44,635 (198.5) | 46,480 (206.8) |
| | 13-1/2 (343) | 26,360 (117.3) | 26,845 (119.4) | 27,630 (122.9) | 28,775 (128.0) | 56,780 (252.6) | 57,825 (257.2) | 59,510 (264.7) | 61,975 (275.7) |
| | 22-1/2 (572) | 43,935 (195.4) | 44,745 (199.0) | 46,050 (204.8) | 47,955 (213.3) | 94,630 (420.9) | 96,370 (428.7) | 99,185 (441.2) | 103,290 (459.5) |
| #10 | 11-1/4 (286) | 20,850 (92.7) | 22,840 (101.6) | 25,585 (113.8) | 26,640 (118.5) | 44,905 (199.7) | 49,190 (218.8) | 55,105 (245.1) | 57,385 (255.3) |
| | 15 (381) | 32,095 (142.8) | 33,145 (147.4) | 34,110 (151.7) | 35,525 (158.0) | 69,135 (307.5) | 71,385 (317.5) | 73,470 (326.8) | 76,510 (340.3) |
| | 25 (635) | 54,240 (241.3) | 55,240 (245.7) | 56,850 (252.9) | 59,205 (263.4) | 116,830 (519.7) | 118,980 (529.2) | 122,450 (544.7) | 127,515 (567.2) |

1 See section 3.1.8 for explanation on development of load values.
2 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 22 - 37 as necessary to the above values. Compare to the steel values in table 21.The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C).
For temperature range C: Max. short term temperature = 248° F (120° C), max. long term temperature = 162° F (72° C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength value by 0.68.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete, multiply design strength (factored resistance) by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors:
#3 to #6 - $\alpha_{seis}$ = 0.60, #7 - $\alpha_{seis}$ = 0.64, #8 - $\alpha_{seis}$ = 0.68, #9 - $\alpha_{seis}$ = 0.71, #10 - $\alpha_{seis}$ = 0.75
See section 3.1.8 for additional information on seismic applications.

**Table 21 — Steel design strength for US rebar[1,2]**

| Rebar size | ASTM A615 Grade 40 [4] | | | ASTM A615 Grade 60 [4] | | | ASTM A706 Grade 60 [4] | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic[5] Shear $\phi V_{sa,eq}$ lb (kN) | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic[5] Shear $\phi V_{sa,eq}$ lb (kN) | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic[5] Shear $\phi V_{sa,eq}$ lb (kN) |
| #3 | 4,290 (19.1) | 2,375 (10.6) | 1,665 (7.4) | 5,720 (25.4) | 3,170 (14.1) | 2,220 (9.9) | 6,600 (29.4) | 3,430 (15.3) | 2,400 (10.7) |
| #4 | 7,800 (34.7) | 4,320 (19.2) | 3,025 (13.4) | 10,400 (46.3) | 5,760 (25.6) | 4,030 (17.9) | 12,000 (53.4) | 6,240 (27.8) | 4,370 (19.5) |
| #5 | 12,090 (53.8) | 6,695 (29.8) | 4,685 (20.9) | 16,120 (71.7) | 8,930 (39.7) | 6,250 (27.8) | 18,600 (82.7) | 9,670 (43.0) | 6,770 (30.1) |
| #6 | 17,160 (76.3) | 9,505 (42.3) | 6,655 (29.6) | 22,880 (101.8) | 12,670 (56.4) | 8,870 (39.5) | 26,400 (117.4) | 13,730 (61.1) | 9,610 (42.8) |
| #7 | 23,400 (104.1) | 12,960 (57.6) | 9,070 (40.3) | 31,200 (138.8) | 17,280 (76.9) | 12,095 (53.8) | 36,000 (160.1) | 18,720 (83.3) | 13,105 (58.3) |
| #8 | 30,810 (137.0) | 17,065 (75.9) | 11,945 (53.1) | 41,080 (182.7) | 22,750 (101.2) | 15,925 (70.8) | 47,400 (210.8) | 24,650 (109.6) | 17,255 (76.7) |
| #9 | 39,000 (173.5) | 21,600 (96.1) | 15,120 (67.3) | 52,000 (231.3) | 28,800 (128.1) | 20,160 (89.7) | 60,000 (266.9) | 31,200 (138.8) | 21,840 (97.2) |
| #10 | 49,530 (220.3) | 27,430 (122.0) | 19,200 (85.4) | 66,040 (293.8) | 36,575 (162.7) | 25,605 (113.9) | 76,200 (339.0) | 39,625 (176.3) | 27,740 (123.4) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 ASTM A706 Grade 60 rebar are considered ductile steel elements. ASTM A615 Grade 40 and 60 rebar are considered brittle steel elements.
3 Tensile = $\phi\ A_{se,N}\ f_{uta}$ as noted in ACI 318 Chapter 17.
4 Shear = $\phi\ 0.60\ A_{se,N}\ f_{uta}$ as noted in ACI 318 Chapter 17.
5 Seismic Shear = $\alpha_{V,seis}\ \phi\ V_{sa}$ : Reduction for seismic shear only.
See section 3.1.8 for additional information on seismic applications.

## Table 22 — Load adjustment factors for #3 rebar in uncracked concrete[1,2,3]

| #3 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | in. (mm) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.31 | 0.23 | 0.13 | n/a | n/a | n/a | 0.08 | 0.06 | 0.04 | 0.17 | 0.13 | 0.08 | n/a | n/a | n/a |
| | 1-7/8 | (48) | 0.59 | 0.57 | 0.54 | 0.32 | 0.23 | 0.13 | 0.53 | 0.53 | 0.52 | 0.09 | 0.07 | 0.04 | 0.19 | 0.14 | 0.08 | n/a | n/a | n/a |
| | 2 | (51) | 0.60 | 0.57 | 0.54 | 0.33 | 0.24 | 0.14 | 0.54 | 0.53 | 0.52 | 0.10 | 0.08 | 0.05 | 0.21 | 0.16 | 0.09 | n/a | n/a | n/a |
| | 3 | (76) | 0.65 | 0.61 | 0.57 | 0.41 | 0.30 | 0.17 | 0.56 | 0.55 | 0.53 | 0.19 | 0.14 | 0.09 | 0.38 | 0.29 | 0.17 | n/a | n/a | n/a |
| | 4 | (102) | 0.70 | 0.65 | 0.59 | 0.49 | 0.36 | 0.21 | 0.57 | 0.56 | 0.54 | 0.29 | 0.22 | 0.13 | 0.50 | 0.41 | 0.26 | n/a | n/a | n/a |
| | 4-5/8 | (117) | 0.73 | 0.67 | 0.60 | 0.55 | 0.40 | 0.23 | 0.59 | 0.57 | 0.55 | 0.36 | 0.27 | 0.16 | 0.56 | 0.45 | 0.33 | 0.58 | n/a | n/a |
| | 5 | (127) | 0.75 | 0.69 | 0.61 | 0.59 | 0.43 | 0.25 | 0.59 | 0.58 | 0.55 | 0.41 | 0.31 | 0.18 | 0.60 | 0.47 | 0.34 | 0.61 | n/a | n/a |
| | 5-3/4 | (146) | 0.78 | 0.71 | 0.63 | 0.68 | 0.50 | 0.29 | 0.61 | 0.59 | 0.56 | 0.51 | 0.38 | 0.23 | 0.68 | 0.52 | 0.36 | 0.65 | 0.59 | n/a |
| | 6 | (152) | 0.80 | 0.72 | 0.63 | 0.71 | 0.52 | 0.30 | 0.61 | 0.59 | 0.56 | 0.54 | 0.40 | 0.24 | 0.71 | 0.53 | 0.37 | 0.66 | 0.60 | n/a |
| | 7 | (178) | 0.85 | 0.76 | 0.66 | 0.83 | 0.61 | 0.35 | 0.63 | 0.61 | 0.58 | 0.68 | 0.51 | 0.31 | 0.83 | 0.61 | 0.41 | 0.72 | 0.65 | n/a |
| | 8 | (203) | 0.90 | 0.80 | 0.68 | 0.95 | 0.69 | 0.40 | 0.65 | 0.62 | 0.59 | 0.83 | 0.62 | 0.37 | 0.95 | 0.69 | 0.44 | 0.77 | 0.70 | n/a |
| | 8-3/4 | (222) | 0.93 | 0.82 | 0.69 | 1.00 | 0.76 | 0.44 | 0.66 | 0.63 | 0.59 | 0.95 | 0.71 | 0.43 | 1.00 | 0.76 | 0.47 | 0.80 | 0.73 | 0.61 |
| | 9 | (229) | 0.94 | 0.83 | 0.70 | | 0.78 | 0.45 | 0.67 | 0.64 | 0.60 | 0.99 | 0.74 | 0.45 | | 0.78 | 0.48 | 0.81 | 0.74 | 0.62 |
| | 10 | (254) | 0.99 | 0.87 | 0.72 | | 0.86 | 0.50 | 0.68 | 0.65 | 0.61 | 1.00 | 0.87 | 0.52 | | 0.86 | 0.51 | 0.86 | 0.78 | 0.66 |
| | 11 | (279) | 1.00 | 0.91 | 0.74 | | 0.95 | 0.55 | 0.70 | 0.67 | 0.62 | | 1.00 | 0.60 | | 0.95 | 0.55 | 0.90 | 0.82 | 0.69 |
| | 12 | (305) | | 0.94 | 0.77 | | 1.00 | 0.60 | 0.72 | 0.68 | 0.63 | | | 0.69 | | 1.00 | 0.60 | 0.94 | 0.85 | 0.72 |
| | 14 | (356) | | 1.00 | 0.81 | | | 0.70 | 0.76 | 0.71 | 0.65 | | | 0.86 | | | 0.70 | 1.00 | 0.92 | 0.78 |
| | 16 | (406) | | | 0.86 | | | 0.80 | 0.79 | 0.74 | 0.67 | | | 1.00 | | | 0.80 | | 0.99 | 0.83 |
| | 18 | (457) | | | 0.90 | | | 0.90 | 0.83 | 0.77 | 0.69 | | | | | | 0.90 | | 1.00 | 0.88 |
| | 24 | (610) | | | 1.00 | | | 1.00 | 0.94 | 0.86 | 0.76 | | | | | | 1.00 | | | 1.00 |
| | 30 | (762) | | | | | | | 1.00 | 0.96 | 0.82 | | | | | | | | | |
| | 36 | (914) | | | | | | | | 1.00 | 0.89 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | | 1.00 | | | | | | | | | |

## Table 23 — Load adjustment factors for #3 rebar in cracked concrete[1,2,3]

| #3 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | in. (mm) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.54 | 0.49 | 0.43 | n/a | n/a | n/a | 0.09 | 0.07 | 0.04 | 0.18 | 0.13 | 0.08 | n/a | n/a | n/a |
| | 1-7/8 | (48) | 0.59 | 0.57 | 0.54 | 0.56 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.10 | 0.07 | 0.04 | 0.19 | 0.15 | 0.09 | n/a | n/a | n/a |
| | 2 | (51) | 0.60 | 0.57 | 0.54 | 0.57 | 0.51 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.08 | 0.05 | 0.21 | 0.16 | 0.10 | n/a | n/a | n/a |
| | 3 | (76) | 0.65 | 0.61 | 0.57 | 0.70 | 0.60 | 0.49 | 0.56 | 0.55 | 0.53 | 0.20 | 0.15 | 0.09 | 0.39 | 0.29 | 0.18 | n/a | n/a | n/a |
| | 4 | (102) | 0.70 | 0.65 | 0.59 | 0.84 | 0.70 | 0.55 | 0.58 | 0.56 | 0.54 | 0.30 | 0.23 | 0.14 | 0.61 | 0.45 | 0.27 | n/a | n/a | n/a |
| | 4-5/8 | (117) | 0.73 | 0.67 | 0.60 | 0.93 | 0.76 | 0.58 | 0.59 | 0.57 | 0.55 | 0.38 | 0.28 | 0.17 | 0.75 | 0.56 | 0.34 | 0.59 | n/a | n/a |
| | 5 | (127) | 0.75 | 0.69 | 0.61 | 0.99 | 0.80 | 0.60 | 0.59 | 0.58 | 0.56 | 0.42 | 0.32 | 0.19 | 0.85 | 0.63 | 0.38 | 0.61 | n/a | n/a |
| | 5-3/4 | (146) | 0.78 | 0.71 | 0.63 | 1.00 | 0.88 | 0.64 | 0.61 | 0.59 | 0.56 | 0.52 | 0.39 | 0.23 | 1.00 | 0.78 | 0.47 | 0.66 | 0.60 | n/a |
| | 6 | (152) | 0.80 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.61 | 0.59 | 0.57 | 0.56 | 0.42 | 0.25 | | 0.83 | 0.50 | 0.67 | 0.61 | n/a |
| | 7 | (178) | 0.85 | 0.76 | 0.66 | | 1.00 | 0.72 | 0.63 | 0.61 | 0.58 | 0.70 | 0.53 | 0.32 | | 1.00 | 0.63 | 0.73 | 0.66 | n/a |
| | 8 | (203) | 0.90 | 0.80 | 0.68 | | | 0.78 | 0.65 | 0.62 | 0.59 | 0.86 | 0.64 | 0.39 | | | 0.77 | 0.78 | 0.70 | n/a |
| | 8-3/4 | (222) | 0.93 | 0.82 | 0.69 | | | 0.83 | 0.66 | 0.64 | 0.60 | 0.98 | 0.73 | 0.44 | | | 0.83 | 0.81 | 0.74 | 0.62 |
| | 9 | (229) | 0.94 | 0.83 | 0.70 | | | 0.85 | 0.67 | 0.64 | 0.60 | 1.00 | 0.77 | 0.46 | | | 0.85 | 0.82 | 0.75 | 0.63 |
| | 10 | (254) | 0.99 | 0.87 | 0.72 | | | 0.91 | 0.69 | 0.66 | 0.61 | | 0.90 | 0.54 | | | 0.91 | 0.87 | 0.79 | 0.66 |
| | 11 | (279) | 1.00 | 0.91 | 0.74 | | | 0.98 | 0.71 | 0.67 | 0.62 | | 1.00 | 0.62 | | | 0.98 | 0.91 | 0.83 | 0.70 |
| | 12 | (305) | | 0.94 | 0.77 | | | 1.00 | 0.73 | 0.69 | 0.63 | | | 0.71 | | | 1.00 | 0.95 | 0.86 | 0.73 |
| | 14 | (356) | | 1.00 | 0.81 | | | | 0.76 | 0.72 | 0.65 | | | 0.89 | | | | 1.00 | 0.93 | 0.79 |
| | 16 | (406) | | | 0.86 | | | | 0.80 | 0.75 | 0.68 | | | 1.00 | | | | | 1.00 | 0.84 |
| | 18 | (457) | | | 0.90 | | | | 0.84 | 0.78 | 0.70 | | | | | | | | | 0.89 |
| | 24 | (610) | | | 1.00 | | | | 0.95 | 0.87 | 0.76 | | | | | | | | | 1.00 |
| | 30 | (762) | | | | | | | 1.00 | 0.97 | 0.83 | | | | | | | | | |
| | 36 | (914) | | | | | | | | 1.00 | 0.90 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | | 1.00 | | | | | | | | | |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 24 — Load adjustment factors for #4 rebar in uncracked concrete[1,2,3]

| #4 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | || To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.27 | 0.20 | 0.12 | n/a | n/a | n/a | 0.06 | 0.04 | 0.02 | 0.11 | 0.08 | 0.05 | n/a | n/a | n/a |
| | 2-1/2 | (64) | 0.59 | 0.57 | 0.54 | 0.31 | 0.23 | 0.13 | 0.53 | 0.53 | 0.52 | 0.09 | 0.07 | 0.04 | 0.19 | 0.14 | 0.08 | n/a | n/a | n/a |
| | 3 | (76) | 0.61 | 0.58 | 0.55 | 0.34 | 0.25 | 0.14 | 0.54 | 0.53 | 0.52 | 0.12 | 0.09 | 0.06 | 0.25 | 0.19 | 0.11 | n/a | n/a | n/a |
| | 4 | (102) | 0.65 | 0.61 | 0.57 | 0.39 | 0.29 | 0.17 | 0.56 | 0.55 | 0.53 | 0.19 | 0.14 | 0.09 | 0.38 | 0.29 | 0.17 | n/a | n/a | n/a |
| | 5 | (127) | 0.69 | 0.64 | 0.58 | 0.46 | 0.33 | 0.20 | 0.57 | 0.56 | 0.54 | 0.27 | 0.20 | 0.12 | 0.47 | 0.38 | 0.24 | n/a | n/a | n/a |
| | 5-3/4 | (146) | 0.71 | 0.66 | 0.60 | 0.51 | 0.37 | 0.22 | 0.58 | 0.57 | 0.55 | 0.33 | 0.25 | 0.15 | 0.52 | 0.42 | 0.30 | 0.56 | n/a | n/a |
| | 6 | (152) | 0.72 | 0.67 | 0.60 | 0.52 | 0.38 | 0.22 | 0.58 | 0.57 | 0.55 | 0.35 | 0.26 | 0.16 | 0.53 | 0.43 | 0.31 | 0.58 | n/a | n/a |
| | 7 | (178) | 0.76 | 0.69 | 0.62 | 0.61 | 0.44 | 0.26 | 0.60 | 0.58 | 0.56 | 0.44 | 0.33 | 0.20 | 0.61 | 0.47 | 0.34 | 0.62 | n/a | n/a |
| | 7-1/4 | (184) | 0.77 | 0.70 | 0.62 | 0.63 | 0.46 | 0.27 | 0.60 | 0.58 | 0.56 | 0.46 | 0.35 | 0.21 | 0.63 | 0.49 | 0.35 | 0.63 | 0.57 | n/a |
| | 8 | (203) | 0.80 | 0.72 | 0.63 | 0.69 | 0.51 | 0.30 | 0.61 | 0.59 | 0.56 | 0.54 | 0.40 | 0.24 | 0.69 | 0.52 | 0.37 | 0.66 | 0.60 | n/a |
| | 9 | (229) | 0.83 | 0.75 | 0.65 | 0.78 | 0.57 | 0.33 | 0.62 | 0.60 | 0.57 | 0.64 | 0.48 | 0.29 | 0.78 | 0.57 | 0.39 | 0.70 | 0.64 | n/a |
| | 10 | (254) | 0.87 | 0.78 | 0.67 | 0.86 | 0.63 | 0.37 | 0.64 | 0.61 | 0.58 | 0.75 | 0.56 | 0.34 | 0.86 | 0.63 | 0.42 | 0.74 | 0.67 | n/a |
| | 11-1/4 | (286) | 0.92 | 0.81 | 0.69 | 0.97 | 0.71 | 0.42 | 0.66 | 0.63 | 0.59 | 0.90 | 0.67 | 0.40 | 0.97 | 0.71 | 0.45 | 0.79 | 0.72 | 0.60 |
| | 12 | (305) | 0.94 | 0.83 | 0.70 | 1.00 | 0.76 | 0.45 | 0.67 | 0.64 | 0.60 | 0.99 | 0.74 | 0.45 | 1.00 | 0.76 | 0.47 | 0.81 | 0.74 | 0.62 |
| | 14 | (356) | 1.00 | 0.89 | 0.73 | | 0.89 | 0.52 | 0.69 | 0.66 | 0.61 | 1.00 | 0.94 | 0.56 | | 0.89 | 0.53 | 0.88 | 0.80 | 0.67 |
| | 16 | (406) | | 0.94 | 0.77 | | 1.00 | 0.59 | 0.72 | 0.68 | 0.63 | | 1.00 | 0.69 | | 1.00 | 0.59 | 0.94 | 0.85 | 0.72 |
| | 18 | (457) | | 1.00 | 0.80 | | | 0.67 | 0.75 | 0.70 | 0.65 | | | 0.82 | | | 0.67 | 1.00 | 0.91 | 0.76 |
| | 20 | (508) | | | 0.83 | | | 0.74 | 0.78 | 0.73 | 0.66 | | | 0.96 | | | 0.74 | | 0.95 | 0.81 |
| | 22 | (559) | | | 0.87 | | | 0.82 | 0.80 | 0.75 | 0.68 | | | 1.00 | | | 0.82 | | 1.00 | 0.84 |
| | 24 | (610) | | | 0.90 | | | 0.89 | 0.83 | 0.77 | 0.69 | | | | | | 0.89 | | | 0.88 |
| | 30 | (762) | | | 1.00 | | | 1.00 | 0.91 | 0.84 | 0.74 | | | | | | 1.00 | | | 0.99 |
| | 36 | (914) | | | | | | | 1.00 | 0.91 | 0.79 | | | | | | | | | 1.00 |
| | >48 | (1219) | | | | | | | | 1.00 | 0.89 | | | | | | | | | |

## Table 25 — Load adjustment factors for #4 rebar in cracked concrete[1,2,3]

| #4 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | || To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.49 | 0.45 | 0.41 | n/a | n/a | n/a | 0.06 | 0.04 | 0.03 | 0.11 | 0.09 | 0.05 | n/a | n/a | n/a |
| | 2-1/2 | (64) | 0.59 | 0.57 | 0.54 | 0.56 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.10 | 0.07 | 0.04 | 0.19 | 0.15 | 0.09 | n/a | n/a | n/a |
| | 3 | (76) | 0.61 | 0.58 | 0.55 | 0.60 | 0.53 | 0.46 | 0.54 | 0.53 | 0.52 | 0.13 | 0.10 | 0.06 | 0.26 | 0.19 | 0.11 | n/a | n/a | n/a |
| | 4 | (102) | 0.65 | 0.61 | 0.57 | 0.70 | 0.60 | 0.49 | 0.56 | 0.55 | 0.53 | 0.20 | 0.15 | 0.09 | 0.39 | 0.29 | 0.18 | n/a | n/a | n/a |
| | 5 | (127) | 0.69 | 0.64 | 0.58 | 0.80 | 0.67 | 0.53 | 0.57 | 0.56 | 0.54 | 0.27 | 0.21 | 0.12 | 0.55 | 0.41 | 0.25 | n/a | n/a | n/a |
| | 5-3/4 | (146) | 0.71 | 0.66 | 0.60 | 0.88 | 0.73 | 0.56 | 0.58 | 0.57 | 0.55 | 0.34 | 0.25 | 0.15 | 0.68 | 0.51 | 0.30 | 0.57 | n/a | n/a |
| | 6 | (152) | 0.72 | 0.67 | 0.60 | 0.91 | 0.75 | 0.57 | 0.58 | 0.57 | 0.55 | 0.36 | 0.27 | 0.16 | 0.72 | 0.54 | 0.32 | 0.58 | n/a | n/a |
| | 7 | (178) | 0.76 | 0.69 | 0.62 | 1.00 | 0.83 | 0.62 | 0.60 | 0.58 | 0.56 | 0.46 | 0.34 | 0.20 | 0.91 | 0.68 | 0.41 | 0.63 | n/a | n/a |
| | 7-1/4 | (184) | 0.77 | 0.70 | 0.62 | | 0.85 | 0.63 | 0.60 | 0.58 | 0.56 | 0.48 | 0.36 | 0.22 | 0.96 | 0.72 | 0.43 | 0.64 | 0.58 | n/a |
| | 8 | (203) | 0.80 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.61 | 0.59 | 0.57 | 0.56 | 0.42 | 0.25 | 1.00 | 0.83 | 0.50 | 0.67 | 0.61 | n/a |
| | 9 | (229) | 0.83 | 0.75 | 0.65 | | 1.00 | 0.70 | 0.63 | 0.60 | 0.57 | 0.66 | 0.50 | 0.30 | | 1.00 | 0.60 | 0.71 | 0.65 | n/a |
| | 10 | (254) | 0.87 | 0.78 | 0.67 | | | 0.75 | 0.64 | 0.62 | 0.58 | 0.78 | 0.58 | 0.35 | | | 0.70 | 0.75 | 0.68 | n/a |
| | 11-1/4 | (286) | 0.92 | 0.81 | 0.69 | | | 0.81 | 0.66 | 0.63 | 0.59 | 0.93 | 0.70 | 0.42 | | | 0.81 | 0.80 | 0.72 | 0.61 |
| | 12 | (305) | 0.94 | 0.83 | 0.70 | | | 0.85 | 0.67 | 0.64 | 0.60 | 1.00 | 0.77 | 0.46 | | | 0.85 | 0.82 | 0.75 | 0.63 |
| | 14 | (356) | 1.00 | 0.89 | 0.73 | | | 0.95 | 0.70 | 0.66 | 0.62 | | 0.97 | 0.58 | | | 0.95 | 0.89 | 0.81 | 0.68 |
| | 16 | (406) | | 0.94 | 0.77 | | | 1.00 | 0.73 | 0.69 | 0.63 | | 1.00 | 0.71 | | | 1.00 | 0.95 | 0.86 | 0.73 |
| | 18 | (457) | | 1.00 | 0.80 | | | | 0.75 | 0.71 | 0.65 | | | 0.84 | | | | 1.00 | 0.91 | 0.77 |
| | 20 | (508) | | | 0.83 | | | | 0.78 | 0.73 | 0.67 | | | 0.99 | | | | | 0.96 | 0.81 |
| | 22 | (559) | | | 0.87 | | | | 0.81 | 0.76 | 0.68 | | | 1.00 | | | | | 1.00 | 0.85 |
| | 24 | (610) | | | 0.90 | | | | 0.84 | 0.78 | 0.70 | | | | | | | | | 0.89 |
| | 30 | (762) | | | 1.00 | | | | 0.92 | 0.85 | 0.75 | | | | | | | | | 1.00 |
| | 36 | (914) | | | | | | | 1.00 | 0.92 | 0.80 | | | | | | | | | |
| | >48 | (1219) | | | | | | | | 1.00 | 0.90 | | | | | | | | | |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 26 — Load adjustment factors for #5 rebar in uncracked concrete[1,2,3]

| #5 Rebar uncracked Concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | ‖ To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) |
| Spacing (s) / Edge distance ($c_{ar}$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.25 | 0.18 | 0.11 | n/a | n/a | n/a | 0.04 | 0.03 | 0.02 | 0.08 | 0.06 | 0.04 | n/a | n/a | n/a |
| | 3-1/8 | (79) | 0.59 | 0.57 | 0.54 | 0.31 | 0.23 | 0.13 | 0.54 | 0.53 | 0.52 | 0.10 | 0.07 | 0.04 | 0.20 | 0.14 | 0.08 | n/a | n/a | n/a |
| | 4 | (102) | 0.62 | 0.59 | 0.55 | 0.35 | 0.25 | 0.15 | 0.55 | 0.54 | 0.53 | 0.15 | 0.10 | 0.06 | 0.29 | 0.20 | 0.12 | n/a | n/a | n/a |
| | 5 | (127) | 0.65 | 0.61 | 0.57 | 0.39 | 0.29 | 0.17 | 0.56 | 0.55 | 0.53 | 0.21 | 0.14 | 0.09 | 0.41 | 0.29 | 0.17 | n/a | n/a | n/a |
| | 6 | (152) | 0.68 | 0.63 | 0.58 | 0.44 | 0.32 | 0.19 | 0.57 | 0.55 | 0.54 | 0.27 | 0.19 | 0.11 | 0.45 | 0.38 | 0.23 | n/a | n/a | n/a |
| | 7 | (178) | 0.71 | 0.66 | 0.59 | 0.49 | 0.36 | 0.21 | 0.58 | 0.56 | 0.55 | 0.34 | 0.24 | 0.14 | 0.50 | 0.41 | 0.28 | n/a | n/a | n/a |
| | 7-1/8 | (181) | 0.71 | 0.66 | 0.60 | 0.50 | 0.37 | 0.22 | 0.58 | 0.56 | 0.55 | 0.35 | 0.24 | 0.15 | 0.51 | 0.41 | 0.29 | 0.57 | n/a | n/a |
| | 8 | (203) | 0.74 | 0.68 | 0.61 | 0.55 | 0.40 | 0.24 | 0.59 | 0.57 | 0.55 | 0.41 | 0.29 | 0.17 | 0.56 | 0.44 | 0.33 | 0.61 | n/a | n/a |
| | 9 | (229) | 0.77 | 0.70 | 0.62 | 0.62 | 0.46 | 0.27 | 0.60 | 0.58 | 0.56 | 0.50 | 0.35 | 0.21 | 0.62 | 0.48 | 0.35 | 0.65 | 0.57 | n/a |
| | 10 | (254) | 0.80 | 0.72 | 0.63 | 0.69 | 0.51 | 0.30 | 0.62 | 0.59 | 0.56 | 0.58 | 0.40 | 0.24 | 0.69 | 0.52 | 0.37 | 0.68 | 0.60 | n/a |
| | 11 | (279) | 0.83 | 0.74 | 0.65 | 0.76 | 0.56 | 0.33 | 0.63 | 0.60 | 0.57 | 0.67 | 0.47 | 0.28 | 0.76 | 0.56 | 0.39 | 0.71 | 0.63 | n/a |
| | 12 | (305) | 0.86 | 0.77 | 0.66 | 0.83 | 0.61 | 0.36 | 0.64 | 0.61 | 0.58 | 0.76 | 0.53 | 0.32 | 0.83 | 0.61 | 0.41 | 0.75 | 0.66 | n/a |
| | 14 | (356) | 0.91 | 0.81 | 0.69 | 0.96 | 0.71 | 0.41 | 0.66 | 0.63 | 0.59 | 0.96 | 0.67 | 0.40 | 0.96 | 0.71 | 0.45 | 0.81 | 0.71 | 0.60 |
| | 16 | (406) | 0.97 | 0.86 | 0.71 | 1.00 | 0.81 | 0.47 | 0.69 | 0.65 | 0.60 | 1.00 | 0.82 | 0.49 | 1.00 | 0.81 | 0.49 | 0.86 | 0.76 | 0.64 |
| | 18 | (457) | 1.00 | 0.90 | 0.74 | | 0.91 | 0.53 | 0.71 | 0.66 | 0.62 | | 0.98 | 0.59 | | 0.91 | 0.54 | 0.91 | 0.81 | 0.68 |
| | 20 | (508) | | 0.94 | 0.77 | | 1.00 | 0.59 | 0.73 | 0.68 | 0.63 | | 1.00 | 0.69 | | 1.00 | 0.59 | 0.96 | 0.85 | 0.72 |
| | 22 | (559) | | 0.99 | 0.79 | | | 0.65 | 0.75 | 0.70 | 0.64 | | | 0.79 | | | 0.65 | 1.00 | 0.90 | 0.76 |
| | 24 | (610) | | 1.00 | 0.82 | | | 0.71 | 0.78 | 0.72 | 0.66 | | | 0.90 | | | 0.71 | | 0.94 | 0.79 |
| | 26 | (660) | | | 0.85 | | | 0.77 | 0.80 | 0.74 | 0.67 | | | 1.00 | | | 0.77 | | 0.97 | 0.82 |
| | 28 | (711) | | | 0.87 | | | 0.83 | 0.82 | 0.76 | 0.68 | | | | | | 0.83 | | 1.00 | 0.85 |
| | 30 | (762) | | | 0.90 | | | 0.89 | 0.85 | 0.77 | 0.69 | | | | | | 0.89 | | | 0.88 |
| | 36 | (914) | | | 0.98 | | | 1.00 | 0.92 | 0.83 | 0.73 | | | | | | 1.00 | | | 0.97 |
| | > 48 | (1219) | | | 1.00 | | | | 1.00 | 0.94 | 0.81 | | | | | | | | | 1.00 |

## Table 27 — Load adjustment factors for #5 rebar in cracked concrete[1,2,3]

| #5 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | ‖ To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) |
| Spacing (s) / Edge distance ($c_{ar}$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.46 | 0.43 | 0.40 | n/a | n/a | n/a | 0.04 | 0.03 | 0.02 | 0.09 | 0.06 | 0.04 | n/a | n/a | n/a |
| | 3-1/8 | (79) | 0.59 | 0.57 | 0.54 | 0.56 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.10 | 0.07 | 0.04 | 0.20 | 0.14 | 0.09 | n/a | n/a | n/a |
| | 4 | (102) | 0.62 | 0.59 | 0.55 | 0.62 | 0.55 | 0.46 | 0.55 | 0.54 | 0.53 | 0.15 | 0.10 | 0.06 | 0.30 | 0.21 | 0.13 | n/a | n/a | n/a |
| | 5 | (127) | 0.65 | 0.61 | 0.57 | 0.70 | 0.60 | 0.49 | 0.56 | 0.55 | 0.53 | 0.21 | 0.15 | 0.09 | 0.41 | 0.29 | 0.18 | n/a | n/a | n/a |
| | 6 | (152) | 0.68 | 0.63 | 0.58 | 0.78 | 0.66 | 0.53 | 0.57 | 0.56 | 0.54 | 0.27 | 0.19 | 0.12 | 0.54 | 0.38 | 0.23 | n/a | n/a | n/a |
| | 7 | (178) | 0.71 | 0.66 | 0.59 | 0.87 | 0.72 | 0.56 | 0.58 | 0.56 | 0.55 | 0.34 | 0.24 | 0.15 | 0.68 | 0.48 | 0.29 | n/a | n/a | n/a |
| | 7-1/8 | (181) | 0.71 | 0.66 | 0.60 | 0.88 | 0.73 | 0.56 | 0.58 | 0.57 | 0.55 | 0.35 | 0.25 | 0.15 | 0.70 | 0.50 | 0.30 | 0.58 | n/a | n/a |
| | 8 | (203) | 0.74 | 0.68 | 0.61 | 0.96 | 0.78 | 0.59 | 0.59 | 0.57 | 0.55 | 0.42 | 0.30 | 0.18 | 0.84 | 0.59 | 0.35 | 0.61 | n/a | n/a |
| | 9 | (229) | 0.77 | 0.70 | 0.62 | 1.00 | 0.85 | 0.62 | 0.60 | 0.58 | 0.56 | 0.50 | 0.35 | 0.21 | 1.00 | 0.71 | 0.42 | 0.65 | 0.58 | n/a |
| | 10 | (254) | 0.80 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.62 | 0.59 | 0.57 | 0.58 | 0.41 | 0.25 | | 0.83 | 0.50 | 0.68 | 0.61 | n/a |
| | 11 | (279) | 0.83 | 0.74 | 0.65 | | 0.98 | 0.69 | 0.63 | 0.60 | 0.57 | 0.67 | 0.48 | 0.29 | | 0.95 | 0.57 | 0.72 | 0.64 | n/a |
| | 12 | (305) | 0.86 | 0.77 | 0.66 | | 1.00 | 0.73 | 0.64 | 0.61 | 0.58 | 0.77 | 0.54 | 0.33 | | 1.00 | 0.65 | 0.75 | 0.67 | n/a |
| | 14 | (356) | 0.91 | 0.81 | 0.69 | | | 0.81 | 0.66 | 0.63 | 0.59 | 0.97 | 0.68 | 0.41 | | | 0.81 | 0.81 | 0.72 | 0.61 |
| | 16 | (406) | 0.97 | 0.86 | 0.71 | | | 0.89 | 0.69 | 0.65 | 0.61 | 1.00 | 0.84 | 0.50 | | | 0.89 | 0.86 | 0.77 | 0.65 |
| | 18 | (457) | 1.00 | 0.90 | 0.74 | | | 0.97 | 0.71 | 0.67 | 0.62 | | 1.00 | 0.60 | | | 0.97 | 0.92 | 0.82 | 0.69 |
| | 20 | (508) | | 0.94 | 0.77 | | | 1.00 | 0.73 | 0.68 | 0.63 | | | 0.70 | | | 1.00 | 0.97 | 0.86 | 0.73 |
| | 22 | (559) | | 0.99 | 0.79 | | | | 0.76 | 0.70 | 0.64 | | | 0.81 | | | | 1.00 | 0.90 | 0.76 |
| | 24 | (610) | | 1.00 | 0.82 | | | | 0.78 | 0.72 | 0.66 | | | 0.92 | | | | | 0.94 | 0.79 |
| | 26 | (660) | | | 0.85 | | | | 0.80 | 0.74 | 0.67 | | | 1.00 | | | | | 0.98 | 0.83 |
| | 28 | (711) | | | 0.87 | | | | 0.83 | 0.76 | 0.68 | | | | | | | | 1.00 | 0.86 |
| | 30 | (762) | | | 0.90 | | | | 0.85 | 0.78 | 0.70 | | | | | | | | | 0.89 |
| | 36 | (914) | | | 0.98 | | | | 0.92 | 0.83 | 0.74 | | | | | | | | | 0.97 |
| | > 48 | (1219) | | | 1.00 | | | | 1.00 | 0.94 | 0.82 | | | | | | | | | 1.00 |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 28 — Load adjustment factors for #6 rebar in uncracked concrete[1,2,3]

| #6 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | in. (mm) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | 0.03 | 0.02 | 0.01 | 0.07 | 0.05 | 0.03 | n/a | n/a | n/a |
| | 3-3/4 | (95) | 0.59 | 0.57 | 0.54 | 0.31 | 0.23 | 0.13 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.04 | 0.22 | 0.14 | 0.08 | n/a | n/a | n/a |
| | 4 | (102) | 0.60 | 0.57 | 0.54 | 0.32 | 0.23 | 0.14 | 0.54 | 0.53 | 0.52 | 0.12 | 0.08 | 0.05 | 0.24 | 0.16 | 0.09 | n/a | n/a | n/a |
| | 5 | (127) | 0.62 | 0.59 | 0.56 | 0.35 | 0.26 | 0.15 | 0.55 | 0.54 | 0.53 | 0.17 | 0.11 | 0.06 | 0.33 | 0.22 | 0.13 | n/a | n/a | n/a |
| | 6 | (152) | 0.65 | 0.61 | 0.57 | 0.39 | 0.29 | 0.17 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.08 | 0.41 | 0.29 | 0.17 | n/a | n/a | n/a |
| | 7 | (178) | 0.67 | 0.63 | 0.58 | 0.43 | 0.32 | 0.19 | 0.57 | 0.55 | 0.54 | 0.28 | 0.18 | 0.11 | 0.45 | 0.36 | 0.21 | n/a | n/a | n/a |
| | 8 | (203) | 0.70 | 0.65 | 0.59 | 0.48 | 0.35 | 0.20 | 0.58 | 0.56 | 0.54 | 0.34 | 0.22 | 0.13 | 0.49 | 0.40 | 0.26 | n/a | n/a | n/a |
| | 8-1/2 | (216) | 0.71 | 0.66 | 0.59 | 0.50 | 0.37 | 0.21 | 0.59 | 0.56 | 0.55 | 0.37 | 0.24 | 0.14 | 0.51 | 0.41 | 0.28 | 0.59 | n/a | n/a |
| | 9 | (229) | 0.72 | 0.67 | 0.60 | 0.52 | 0.38 | 0.22 | 0.59 | 0.57 | 0.55 | 0.40 | 0.26 | 0.15 | 0.53 | 0.43 | 0.31 | 0.60 | n/a | n/a |
| | 10 | (254) | 0.75 | 0.69 | 0.61 | 0.57 | 0.42 | 0.25 | 0.60 | 0.58 | 0.55 | 0.47 | 0.31 | 0.18 | 0.57 | 0.46 | 0.33 | 0.64 | n/a | n/a |
| | 10-3/4 | (273) | 0.77 | 0.70 | 0.62 | 0.62 | 0.45 | 0.27 | 0.61 | 0.58 | 0.56 | 0.53 | 0.34 | 0.20 | 0.62 | 0.48 | 0.35 | 0.66 | 0.57 | n/a |
| | 12 | (305) | 0.80 | 0.72 | 0.63 | 0.69 | 0.51 | 0.30 | 0.62 | 0.59 | 0.56 | 0.62 | 0.40 | 0.24 | 0.69 | 0.52 | 0.37 | 0.70 | 0.60 | n/a |
| | 14 | (356) | 0.85 | 0.76 | 0.66 | 0.80 | 0.59 | 0.35 | 0.64 | 0.61 | 0.57 | 0.78 | 0.51 | 0.30 | 0.80 | 0.59 | 0.40 | 0.75 | 0.65 | n/a |
| | 16 | (406) | 0.90 | 0.80 | 0.68 | 0.92 | 0.67 | 0.39 | 0.66 | 0.62 | 0.59 | 0.96 | 0.62 | 0.37 | 0.92 | 0.67 | 0.43 | 0.80 | 0.70 | n/a |
| | 16-3/4 | (425) | 0.91 | 0.81 | 0.69 | 0.96 | 0.71 | 0.41 | 0.67 | 0.63 | 0.59 | 1.00 | 0.67 | 0.39 | 0.96 | 0.71 | 0.45 | 0.82 | 0.71 | 0.60 |
| | 18 | (457) | 0.94 | 0.83 | 0.70 | 1.00 | 0.76 | 0.44 | 0.68 | 0.64 | 0.60 | | 0.74 | 0.44 | 1.00 | 0.76 | 0.47 | 0.85 | 0.74 | 0.62 |
| | 20 | (508) | 0.99 | 0.87 | 0.72 | | 0.84 | 0.49 | 0.70 | 0.65 | 0.61 | | 0.87 | 0.51 | | 0.84 | 0.51 | 0.90 | 0.78 | 0.65 |
| | 22 | (559) | 1.00 | 0.91 | 0.74 | | 0.93 | 0.54 | 0.72 | 0.67 | 0.62 | | 1.00 | 0.59 | | 0.93 | 0.55 | 0.94 | 0.82 | 0.68 |
| | 24 | (610) | | 0.94 | 0.77 | | 1.00 | 0.59 | 0.74 | 0.68 | 0.63 | | | 0.67 | | 1.00 | 0.59 | 0.99 | 0.85 | 0.72 |
| | 26 | (660) | | 0.98 | 0.79 | | | 0.64 | 0.76 | 0.70 | 0.64 | | | 0.76 | | | 0.64 | 1.00 | 0.89 | 0.74 |
| | 28 | (711) | | 1.00 | 0.81 | | | 0.69 | 0.78 | 0.71 | 0.65 | | | 0.85 | | | 0.69 | | 0.92 | 0.77 |
| | 30 | (762) | | | 0.83 | | | 0.74 | 0.80 | 0.73 | 0.66 | | | 0.94 | | | 0.74 | | 0.95 | 0.80 |
| | 36 | (914) | | | 0.90 | | | 0.89 | 0.86 | 0.77 | 0.69 | | | 1.00 | | | 0.89 | | 1.00 | 0.88 |
| | > 48 | (1219) | | | 1.00 | | | 1.00 | 0.99 | 0.86 | 0.76 | | | | | | 1.00 | | | 1.00 |

## Table 29 — Load adjustment factors for #6 rebar in cracked concrete[1,2,3]

| #6 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | in. (mm) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.44 | 0.42 | 0.39 | n/a | n/a | n/a | 0.03 | 0.02 | 0.01 | 0.07 | 0.05 | 0.03 | n/a | n/a | n/a |
| | 3-3/4 | (95) | 0.59 | 0.57 | 0.54 | 0.56 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.04 | 0.22 | 0.14 | 0.08 | n/a | n/a | n/a |
| | 4 | (102) | 0.60 | 0.57 | 0.54 | 0.57 | 0.51 | 0.44 | 0.54 | 0.53 | 0.52 | 0.12 | 0.08 | 0.05 | 0.24 | 0.16 | 0.09 | n/a | n/a | n/a |
| | 5 | (127) | 0.62 | 0.59 | 0.56 | 0.63 | 0.56 | 0.47 | 0.55 | 0.54 | 0.53 | 0.17 | 0.11 | 0.07 | 0.34 | 0.22 | 0.13 | n/a | n/a | n/a |
| | 6 | (152) | 0.65 | 0.61 | 0.57 | 0.70 | 0.60 | 0.49 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.09 | 0.44 | 0.29 | 0.17 | n/a | n/a | n/a |
| | 7 | (178) | 0.67 | 0.63 | 0.58 | 0.77 | 0.65 | 0.52 | 0.57 | 0.55 | 0.54 | 0.28 | 0.18 | 0.11 | 0.56 | 0.36 | 0.22 | n/a | n/a | n/a |
| | 8 | (203) | 0.70 | 0.65 | 0.59 | 0.84 | 0.70 | 0.55 | 0.58 | 0.56 | 0.54 | 0.34 | 0.22 | 0.13 | 0.68 | 0.44 | 0.26 | n/a | n/a | n/a |
| | 8-1/2 | (216) | 0.71 | 0.66 | 0.59 | 0.88 | 0.72 | 0.56 | 0.59 | 0.56 | 0.55 | 0.37 | 0.24 | 0.14 | 0.75 | 0.49 | 0.29 | 0.59 | n/a | n/a |
| | 9 | (229) | 0.72 | 0.67 | 0.60 | 0.91 | 0.75 | 0.57 | 0.59 | 0.57 | 0.55 | 0.41 | 0.26 | 0.16 | 0.82 | 0.53 | 0.32 | 0.61 | n/a | n/a |
| | 10 | (254) | 0.75 | 0.69 | 0.61 | 0.99 | 0.80 | 0.60 | 0.60 | 0.58 | 0.55 | 0.48 | 0.31 | 0.18 | 0.95 | 0.62 | 0.37 | 0.64 | n/a | n/a |
| | 10-3/4 | (273) | 0.77 | 0.70 | 0.62 | 1.00 | 0.84 | 0.62 | 0.61 | 0.58 | 0.56 | 0.53 | 0.35 | 0.21 | 1.00 | 0.69 | 0.41 | 0.66 | 0.57 | n/a |
| | 12 | (305) | 0.80 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.62 | 0.59 | 0.56 | 0.63 | 0.41 | 0.24 | | 0.82 | 0.49 | 0.70 | 0.61 | n/a |
| | 14 | (356) | 0.85 | 0.76 | 0.66 | | 1.00 | 0.72 | 0.64 | 0.61 | 0.58 | 0.79 | 0.51 | 0.31 | | 1.00 | 0.61 | 0.76 | 0.65 | n/a |
| | 16 | (406) | 0.90 | 0.80 | 0.68 | | | 0.78 | 0.66 | 0.62 | 0.59 | 0.97 | 0.63 | 0.37 | | | 0.75 | 0.81 | 0.70 | n/a |
| | 16-3/4 | (425) | 0.91 | 0.81 | 0.69 | | | 0.81 | 0.67 | 0.63 | 0.59 | 1.00 | 0.67 | 0.40 | | | 0.80 | 0.83 | 0.72 | 0.60 |
| | 18 | (457) | 0.94 | 0.83 | 0.70 | | | 0.85 | 0.68 | 0.64 | 0.60 | | 0.75 | 0.45 | | | 0.85 | 0.86 | 0.74 | 0.62 |
| | 20 | (508) | 0.99 | 0.87 | 0.72 | | | 0.91 | 0.70 | 0.65 | 0.61 | | 0.88 | 0.52 | | | 0.91 | 0.90 | 0.78 | 0.66 |
| | 22 | (559) | 1.00 | 0.91 | 0.74 | | | 0.98 | 0.72 | 0.67 | 0.62 | | 1.00 | 0.60 | | | 0.98 | 0.95 | 0.82 | 0.69 |
| | 24 | (610) | | 0.94 | 0.77 | | | 1.00 | 0.74 | 0.68 | 0.63 | | | 0.69 | | | 1.00 | 0.99 | 0.86 | 0.72 |
| | 26 | (660) | | 0.98 | 0.79 | | | | 0.76 | 0.70 | 0.64 | | | 0.77 | | | | 1.00 | 0.89 | 0.75 |
| | 28 | (711) | | 1.00 | 0.81 | | | | 0.79 | 0.71 | 0.65 | | | 0.87 | | | | | 0.92 | 0.78 |
| | 30 | (762) | | | 0.83 | | | | 0.81 | 0.73 | 0.66 | | | 0.96 | | | | | 0.96 | 0.81 |
| | 36 | (914) | | | 0.90 | | | | 0.87 | 0.77 | 0.69 | | | 1.00 | | | | | 1.00 | 0.88 |
| | > 48 | (1219) | | | 1.00 | | | | 0.99 | 0.87 | 0.76 | | | | | | | | | 1.00 |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 30 — Load adjustment factors for #7 rebar in uncracked concrete[1,2,3]

| #7 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | in. | 7-7/8 | 10-1/2 | 17-1/2 | 7-7/8 | 10-1/2 | 17-1/2 | 7-7/8 | 10-1/2 | 17-1/2 | 7-7/8 | 10-1/2 | 17-1/2 | 7-7/8 | 10-1/2 | 17-1/2 | 7-7/8 | 10-1/2 | 17-1/2 |
| | | (mm) | (200) | (267) | (445) | (200) | (267) | (445) | (200) | (267) | (445) | (200) | (267) | (445) | (200) | (267) | (445) | (200) | (267) | (445) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.23 | 0.17 | 0.10 | n/a | n/a | n/a | 0.03 | 0.02 | 0.01 | 0.05 | 0.04 | 0.02 | n/a | n/a | n/a |
| | 4-3/8 | (111) | 0.59 | 0.57 | 0.54 | 0.31 | 0.23 | 0.13 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.04 | 0.22 | 0.14 | 0.08 | n/a | n/a | n/a |
| | 5 | (127) | 0.61 | 0.58 | 0.55 | 0.33 | 0.24 | 0.14 | 0.54 | 0.53 | 0.52 | 0.13 | 0.09 | 0.05 | 0.27 | 0.17 | 0.09 | n/a | n/a | n/a |
| | 6 | (152) | 0.63 | 0.60 | 0.56 | 0.36 | 0.26 | 0.15 | 0.55 | 0.54 | 0.53 | 0.17 | 0.11 | 0.06 | 0.35 | 0.23 | 0.12 | n/a | n/a | n/a |
| | 7 | (178) | 0.65 | 0.61 | 0.57 | 0.39 | 0.29 | 0.17 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.08 | 0.40 | 0.29 | 0.16 | n/a | n/a | n/a |
| | 8 | (203) | 0.67 | 0.63 | 0.58 | 0.43 | 0.31 | 0.18 | 0.57 | 0.55 | 0.53 | 0.27 | 0.17 | 0.09 | 0.44 | 0.35 | 0.19 | n/a | n/a | n/a |
| | 9 | (229) | 0.69 | 0.64 | 0.59 | 0.46 | 0.34 | 0.20 | 0.58 | 0.56 | 0.54 | 0.32 | 0.21 | 0.11 | 0.47 | 0.39 | 0.23 | n/a | n/a | n/a |
| | 9-7/8 | (251) | 0.71 | 0.66 | 0.59 | 0.49 | 0.36 | 0.21 | 0.59 | 0.56 | 0.54 | 0.37 | 0.24 | 0.13 | 0.51 | 0.41 | 0.26 | 0.59 | n/a | n/a |
| | 10 | (254) | 0.71 | 0.66 | 0.60 | 0.50 | 0.37 | 0.22 | 0.59 | 0.57 | 0.54 | 0.38 | 0.24 | 0.13 | 0.51 | 0.41 | 0.27 | 0.59 | n/a | n/a |
| | 11 | (279) | 0.73 | 0.67 | 0.60 | 0.54 | 0.40 | 0.23 | 0.60 | 0.57 | 0.55 | 0.43 | 0.28 | 0.15 | 0.55 | 0.44 | 0.31 | 0.62 | n/a | n/a |
| | 12 | (305) | 0.75 | 0.69 | 0.61 | 0.59 | 0.43 | 0.25 | 0.60 | 0.58 | 0.55 | 0.49 | 0.32 | 0.17 | 0.59 | 0.46 | 0.34 | 0.65 | n/a | n/a |
| | 12-1/2 | (318) | 0.76 | 0.70 | 0.62 | 0.61 | 0.45 | 0.26 | 0.61 | 0.58 | 0.55 | 0.52 | 0.34 | 0.19 | 0.61 | 0.48 | 0.35 | 0.66 | 0.57 | n/a |
| | 14 | (356) | 0.80 | 0.72 | 0.63 | 0.69 | 0.50 | 0.30 | 0.62 | 0.59 | 0.56 | 0.62 | 0.40 | 0.22 | 0.69 | 0.52 | 0.37 | 0.70 | 0.60 | n/a |
| | 16 | (406) | 0.84 | 0.75 | 0.65 | 0.78 | 0.58 | 0.34 | 0.64 | 0.60 | 0.57 | 0.76 | 0.49 | 0.27 | 0.78 | 0.58 | 0.39 | 0.75 | 0.65 | n/a |
| | 18 | (457) | 0.88 | 0.79 | 0.67 | 0.88 | 0.65 | 0.38 | 0.66 | 0.62 | 0.58 | 0.91 | 0.59 | 0.32 | 0.88 | 0.65 | 0.42 | 0.79 | 0.68 | n/a |
| | 19-1/2 | (495) | 0.91 | 0.81 | 0.69 | 0.96 | 0.70 | 0.41 | 0.67 | 0.63 | 0.58 | 1.00 | 0.66 | 0.36 | 0.96 | 0.70 | 0.45 | 0.82 | 0.71 | 0.58 |
| | 20 | (508) | 0.92 | 0.82 | 0.69 | 0.98 | 0.72 | 0.42 | 0.67 | 0.63 | 0.59 | | 0.69 | 0.38 | 0.98 | 0.72 | 0.45 | 0.83 | 0.72 | 0.59 |
| | 22 | (559) | 0.97 | 0.85 | 0.71 | 1.00 | 0.79 | 0.46 | 0.69 | 0.64 | 0.60 | | 0.80 | 0.43 | 1.00 | 0.79 | 0.48 | 0.87 | 0.76 | 0.62 |
| | 24 | (610) | 1.00 | 0.88 | 0.73 | | 0.87 | 0.51 | 0.71 | 0.66 | 0.60 | | 0.91 | 0.49 | | 0.87 | 0.52 | 0.91 | 0.79 | 0.65 |
| | 26 | (660) | | 0.91 | 0.75 | | 0.94 | 0.55 | 0.73 | 0.67 | 0.61 | | 1.00 | 0.56 | | 0.94 | 0.55 | 0.95 | 0.82 | 0.67 |
| | 28 | (711) | | 0.94 | 0.77 | | 1.00 | 0.59 | 0.74 | 0.68 | 0.62 | | | 0.62 | | 1.00 | 0.59 | 0.99 | 0.85 | 0.70 |
| | 30 | (762) | | 0.98 | 0.79 | | | 0.63 | 0.76 | 0.70 | 0.63 | | | 0.69 | | | 0.63 | 1.00 | 0.88 | 0.72 |
| | 36 | (914) | | 1.00 | 0.84 | | | 0.76 | 0.81 | 0.73 | 0.66 | | | 0.91 | | | 0.76 | | 0.97 | 0.79 |
| | > 48 | (1219) | | | 0.96 | | | 1.00 | 0.92 | 0.81 | 0.71 | | | 1.00 | | | 1.00 | | 1.00 | 0.91 |

## Table 31 — Load adjustment factors for #7 rebar in cracked concrete[1,2,3]

| #7 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | in. | 7-7/8 | 10-1/2 | 17-1/2 | 7-7/8 | 10-1/2 | 17-1/2 | 7-7/8 | 10-1/2 | 17-1/2 | 7-7/8 | 10-1/2 | 17-1/2 | 7-7/8 | 10-1/2 | 17-1/2 | 7-7/8 | 10-1/2 | 17-1/2 |
| | | (mm) | (200) | (267) | (445) | (200) | (267) | (445) | (200) | (267) | (445) | (200) | (267) | (445) | (200) | (267) | (445) | (200) | (267) | (445) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.43 | 0.41 | 0.38 | n/a | n/a | n/a | 0.03 | 0.02 | 0.01 | 0.06 | 0.04 | 0.03 | n/a | n/a | n/a |
| | 4-3/8 | (111) | 0.59 | 0.57 | 0.54 | 0.56 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.09 | 0.05 | 0.23 | 0.17 | 0.10 | n/a | n/a | n/a |
| | 5 | (127) | 0.61 | 0.58 | 0.55 | 0.59 | 0.52 | 0.45 | 0.54 | 0.54 | 0.53 | 0.14 | 0.10 | 0.06 | 0.28 | 0.21 | 0.13 | n/a | n/a | n/a |
| | 6 | (152) | 0.63 | 0.60 | 0.56 | 0.64 | 0.56 | 0.47 | 0.55 | 0.54 | 0.53 | 0.18 | 0.14 | 0.08 | 0.37 | 0.27 | 0.16 | n/a | n/a | n/a |
| | 7 | (178) | 0.65 | 0.61 | 0.57 | 0.70 | 0.60 | 0.49 | 0.56 | 0.55 | 0.54 | 0.23 | 0.17 | 0.10 | 0.46 | 0.35 | 0.21 | n/a | n/a | n/a |
| | 8 | (203) | 0.67 | 0.63 | 0.58 | 0.76 | 0.64 | 0.52 | 0.57 | 0.56 | 0.54 | 0.28 | 0.21 | 0.13 | 0.56 | 0.42 | 0.25 | n/a | n/a | n/a |
| | 9 | (229) | 0.69 | 0.64 | 0.59 | 0.82 | 0.68 | 0.54 | 0.58 | 0.57 | 0.55 | 0.34 | 0.25 | 0.15 | 0.67 | 0.50 | 0.30 | n/a | n/a | n/a |
| | 9-7/8 | (251) | 0.71 | 0.66 | 0.59 | 0.87 | 0.72 | 0.56 | 0.59 | 0.57 | 0.55 | 0.39 | 0.29 | 0.17 | 0.77 | 0.58 | 0.35 | 0.59 | n/a | n/a |
| | 10 | (254) | 0.71 | 0.66 | 0.60 | 0.88 | 0.73 | 0.56 | 0.59 | 0.57 | 0.55 | 0.39 | 0.30 | 0.18 | 0.79 | 0.59 | 0.35 | 0.60 | n/a | n/a |
| | 11 | (279) | 0.73 | 0.67 | 0.60 | 0.95 | 0.77 | 0.59 | 0.60 | 0.58 | 0.56 | 0.45 | 0.34 | 0.20 | 0.91 | 0.68 | 0.41 | 0.63 | n/a | n/a |
| | 12 | (305) | 0.75 | 0.69 | 0.61 | 1.00 | 0.82 | 0.61 | 0.61 | 0.59 | 0.56 | 0.52 | 0.39 | 0.23 | 1.00 | 0.78 | 0.47 | 0.66 | n/a | n/a |
| | 12-1/2 | (318) | 0.76 | 0.70 | 0.62 | | 0.84 | 0.62 | 0.61 | 0.59 | 0.57 | 0.55 | 0.41 | 0.25 | | 0.83 | 0.50 | 0.67 | 0.61 | n/a |
| | 14 | (356) | 0.80 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.63 | 0.60 | 0.57 | 0.65 | 0.49 | 0.29 | | 0.91 | 0.59 | 0.71 | 0.64 | n/a |
| | 16 | (406) | 0.84 | 0.75 | 0.65 | | 1.00 | 0.71 | 0.64 | 0.62 | 0.58 | 0.80 | 0.60 | 0.36 | | 1.00 | 0.71 | 0.76 | 0.69 | n/a |
| | 18 | (457) | 0.88 | 0.79 | 0.67 | | | 0.76 | 0.66 | 0.63 | 0.59 | 0.95 | 0.71 | 0.43 | | | 0.76 | 0.80 | 0.73 | n/a |
| | 19-1/2 | (495) | 0.91 | 0.81 | 0.69 | | | 0.80 | 0.67 | 0.64 | 0.60 | 1.00 | 0.80 | 0.48 | | | 0.80 | 0.84 | 0.76 | 0.64 |
| | 20 | (508) | 0.92 | 0.82 | 0.69 | | | 0.82 | 0.68 | 0.65 | 0.61 | | 0.84 | 0.50 | | | 0.82 | 0.85 | 0.77 | 0.65 |
| | 22 | (559) | 0.97 | 0.85 | 0.71 | | | 0.87 | 0.70 | 0.66 | 0.62 | | 0.96 | 0.58 | | | 0.87 | 0.89 | 0.81 | 0.68 |
| | 24 | (610) | 1.00 | 0.88 | 0.73 | | | 0.93 | 0.71 | 0.68 | 0.63 | | 1.00 | 0.66 | | | 0.93 | 0.93 | 0.84 | 0.71 |
| | 26 | (660) | | 0.91 | 0.75 | | | 0.99 | 0.73 | 0.69 | 0.64 | | | 0.74 | | | 0.99 | 0.96 | 0.88 | 0.74 |
| | 28 | (711) | | 0.94 | 0.77 | | | 1.00 | 0.75 | 0.71 | 0.65 | | | 0.83 | | | 1.00 | 1.00 | 0.91 | 0.77 |
| | 30 | (762) | | 0.98 | 0.79 | | | | 0.77 | 0.72 | 0.66 | | | 0.92 | | | | 1.00 | 0.94 | 0.79 |
| | 36 | (914) | | 1.00 | 0.84 | | | | 0.82 | 0.77 | 0.69 | | | 1.00 | | | | | 1.00 | 0.87 |
| | > 48 | (1219) | | | 0.96 | | | | 0.93 | 0.85 | 0.75 | | | | | | | | | 1.00 |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 32 — Load adjustment factors for #8 rebar in uncracked concrete[1,2,3]

| #8 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | || To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.23 | 0.17 | 0.10 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.05 | 0.03 | 0.01 | n/a | n/a | n/a |
| | 5 | (127) | 0.59 | 0.57 | 0.54 | 0.31 | 0.23 | 0.13 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.04 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 6 | (152) | 0.61 | 0.58 | 0.55 | 0.33 | 0.25 | 0.14 | 0.55 | 0.53 | 0.52 | 0.14 | 0.09 | 0.05 | 0.29 | 0.19 | 0.09 | n/a | n/a | n/a |
| | 7 | (178) | 0.63 | 0.60 | 0.56 | 0.36 | 0.27 | 0.16 | 0.55 | 0.54 | 0.53 | 0.18 | 0.12 | 0.06 | 0.36 | 0.23 | 0.12 | n/a | n/a | n/a |
| | 8 | (203) | 0.65 | 0.61 | 0.57 | 0.39 | 0.29 | 0.17 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.40 | 0.29 | 0.15 | n/a | n/a | n/a |
| | 9 | (229) | 0.67 | 0.63 | 0.58 | 0.42 | 0.31 | 0.18 | 0.57 | 0.55 | 0.53 | 0.26 | 0.17 | 0.09 | 0.43 | 0.34 | 0.17 | n/a | n/a | n/a |
| | 10 | (254) | 0.69 | 0.64 | 0.58 | 0.45 | 0.33 | 0.20 | 0.58 | 0.56 | 0.54 | 0.31 | 0.20 | 0.10 | 0.46 | 0.38 | 0.20 | n/a | n/a | n/a |
| | 11 | (279) | 0.70 | 0.65 | 0.59 | 0.48 | 0.36 | 0.21 | 0.58 | 0.56 | 0.54 | 0.35 | 0.23 | 0.12 | 0.50 | 0.40 | 0.23 | n/a | n/a | n/a |
| | 11-1/4 | (286) | 0.71 | 0.66 | 0.59 | 0.49 | 0.36 | 0.21 | 0.59 | 0.56 | 0.54 | 0.37 | 0.24 | 0.12 | 0.50 | 0.41 | 0.24 | 0.58 | n/a | n/a |
| | 12 | (305) | 0.72 | 0.67 | 0.60 | 0.52 | 0.38 | 0.22 | 0.59 | 0.57 | 0.54 | 0.40 | 0.26 | 0.13 | 0.53 | 0.43 | 0.27 | 0.60 | n/a | n/a |
| | 13 | (330) | 0.74 | 0.68 | 0.61 | 0.56 | 0.41 | 0.24 | 0.60 | 0.57 | 0.55 | 0.46 | 0.30 | 0.15 | 0.56 | 0.45 | 0.30 | 0.63 | n/a | n/a |
| | 14 | (356) | 0.76 | 0.69 | 0.62 | 0.60 | 0.44 | 0.26 | 0.61 | 0.58 | 0.55 | 0.51 | 0.33 | 0.17 | 0.60 | 0.47 | 0.34 | 0.65 | n/a | n/a |
| | 14-1/4 | (362) | 0.76 | 0.70 | 0.62 | 0.61 | 0.45 | 0.26 | 0.61 | 0.58 | 0.55 | 0.52 | 0.34 | 0.17 | 0.61 | 0.48 | 0.34 | 0.66 | 0.57 | n/a |
| | 16 | (406) | 0.80 | 0.72 | 0.63 | 0.69 | 0.50 | 0.30 | 0.62 | 0.59 | 0.56 | 0.62 | 0.40 | 0.21 | 0.69 | 0.52 | 0.37 | 0.70 | 0.60 | n/a |
| | 18 | (457) | 0.83 | 0.75 | 0.65 | 0.77 | 0.57 | 0.33 | 0.64 | 0.60 | 0.57 | 0.74 | 0.48 | 0.25 | 0.77 | 0.57 | 0.39 | 0.74 | 0.64 | n/a |
| | 20 | (508) | 0.87 | 0.78 | 0.67 | 0.86 | 0.63 | 0.37 | 0.65 | 0.61 | 0.57 | 0.87 | 0.56 | 0.29 | 0.86 | 0.63 | 0.42 | 0.78 | 0.67 | n/a |
| | 22 | (559) | 0.91 | 0.81 | 0.68 | 0.94 | 0.69 | 0.41 | 0.67 | 0.63 | 0.58 | 1.00 | 0.65 | 0.33 | 0.94 | 0.69 | 0.44 | 0.82 | 0.71 | n/a |
| | 22-1/4 | (565) | 0.91 | 0.81 | 0.69 | 0.95 | 0.70 | 0.41 | 0.67 | 0.63 | 0.58 | | 0.66 | 0.34 | 0.95 | 0.70 | 0.45 | 0.82 | 0.71 | 0.57 |
| | 24 | (610) | 0.94 | 0.83 | 0.70 | 1.00 | 0.76 | 0.44 | 0.68 | 0.64 | 0.59 | | 0.74 | 0.38 | 1.00 | 0.76 | 0.47 | 0.85 | 0.74 | 0.59 |
| | 26 | (660) | 0.98 | 0.86 | 0.72 | | 0.82 | 0.48 | 0.70 | 0.65 | 0.59 | | 0.84 | 0.43 | | 0.82 | 0.50 | 0.89 | 0.77 | 0.61 |
| | 28 | (711) | 1.00 | 0.89 | 0.73 | | 0.88 | 0.52 | 0.71 | 0.66 | 0.60 | | 0.94 | 0.48 | | 0.88 | 0.53 | 0.92 | 0.80 | 0.64 |
| | 30 | (762) | | 0.92 | 0.75 | | 0.95 | 0.55 | 0.73 | 0.67 | 0.61 | | 1.00 | 0.53 | | 0.95 | 0.55 | 0.95 | 0.83 | 0.66 |
| | 36 | (914) | | 1.00 | 0.80 | | 1.00 | 0.67 | 0.77 | 0.70 | 0.63 | | | 0.69 | | 1.00 | 0.67 | 1.00 | 0.91 | 0.72 |
| | > 48 | (1219) | | | 0.90 | | | 0.89 | 0.86 | 0.77 | 0.67 | | | 1.00 | | | 0.89 | | 1.00 | 0.83 |

## Table 33 — Load adjustment factors for #8 rebar in cracked concrete[1,2,3]

| #8 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | || To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.42 | 0.40 | 0.38 | n/a | n/a | n/a | 0.02 | 0.02 | 0.01 | 0.05 | 0.03 | 0.02 | n/a | n/a | n/a |
| | 5 | (127) | 0.59 | 0.57 | 0.54 | 0.56 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.08 | 0.05 | 0.22 | 0.16 | 0.10 | n/a | n/a | n/a |
| | 6 | (152) | 0.61 | 0.58 | 0.55 | 0.60 | 0.53 | 0.46 | 0.55 | 0.54 | 0.53 | 0.14 | 0.10 | 0.06 | 0.29 | 0.21 | 0.13 | n/a | n/a | n/a |
| | 7 | (178) | 0.63 | 0.60 | 0.56 | 0.65 | 0.57 | 0.47 | 0.55 | 0.54 | 0.53 | 0.18 | 0.13 | 0.08 | 0.36 | 0.26 | 0.16 | n/a | n/a | n/a |
| | 8 | (203) | 0.65 | 0.61 | 0.57 | 0.70 | 0.60 | 0.49 | 0.56 | 0.55 | 0.54 | 0.22 | 0.16 | 0.10 | 0.44 | 0.32 | 0.19 | n/a | n/a | n/a |
| | 9 | (229) | 0.67 | 0.63 | 0.58 | 0.75 | 0.64 | 0.51 | 0.57 | 0.56 | 0.54 | 0.26 | 0.19 | 0.12 | 0.53 | 0.38 | 0.23 | n/a | n/a | n/a |
| | 10 | (254) | 0.69 | 0.64 | 0.58 | 0.80 | 0.67 | 0.53 | 0.58 | 0.56 | 0.54 | 0.31 | 0.22 | 0.13 | 0.62 | 0.45 | 0.27 | n/a | n/a | n/a |
| | 11 | (279) | 0.70 | 0.65 | 0.59 | 0.86 | 0.71 | 0.55 | 0.58 | 0.57 | 0.55 | 0.36 | 0.26 | 0.16 | 0.72 | 0.52 | 0.31 | n/a | n/a | n/a |
| | 11-1/4 | (286) | 0.71 | 0.66 | 0.59 | 0.87 | 0.72 | 0.56 | 0.59 | 0.57 | 0.55 | 0.37 | 0.27 | 0.16 | 0.74 | 0.54 | 0.32 | 0.59 | n/a | n/a |
| | 12 | (305) | 0.72 | 0.67 | 0.60 | 0.91 | 0.75 | 0.57 | 0.59 | 0.57 | 0.55 | 0.41 | 0.30 | 0.18 | 0.82 | 0.59 | 0.35 | 0.61 | n/a | n/a |
| | 13 | (330) | 0.74 | 0.68 | 0.61 | 0.97 | 0.79 | 0.59 | 0.60 | 0.58 | 0.56 | 0.46 | 0.33 | 0.20 | 0.92 | 0.67 | 0.40 | 0.63 | n/a | n/a |
| | 14 | (356) | 0.76 | 0.69 | 0.62 | 1.00 | 0.83 | 0.62 | 0.61 | 0.59 | 0.56 | 0.51 | 0.37 | 0.22 | 1.00 | 0.74 | 0.45 | 0.65 | n/a | n/a |
| | 14-1/4 | (362) | 0.76 | 0.70 | 0.62 | | 0.84 | 0.62 | 0.61 | 0.59 | 0.56 | 0.53 | 0.38 | 0.23 | | 0.76 | 0.46 | 0.66 | 0.59 | n/a |
| | 16 | (406) | 0.80 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.62 | 0.60 | 0.57 | 0.63 | 0.45 | 0.27 | | 0.91 | 0.55 | 0.70 | 0.63 | n/a |
| | 18 | (457) | 0.83 | 0.75 | 0.65 | | 1.00 | 0.70 | 0.64 | 0.61 | 0.58 | 0.75 | 0.54 | 0.33 | | 1.00 | 0.65 | 0.74 | 0.67 | n/a |
| | 20 | (508) | 0.87 | 0.78 | 0.67 | | | 0.75 | 0.65 | 0.62 | 0.59 | 0.88 | 0.64 | 0.38 | | | 0.75 | 0.78 | 0.70 | n/a |
| | 22 | (559) | 0.91 | 0.81 | 0.68 | | | 0.80 | 0.67 | 0.64 | 0.60 | 1.00 | 0.73 | 0.44 | | | 0.80 | 0.82 | 0.74 | n/a |
| | 22-1/4 | (565) | 0.91 | 0.81 | 0.69 | | | 0.80 | 0.67 | 0.64 | 0.60 | | 0.75 | 0.45 | | | 0.80 | 0.82 | 0.74 | 0.62 |
| | 24 | (610) | 0.94 | 0.83 | 0.70 | | | 0.85 | 0.68 | 0.65 | 0.61 | | 0.84 | 0.50 | | | 0.85 | 0.86 | 0.77 | 0.65 |
| | 26 | (660) | 0.98 | 0.86 | 0.72 | | | 0.90 | 0.70 | 0.66 | 0.61 | | 0.94 | 0.57 | | | 0.90 | 0.89 | 0.80 | 0.68 |
| | 28 | (711) | 1.00 | 0.89 | 0.73 | | | 0.95 | 0.71 | 0.67 | 0.62 | | 1.00 | 0.63 | | | 0.95 | 0.92 | 0.83 | 0.70 |
| | 30 | (762) | | 0.92 | 0.75 | | | 1.00 | 0.73 | 0.68 | 0.63 | | | 0.70 | | | 1.00 | 0.96 | 0.86 | 0.73 |
| | 36 | (914) | | 1.00 | 0.80 | | | | 0.77 | 0.72 | 0.66 | | | 0.92 | | | | 1.00 | 0.94 | 0.79 |
| | > 48 | (1219) | | | 0.90 | | | | 0.87 | 0.80 | 0.71 | | | 1.00 | | | | | 1.00 | 0.92 |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 34 — Load adjustment factors for #9 rebar in uncracked concrete[1,2,3]

| #9 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | in. (mm) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) |
| Spacing (s) / Edge distance ($c_{ar}$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.22 | 0.16 | 0.10 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.02 | 0.01 | n/a | n/a | n/a |
| | 5-5/8 | (143) | 0.59 | 0.57 | 0.54 | 0.31 | 0.23 | 0.13 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.03 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 6 | (152) | 0.60 | 0.57 | 0.54 | 0.32 | 0.23 | 0.14 | 0.54 | 0.53 | 0.52 | 0.12 | 0.08 | 0.04 | 0.24 | 0.16 | 0.07 | n/a | n/a | n/a |
| | 7 | (178) | 0.62 | 0.59 | 0.55 | 0.34 | 0.25 | 0.15 | 0.55 | 0.54 | 0.52 | 0.15 | 0.10 | 0.05 | 0.30 | 0.20 | 0.09 | n/a | n/a | n/a |
| | 8 | (203) | 0.63 | 0.60 | 0.56 | 0.37 | 0.27 | 0.16 | 0.55 | 0.54 | 0.52 | 0.18 | 0.12 | 0.06 | 0.37 | 0.24 | 0.11 | n/a | n/a | n/a |
| | 9 | (229) | 0.65 | 0.61 | 0.57 | 0.40 | 0.29 | 0.17 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.41 | 0.29 | 0.14 | n/a | n/a | n/a |
| | 10 | (254) | 0.66 | 0.62 | 0.57 | 0.42 | 0.31 | 0.18 | 0.57 | 0.55 | 0.53 | 0.26 | 0.17 | 0.08 | 0.44 | 0.33 | 0.16 | n/a | n/a | n/a |
| | 11 | (279) | 0.68 | 0.64 | 0.58 | 0.45 | 0.33 | 0.19 | 0.57 | 0.56 | 0.53 | 0.30 | 0.19 | 0.09 | 0.46 | 0.38 | 0.19 | n/a | n/a | n/a |
| | 12 | (305) | 0.70 | 0.65 | 0.59 | 0.48 | 0.35 | 0.20 | 0.58 | 0.56 | 0.54 | 0.34 | 0.22 | 0.11 | 0.49 | 0.40 | 0.21 | n/a | n/a | n/a |
| | 12-7/8 | (327) | 0.71 | 0.66 | 0.60 | 0.51 | 0.37 | 0.22 | 0.59 | 0.57 | 0.54 | 0.38 | 0.24 | 0.12 | 0.52 | 0.42 | 0.23 | 0.59 | n/a | n/a |
| | 13 | (330) | 0.71 | 0.66 | 0.60 | 0.51 | 0.37 | 0.22 | 0.59 | 0.57 | 0.54 | 0.38 | 0.25 | 0.12 | 0.52 | 0.42 | 0.24 | 0.59 | n/a | n/a |
| | 14 | (356) | 0.73 | 0.67 | 0.60 | 0.54 | 0.39 | 0.23 | 0.59 | 0.57 | 0.54 | 0.43 | 0.28 | 0.13 | 0.55 | 0.44 | 0.27 | 0.61 | n/a | n/a |
| | 16 | (406) | 0.76 | 0.70 | 0.62 | 0.62 | 0.45 | 0.26 | 0.61 | 0.58 | 0.55 | 0.52 | 0.34 | 0.16 | 0.62 | 0.48 | 0.33 | 0.66 | n/a | n/a |
| | 16-1/4 | (413) | 0.77 | 0.70 | 0.62 | 0.63 | 0.46 | 0.27 | 0.61 | 0.58 | 0.55 | 0.53 | 0.35 | 0.17 | 0.63 | 0.48 | 0.33 | 0.66 | 0.57 | n/a |
| | 18 | (457) | 0.80 | 0.72 | 0.63 | 0.69 | 0.51 | 0.30 | 0.62 | 0.59 | 0.56 | 0.62 | 0.40 | 0.19 | 0.69 | 0.52 | 0.37 | 0.70 | 0.60 | n/a |
| | 20 | (508) | 0.83 | 0.75 | 0.65 | 0.77 | 0.56 | 0.33 | 0.63 | 0.60 | 0.56 | 0.73 | 0.47 | 0.23 | 0.77 | 0.56 | 0.39 | 0.73 | 0.64 | n/a |
| | 22 | (559) | 0.86 | 0.77 | 0.66 | 0.85 | 0.62 | 0.36 | 0.65 | 0.61 | 0.57 | 0.84 | 0.55 | 0.26 | 0.85 | 0.62 | 0.41 | 0.77 | 0.67 | n/a |
| | 24 | (610) | 0.90 | 0.80 | 0.68 | 0.93 | 0.68 | 0.40 | 0.66 | 0.62 | 0.57 | 0.96 | 0.62 | 0.30 | 0.93 | 0.68 | 0.43 | 0.80 | 0.70 | n/a |
| | 25-1/4 | (641) | 0.92 | 0.81 | 0.69 | 0.97 | 0.71 | 0.42 | 0.67 | 0.63 | 0.58 | 1.00 | 0.67 | 0.32 | 0.97 | 0.71 | 0.45 | 0.83 | 0.71 | 0.56 |
| | 26 | (660) | 0.93 | 0.82 | 0.69 | 1.00 | 0.73 | 0.43 | 0.68 | 0.63 | 0.58 | | 0.70 | 0.34 | 1.00 | 0.73 | 0.46 | 0.84 | 0.73 | 0.57 |
| | 28 | (711) | 0.96 | 0.85 | 0.71 | | 0.79 | 0.46 | 0.69 | 0.64 | 0.59 | | 0.78 | 0.38 | | 0.79 | 0.48 | 0.87 | 0.75 | 0.59 |
| | 30 | (762) | 0.99 | 0.87 | 0.72 | | 0.84 | 0.49 | 0.70 | 0.65 | 0.59 | | 0.87 | 0.42 | | 0.84 | 0.51 | 0.90 | 0.78 | 0.61 |
| | 36 | (914) | 1.00 | 0.94 | 0.77 | | 1.00 | 0.59 | 0.74 | 0.68 | 0.61 | | 1.00 | 0.55 | | 1.00 | 0.59 | 0.99 | 0.85 | 0.67 |
| | > 48 | (1219) | | 1.00 | 0.86 | | | 0.79 | 0.82 | 0.74 | 0.65 | | | 0.84 | | | 0.79 | 1.00 | 0.99 | 0.77 |

## Table 35 — Load adjustment factors for #9 rebar in cracked concrete[1,2,3]

| #9 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | in. (mm) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) |
| Spacing (s) / Edge distance ($c_{ar}$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.41 | 0.39 | 0.38 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.03 | 0.02 | n/a | n/a | n/a |
| | 5-5/8 | (143) | 0.59 | 0.57 | 0.54 | 0.56 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.04 | 0.22 | 0.15 | 0.09 | n/a | n/a | n/a |
| | 6 | (152) | 0.60 | 0.57 | 0.54 | 0.57 | 0.51 | 0.44 | 0.54 | 0.53 | 0.52 | 0.12 | 0.08 | 0.05 | 0.24 | 0.16 | 0.10 | n/a | n/a | n/a |
| | 7 | (178) | 0.62 | 0.59 | 0.55 | 0.61 | 0.54 | 0.46 | 0.55 | 0.54 | 0.53 | 0.15 | 0.10 | 0.06 | 0.30 | 0.21 | 0.12 | n/a | n/a | n/a |
| | 8 | (203) | 0.63 | 0.60 | 0.56 | 0.65 | 0.57 | 0.48 | 0.55 | 0.54 | 0.53 | 0.19 | 0.13 | 0.08 | 0.37 | 0.25 | 0.15 | n/a | n/a | n/a |
| | 9 | (229) | 0.65 | 0.61 | 0.57 | 0.70 | 0.60 | 0.49 | 0.56 | 0.55 | 0.53 | 0.22 | 0.15 | 0.09 | 0.44 | 0.30 | 0.18 | n/a | n/a | n/a |
| | 10 | (254) | 0.66 | 0.62 | 0.57 | 0.74 | 0.63 | 0.51 | 0.57 | 0.55 | 0.54 | 0.26 | 0.18 | 0.11 | 0.52 | 0.35 | 0.21 | n/a | n/a | n/a |
| | 11 | (279) | 0.68 | 0.64 | 0.58 | 0.79 | 0.67 | 0.53 | 0.57 | 0.56 | 0.54 | 0.30 | 0.20 | 0.12 | 0.60 | 0.40 | 0.24 | n/a | n/a | n/a |
| | 12 | (305) | 0.70 | 0.65 | 0.59 | 0.84 | 0.70 | 0.55 | 0.58 | 0.56 | 0.54 | 0.34 | 0.23 | 0.14 | 0.68 | 0.46 | 0.28 | n/a | n/a | n/a |
| | 12-7/8 | (327) | 0.71 | 0.66 | 0.60 | 0.88 | 0.73 | 0.56 | 0.59 | 0.57 | 0.55 | 0.38 | 0.26 | 0.15 | 0.76 | 0.51 | 0.31 | 0.59 | n/a | n/a |
| | 13 | (330) | 0.71 | 0.66 | 0.60 | 0.89 | 0.73 | 0.56 | 0.59 | 0.57 | 0.55 | 0.39 | 0.26 | 0.16 | 0.77 | 0.52 | 0.31 | 0.59 | n/a | n/a |
| | 14 | (356) | 0.73 | 0.67 | 0.60 | 0.94 | 0.77 | 0.58 | 0.60 | 0.57 | 0.55 | 0.43 | 0.29 | 0.17 | 0.86 | 0.58 | 0.35 | 0.62 | n/a | n/a |
| | 16 | (406) | 0.76 | 0.70 | 0.62 | 1.00 | 0.84 | 0.62 | 0.61 | 0.58 | 0.56 | 0.53 | 0.36 | 0.21 | 1.00 | 0.71 | 0.43 | 0.66 | n/a | n/a |
| | 16-1/4 | (413) | 0.77 | 0.70 | 0.62 | | 0.85 | 0.63 | 0.61 | 0.58 | 0.56 | 0.54 | 0.36 | 0.22 | | 0.73 | 0.44 | 0.66 | 0.58 | n/a |
| | 18 | (457) | 0.80 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.62 | 0.59 | 0.57 | 0.63 | 0.42 | 0.25 | | 0.85 | 0.51 | 0.70 | 0.61 | n/a |
| | 20 | (508) | 0.83 | 0.75 | 0.65 | | 0.99 | 0.70 | 0.64 | 0.60 | 0.57 | 0.73 | 0.50 | 0.30 | | 0.99 | 0.60 | 0.74 | 0.65 | n/a |
| | 22 | (559) | 0.86 | 0.77 | 0.66 | | 1.00 | 0.74 | 0.65 | 0.61 | 0.58 | 0.85 | 0.57 | 0.34 | | 1.00 | 0.69 | 0.77 | 0.68 | n/a |
| | 24 | (610) | 0.90 | 0.80 | 0.68 | | | 0.78 | 0.66 | 0.63 | 0.59 | 0.97 | 0.65 | 0.39 | | | 0.78 | 0.81 | 0.71 | n/a |
| | 25-1/4 | (641) | 0.92 | 0.81 | 0.69 | | | 0.81 | 0.67 | 0.63 | 0.59 | 1.00 | 0.70 | 0.42 | | | 0.81 | 0.83 | 0.73 | 0.61 |
| | 26 | (660) | 0.93 | 0.82 | 0.69 | | | 0.82 | 0.68 | 0.64 | 0.60 | | 0.74 | 0.44 | | | 0.82 | 0.84 | 0.74 | 0.62 |
| | 28 | (711) | 0.96 | 0.85 | 0.71 | | | 0.87 | 0.69 | 0.65 | 0.60 | | 0.82 | 0.49 | | | 0.87 | 0.87 | 0.76 | 0.65 |
| | 30 | (762) | 0.99 | 0.87 | 0.72 | | | 0.91 | 0.70 | 0.66 | 0.61 | | 0.91 | 0.55 | | | 0.91 | 0.90 | 0.79 | 0.67 |
| | 36 | (914) | 1.00 | 0.94 | 0.77 | | | 1.00 | 0.74 | 0.69 | 0.63 | | 1.00 | 0.72 | | | 1.00 | 0.99 | 0.87 | 0.73 |
| | > 48 | (1219) | | 1.00 | 0.86 | | | | 0.83 | 0.75 | 0.68 | | | 1.00 | | | | 1.00 | 1.00 | 0.84 |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 36 — Load adjustment factors for #10 rebar in uncracked concrete [1,2,3]

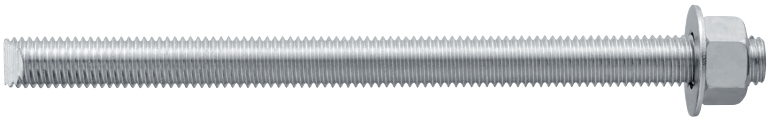
| #10 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | ‖ To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.22 | 0.16 | 0.09 | n/a | n/a | n/a | 0.02 | 0.01 | 0.00 | 0.03 | 0.02 | 0.01 | n/a | n/a | n/a |
| | 6-1/4 | (159) | 0.59 | 0.57 | 0.54 | 0.32 | 0.23 | 0.13 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.03 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 7 | (178) | 0.60 | 0.58 | 0.55 | 0.33 | 0.24 | 0.14 | 0.54 | 0.53 | 0.52 | 0.13 | 0.08 | 0.04 | 0.26 | 0.17 | 0.08 | n/a | n/a | n/a |
| | 8 | (203) | 0.62 | 0.59 | 0.55 | 0.36 | 0.25 | 0.15 | 0.55 | 0.54 | 0.52 | 0.16 | 0.10 | 0.05 | 0.31 | 0.20 | 0.10 | n/a | n/a | n/a |
| | 9 | (229) | 0.63 | 0.60 | 0.56 | 0.38 | 0.27 | 0.16 | 0.55 | 0.54 | 0.52 | 0.19 | 0.12 | 0.06 | 0.38 | 0.24 | 0.11 | n/a | n/a | n/a |
| | 10 | (254) | 0.65 | 0.61 | 0.57 | 0.40 | 0.29 | 0.17 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.42 | 0.29 | 0.13 | n/a | n/a | n/a |
| | 11 | (279) | 0.66 | 0.62 | 0.57 | 0.43 | 0.31 | 0.18 | 0.57 | 0.55 | 0.53 | 0.25 | 0.16 | 0.08 | 0.44 | 0.33 | 0.15 | n/a | n/a | n/a |
| | 12 | (305) | 0.68 | 0.63 | 0.58 | 0.45 | 0.32 | 0.19 | 0.57 | 0.55 | 0.53 | 0.29 | 0.19 | 0.09 | 0.47 | 0.38 | 0.17 | n/a | n/a | n/a |
| | 13 | (330) | 0.69 | 0.64 | 0.59 | 0.48 | 0.34 | 0.20 | 0.58 | 0.56 | 0.54 | 0.33 | 0.21 | 0.10 | 0.49 | 0.39 | 0.20 | n/a | n/a | n/a |
| | 14 | (356) | 0.71 | 0.66 | 0.59 | 0.51 | 0.36 | 0.21 | 0.59 | 0.56 | 0.54 | 0.36 | 0.24 | 0.11 | 0.52 | 0.41 | 0.22 | n/a | n/a | n/a |
| | 14-1/4 | (362) | 0.71 | 0.66 | 0.60 | 0.51 | 0.37 | 0.22 | 0.59 | 0.56 | 0.54 | 0.37 | 0.24 | 0.11 | 0.53 | 0.41 | 0.23 | 0.59 | n/a | n/a |
| | 15 | (381) | 0.72 | 0.67 | 0.60 | 0.54 | 0.38 | 0.22 | 0.59 | 0.57 | 0.54 | 0.40 | 0.26 | 0.12 | 0.55 | 0.43 | 0.24 | 0.60 | n/a | n/a |
| | 16 | (406) | 0.74 | 0.68 | 0.61 | 0.57 | 0.40 | 0.24 | 0.60 | 0.57 | 0.54 | 0.45 | 0.29 | 0.13 | 0.57 | 0.44 | 0.27 | 0.62 | n/a | n/a |
| | 17 | (432) | 0.75 | 0.69 | 0.61 | 0.60 | 0.43 | 0.25 | 0.60 | 0.58 | 0.55 | 0.49 | 0.32 | 0.15 | 0.60 | 0.46 | 0.29 | 0.64 | n/a | n/a |
| | 18 | (457) | 0.77 | 0.70 | 0.62 | 0.64 | 0.46 | 0.27 | 0.61 | 0.58 | 0.55 | 0.53 | 0.35 | 0.16 | 0.64 | 0.48 | 0.32 | 0.66 | 0.57 | n/a |
| | 20 | (508) | 0.80 | 0.72 | 0.63 | 0.71 | 0.51 | 0.30 | 0.62 | 0.59 | 0.55 | 0.62 | 0.40 | 0.19 | 0.71 | 0.52 | 0.37 | 0.70 | 0.60 | n/a |
| | 22 | (559) | 0.83 | 0.74 | 0.65 | 0.78 | 0.56 | 0.33 | 0.63 | 0.60 | 0.56 | 0.72 | 0.47 | 0.22 | 0.78 | 0.56 | 0.39 | 0.73 | 0.63 | n/a |
| | 24 | (610) | 0.86 | 0.77 | 0.66 | 0.85 | 0.61 | 0.36 | 0.65 | 0.61 | 0.57 | 0.82 | 0.53 | 0.25 | 0.85 | 0.61 | 0.41 | 0.76 | 0.66 | n/a |
| | 26 | (660) | 0.89 | 0.79 | 0.67 | 0.92 | 0.66 | 0.39 | 0.66 | 0.62 | 0.57 | 0.92 | 0.60 | 0.28 | 0.92 | 0.66 | 0.43 | 0.79 | 0.69 | n/a |
| | 28 | (711) | 0.91 | 0.81 | 0.69 | 0.99 | 0.71 | 0.41 | 0.67 | 0.63 | 0.58 | 1.00 | 0.67 | 0.31 | 0.99 | 0.71 | 0.45 | 0.82 | 0.71 | 0.55 |
| | 30 | (762) | 0.94 | 0.83 | 0.70 | 1.00 | 0.76 | 0.44 | 0.68 | 0.64 | 0.58 | | 0.74 | 0.35 | 1.00 | 0.76 | 0.47 | 0.85 | 0.74 | 0.57 |
| | 36 | (914) | 1.00 | 0.90 | 0.74 | | 0.91 | 0.53 | 0.72 | 0.66 | 0.60 | | 0.98 | 0.45 | | 0.91 | 0.54 | 0.94 | 0.81 | 0.63 |
| | > 48 | (1219) | | 1.00 | 0.82 | | 1.00 | 0.71 | 0.79 | 0.72 | 0.63 | | 1.00 | 0.70 | | 1.00 | 0.71 | 1.00 | 0.94 | 0.72 |

## Table 37 — Load adjustment factors for #10 rebar in cracked concrete [1,2,3]

| #10 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | ‖ To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.40 | 0.39 | 0.37 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.03 | 0.02 | 0.01 | n/a | n/a | n/a |
| | 6-1/4 | (159) | 0.59 | 0.57 | 0.54 | 0.56 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.04 | 0.22 | 0.14 | 0.08 | n/a | n/a | n/a |
| | 7 | (178) | 0.60 | 0.58 | 0.55 | 0.58 | 0.52 | 0.45 | 0.54 | 0.53 | 0.52 | 0.13 | 0.08 | 0.05 | 0.26 | 0.17 | 0.10 | n/a | n/a | n/a |
| | 8 | (203) | 0.62 | 0.59 | 0.55 | 0.62 | 0.55 | 0.46 | 0.55 | 0.54 | 0.53 | 0.16 | 0.10 | 0.06 | 0.32 | 0.21 | 0.12 | n/a | n/a | n/a |
| | 9 | (229) | 0.63 | 0.60 | 0.56 | 0.66 | 0.57 | 0.48 | 0.55 | 0.54 | 0.53 | 0.19 | 0.12 | 0.07 | 0.38 | 0.25 | 0.15 | n/a | n/a | n/a |
| | 10 | (254) | 0.65 | 0.61 | 0.57 | 0.70 | 0.60 | 0.49 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.09 | 0.44 | 0.29 | 0.17 | n/a | n/a | n/a |
| | 11 | (279) | 0.66 | 0.62 | 0.57 | 0.74 | 0.63 | 0.51 | 0.57 | 0.55 | 0.54 | 0.26 | 0.17 | 0.10 | 0.51 | 0.33 | 0.20 | n/a | n/a | n/a |
| | 12 | (305) | 0.68 | 0.63 | 0.58 | 0.78 | 0.66 | 0.53 | 0.57 | 0.55 | 0.54 | 0.29 | 0.19 | 0.11 | 0.58 | 0.38 | 0.22 | n/a | n/a | n/a |
| | 13 | (330) | 0.69 | 0.64 | 0.59 | 0.82 | 0.69 | 0.54 | 0.58 | 0.56 | 0.54 | 0.33 | 0.21 | 0.13 | 0.66 | 0.43 | 0.25 | n/a | n/a | n/a |
| | 14 | (356) | 0.71 | 0.66 | 0.59 | 0.87 | 0.72 | 0.56 | 0.59 | 0.56 | 0.55 | 0.37 | 0.24 | 0.14 | 0.73 | 0.48 | 0.28 | n/a | n/a | n/a |
| | 14-1/4 | (362) | 0.71 | 0.66 | 0.60 | 0.88 | 0.73 | 0.56 | 0.59 | 0.57 | 0.55 | 0.38 | 0.25 | 0.15 | 0.75 | 0.49 | 0.29 | 0.59 | n/a | n/a |
| | 15 | (381) | 0.72 | 0.67 | 0.60 | 0.91 | 0.75 | 0.57 | 0.59 | 0.57 | 0.55 | 0.41 | 0.26 | 0.16 | 0.82 | 0.53 | 0.31 | 0.61 | n/a | n/a |
| | 16 | (406) | 0.74 | 0.68 | 0.61 | 0.96 | 0.78 | 0.59 | 0.60 | 0.57 | 0.55 | 0.45 | 0.29 | 0.17 | 0.90 | 0.58 | 0.35 | 0.63 | n/a | n/a |
| | 17 | (432) | 0.75 | 0.69 | 0.61 | 1.00 | 0.81 | 0.61 | 0.60 | 0.58 | 0.55 | 0.49 | 0.32 | 0.19 | 0.98 | 0.64 | 0.38 | 0.64 | n/a | n/a |
| | 18 | (457) | 0.77 | 0.70 | 0.62 | | 0.85 | 0.62 | 0.61 | 0.58 | 0.56 | 0.54 | 0.35 | 0.21 | 1.00 | 0.70 | 0.41 | 0.66 | 0.57 | n/a |
| | 20 | (508) | 0.80 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.62 | 0.59 | 0.56 | 0.63 | 0.41 | 0.24 | | 0.82 | 0.48 | 0.70 | 0.61 | n/a |
| | 22 | (559) | 0.83 | 0.74 | 0.65 | | 0.98 | 0.69 | 0.63 | 0.60 | 0.57 | 0.72 | 0.47 | 0.28 | | 0.94 | 0.56 | 0.73 | 0.63 | n/a |
| | 24 | (610) | 0.86 | 0.77 | 0.66 | | 1.00 | 0.73 | 0.65 | 0.61 | 0.58 | 0.82 | 0.54 | 0.32 | | 1.00 | 0.63 | 0.77 | 0.66 | n/a |
| | 26 | (660) | 0.89 | 0.79 | 0.67 | | | 0.77 | 0.66 | 0.62 | 0.58 | 0.93 | 0.60 | 0.36 | | | 0.71 | 0.80 | 0.69 | n/a |
| | 28 | (711) | 0.91 | 0.81 | 0.69 | | | 0.81 | 0.67 | 0.63 | 0.59 | 1.00 | 0.68 | 0.40 | | | 0.80 | 0.83 | 0.72 | 0.60 |
| | 30 | (762) | 0.94 | 0.83 | 0.70 | | | 0.85 | 0.68 | 0.64 | 0.60 | | 0.75 | 0.44 | | | 0.85 | 0.86 | 0.74 | 0.62 |
| | 36 | (914) | 1.00 | 0.90 | 0.74 | | | 0.97 | 0.72 | 0.66 | 0.62 | | 0.98 | 0.58 | | | 0.97 | 0.94 | 0.81 | 0.68 |
| | > 48 | (1219) | | 1.00 | 0.82 | | | 1.00 | 0.79 | 0.72 | 0.65 | | 1.00 | 0.90 | | | 1.00 | 1.00 | 0.94 | 0.79 |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

**HIT-HY 200 V3 Adhesive with HAS Threaded Rod**



Hilti HAS threaded rod

**Figure 9 — Hilti HAS threaded rod installation conditions**

| | | | | | |
|---|---|---|---|---|---|
| Permissible concrete conditions |  Uncracked concrete |  Dry concrete | Permissible drilling method |  Hammer drilling with carbide tipped drill bit | |
| |  Cracked concrete |  Water saturated concrete | |  Hilti TE-CD or TE-YD Hollow Drill Bit | |
| | |  Water-filled holes | | | |

**Table 38 — Hilti HAS threaded rod specifications**

| Setting information | | Symbol | Units | Nominal rod diameter, d | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 |
| Nominal bit diameter | | $d_o$ | in. | 7/16 | 9/16 | 3/4 | 7/8 | 1 | 1-1/8 | 1-3/8 |
| Effective embedment | minimum | $h_{ef,min}$ | in. (mm) | 2-3/8 (60) | 2-3/4 (70) | 3-1/8 (79) | 3-1/2 (89) | 3-1/2 (89) | 4 (102) | 5 (127) |
| | maximum | $h_{ef,max}$ | in. (mm) | 7-1/2 (191) | 10 (254) | 12-1/2 (318) | 15 (381) | 17-1/2 (445) | 20 (508) | 25 (635) |
| Diameter of fixture hole | through-set |  | in. | 1/2 | 5/8 | 13/16[1] | 15/16[1] | 1-1/8[1] | 1-1/4[1] | 1-1/2[1] |
| Diameter of fixture hole | preset |  | in. | 7/16 | 9/16 | 11/16 | 13/16 | 15/16 | 1-1/8 | 1-3/8 |
| Installation torque | | $T_{inst}$ | ft-lb (Nm) | 15 (20) | 30 (40) | 60 (80) | 100 (136) | 125 (169) | 150 (203) | 200 (271) |
| Minimum concrete thickness | | $h_{min}$ | in. (mm) | $h_{ef}$+1-1/4 ($h_{ef}$+30) | | $h_{ef}+2d_o$ | | | | |
| Minimum edge distance | | $c_{min}$ | in. (mm) | 1-3/4 (45) | 1-3/4 (45) | 2[2] (50)[2] | 2-1/8[2] (55)[2] | 2-1/4[2] (60)[2] | 2-3/4[2] (70)[2] | 3-1/8[2] (80)[2] |
| Minimum anchor spacing | | $s_{min}$ | in. (mm) | 1-7/8 (48) | 2-1/2 (64) | 3-1/8 (79) | 3-3/4 (95) | 4-3/4 (111) | 5 (127) | 6-1/4 (159) |

1 Install using (2) washers. See Figure 11.
2 Edge distance of 1-3/4-inch (44mm) is permitted provided the installation torque is reduced to 0.30 $T_{inst}$ for 5d < s < 16-in. and to 0.5 $T_{inst}$ for s > 16-in.

**Figure 10 — Hilti HAS threaded rods**

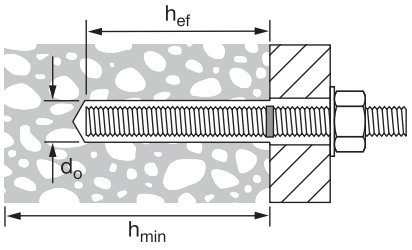



**Figure 11 — Installation with (2) washers**



## Table 39 — Hilti HIT-HY 200 V3 adhesive design strength with concrete / bond failure for threaded rod in uncracked concrete [1,2,3,4,5,6,7,8,9]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8 | 2-3/8 (60) | 2,855 (12.7) | 3,125 (13.9) | 3,610 (16.1) | 4,405 (19.6) | 3,075 (13.7) | 3,370 (15.0) | 3,890 (17.3) | 4,745 (21.1) |
| | 3-3/8 (86) | 4,835 (21.5) | 5,300 (23.6) | 6,015 (26.8) | 6,260 (27.8) | 10,415 (46.3) | 11,410 (50.8) | 12,950 (57.6) | 13,490 (60.0) |
| | 4-1/2 (114) | 7,445 (33.1) | 7,790 (34.7) | 8,020 (35.7) | 8,350 (37.1) | 16,035 (71.3) | 16,780 (74.6) | 17,270 (76.8) | 17,985 (80.0) |
| | 7-1/2 (191) | 12,750 (56.7) | 12,985 (57.8) | 13,365 (59.5) | 13,915 (61.9) | 27,460 (122.1) | 27,965 (124.4) | 28,785 (128.0) | 29,975 (133.3) |
| 1/2 | 2-3/4 (70) | 3,555 (15.8) | 3,895 (17.3) | 4,500 (20.0) | 5,510 (24.5) | 7,660 (34.1) | 8,395 (37.3) | 9,690 (43.1) | 11,870 (52.8) |
| | 4-1/2 (114) | 7,445 (33.1) | 8,155 (36.3) | 9,420 (41.9) | 11,135 (49.5) | 16,035 (71.3) | 17,570 (78.2) | 20,285 (90.2) | 23,980 (106.7) |
| | 6 (152) | 11,465 (51.0) | 12,560 (55.9) | 14,255 (63.4) | 14,845 (66.0) | 24,690 (109.8) | 27,045 (120.3) | 30,700 (136.6) | 31,970 (142.2) |
| | 10 (254) | 22,665 (100.8) | 23,085 (102.7) | 23,755 (105.7) | 24,740 (110.0) | 48,820 (217.2) | 49,720 (221.2) | 51,170 (227.6) | 53,285 (237.0) |
| 5/8 | 3-1/8 (79) | 4,310 (19.2) | 4,720 (21.0) | 5,450 (24.2) | 6,675 (29.7) | 9,280 (41.3) | 10,165 (45.2) | 11,740 (52.2) | 14,380 (64.0) |
| | 5-5/8 (143) | 10,405 (46.3) | 11,400 (50.7) | 13,165 (58.6) | 16,120 (71.7) | 22,415 (99.7) | 24,550 (109.2) | 28,350 (126.1) | 34,720 (154.4) |
| | 7-1/2 (191) | 16,020 (71.3) | 17,550 (78.1) | 20,265 (90.1) | 23,195 (103.2) | 34,505 (153.5) | 37,800 (168.1) | 43,650 (194.2) | 49,955 (222.2) |
| | 12-1/2 (318) | 34,470 (153.3) | 36,070 (160.4) | 37,120 (165.1) | 38,655 (171.9) | 74,245 (330.3) | 77,685 (345.6) | 79,955 (355.7) | 83,260 (370.4) |
| 3/4 | 3-1/2 (89) | 5,105 (22.7) | 5,595 (24.9) | 6,460 (28.7) | 7,910 (35.2) | 11,000 (48.9) | 12,050 (53.6) | 13,915 (61.9) | 17,040 (75.8) |
| | 6-3/4 (171) | 13,680 (60.9) | 14,985 (66.7) | 17,305 (77.0) | 21,190 (94.3) | 29,460 (131.0) | 32,275 (143.6) | 37,265 (165.8) | 45,645 (203.0) |
| | 9 (229) | 21,060 (93.7) | 23,070 (102.6) | 26,640 (118.5) | 32,625 (145.1) | 45,360 (201.8) | 49,690 (221.0) | 57,375 (255.2) | 70,270 (312.6) |
| | 15 (381) | 45,315 (201.6) | 49,640 (220.8) | 53,455 (237.8) | 55,665 (247.6) | 97,600 (434.1) | 106,915 (475.6) | 115,130 (512.1) | 119,895 (533.3) |
| 7/8 | 3-1/2 (89) | 5,105 (22.7) | 5,595 (24.9) | 6,460 (28.7) | 7,910 (35.2) | 11,000 (48.9) | 12,050 (53.6) | 13,915 (61.9) | 17,040 (75.8) |
| | 7-7/8 (200) | 17,235 (76.7) | 18,885 (84.0) | 21,805 (97.0) | 26,705 (118.8) | 37,125 (165.1) | 40,670 (180.9) | 46,960 (208.9) | 57,515 (255.8) |
| | 10-1/2 (267) | 26,540 (118.1) | 29,070 (129.3) | 33,570 (149.3) | 41,115 (182.9) | 57,160 (254.3) | 62,615 (278.5) | 72,300 (321.6) | 88,550 (393.9) |
| | 17-1/2 (445) | 57,100 (254.0) | 62,550 (278.2) | 72,230 (321.3) | 75,770 (337.0) | 122,990 (547.1) | 134,730 (599.3) | 155,570 (692.0) | 163,190 (725.9) |
| 1 | 4 (102) | 6,240 (27.8) | 6,835 (30.4) | 7,895 (35.1) | 9,665 (43.0) | 13,440 (59.8) | 14,725 (65.5) | 17,000 (75.6) | 20,820 (92.6) |
| | 9 (229) | 21,060 (93.7) | 23,070 (102.6) | 26,640 (118.5) | 32,625 (145.1) | 45,360 (201.8) | 49,690 (221.0) | 57,375 (255.2) | 70,270 (312.6) |
| | 12 (305) | 32,425 (144.2) | 35,520 (158.0) | 41,015 (182.4) | 50,230 (223.4) | 69,835 (310.6) | 76,500 (340.3) | 88,335 (392.9) | 108,190 (481.3) |
| | 20 (508) | 69,765 (310.3) | 76,425 (340.0) | 88,245 (392.5) | 98,960 (440.2) | 150,265 (668.4) | 164,605 (732.2) | 190,070 (845.5) | 213,150 (948.1) |
| 1-1/4 | 5 (127) | 8,720 (38.8) | 9,555 (42.5) | 11,030 (49.1) | 13,510 (60.1) | 18,785 (83.6) | 20,575 (91.5) | 23,760 (105.7) | 29,100 (129.4) |
| | 11-1/4 (286) | 29,430 (130.9) | 32,240 (143.4) | 37,230 (165.6) | 45,595 (202.8) | 63,395 (282.0) | 69,445 (308.9) | 80,185 (356.7) | 98,205 (436.8) |
| | 15 (381) | 45,315 (201.6) | 49,640 (220.8) | 57,320 (255.0) | 70,200 (312.3) | 97,600 (434.1) | 106,915 (475.6) | 123,455 (549.2) | 151,200 (672.6) |
| | 25 (635) | 97,500 (433.7) | 106,805 (475.1) | 123,330 (548.6) | 151,045 (671.9) | 210,000 (934.1) | 230,045 (1023.3) | 265,630 (1181.6) | 325,330 (1447.1) |

1 See section 3.1.8 for explanation on development of load values.
2 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 42 - 55 as necessary to the above values. Compare to the steel values in table 41. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C).
For temperature range C: Max. short term temperature = 248° F (120° C), max. long term temperature = 162° F (72° C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength value by 0.42.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete, multiply design strength (factored resistance) by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 40 — Hilti HIT-HY 200 V3 adhesive design strength with concrete / bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8 | 2-3/8 (60) | 1,900 (8.5) | 1,935 (8.6) | 1,990 (8.9) | 2,075 (9.2) | 2,045 (9.1) | 2,085 (9.3) | 2,145 (9.5) | 2,235 (9.9) |
| | 3-3/8 (86) | 2,700 (12.0) | 2,750 (12.2) | 2,830 (12.6) | 2,950 (13.1) | 5,815 (25.9) | 5,925 (26.4) | 6,095 (27.1) | 6,350 (28.2) |
| | 4-1/2 (114) | 3,600 (16.0) | 3,665 (16.3) | 3,775 (16.8) | 3,930 (17.5) | 7,755 (34.5) | 7,900 (35.1) | 8,130 (36.2) | 8,465 (37.7) |
| | 7-1/2 (191) | 6,000 (26.7) | 6,110 (27.2) | 6,290 (28.0) | 6,550 (29.1) | 12,925 (57.5) | 13,165 (58.6) | 13,550 (60.3) | 14,110 (62.8) |
| 1/2 | 2-3/4 (70) | 2,520 (11.2) | 2,760 (12.3) | 3,185 (14.2) | 3,480 (15.5) | 5,425 (24.1) | 5,945 (26.4) | 6,865 (30.5) | 7,490 (33.3) |
| | 4-1/2 (114) | 5,215 (23.2) | 5,310 (23.6) | 5,465 (24.3) | 5,690 (25.3) | 11,230 (50.0) | 11,440 (50.9) | 11,770 (52.4) | 12,260 (54.5) |
| | 6 (152) | 6,955 (30.9) | 7,080 (31.5) | 7,290 (32.4) | 7,590 (33.8) | 14,975 (66.6) | 15,250 (67.8) | 15,695 (69.8) | 16,345 (72.7) |
| | 10 (254) | 11,590 (51.6) | 11,800 (52.5) | 12,145 (54.0) | 12,650 (56.3) | 24,960 (111.0) | 25,420 (113.1) | 26,160 (116.4) | 27,245 (121.2) |
| 5/8 | 3-1/8 (79) | 3,050 (13.6) | 3,345 (14.9) | 3,860 (17.2) | 4,730 (21.0) | 6,575 (29.2) | 7,200 (32.0) | 8,315 (37.0) | 10,185 (45.3) |
| | 5-5/8 (143) | 7,370 (32.8) | 8,075 (35.9) | 8,805 (39.2) | 9,170 (40.8) | 15,875 (70.6) | 17,390 (77.4) | 18,960 (84.3) | 19,745 (87.8) |
| | 7-1/2 (191) | 11,200 (49.8) | 11,405 (50.7) | 11,740 (52.2) | 12,225 (54.4) | 24,120 (107.3) | 24,565 (109.3) | 25,280 (112.5) | 26,330 (117.1) |
| | 12-1/2 (318) | 18,665 (83.0) | 19,010 (84.6) | 19,565 (87.0) | 20,375 (90.6) | 40,205 (178.8) | 40,940 (182.1) | 42,135 (187.4) | 43,880 (195.2) |
| 3/4 | 3-1/2 (89) | 3,620 (16.1) | 3,965 (17.6) | 4,575 (20.4) | 5,605 (24.9) | 7,790 (34.7) | 8,535 (38.0) | 9,855 (43.8) | 12,070 (53.7) |
| | 6-3/4 (171) | 9,690 (43.1) | 10,615 (47.2) | 12,255 (54.5) | 14,215 (63.2) | 20,870 (92.8) | 22,860 (101.7) | 26,395 (117.4) | 30,620 (136.2) |
| | 9 (229) | 14,920 (66.4) | 16,340 (72.7) | 18,205 (81.0) | 18,955 (84.3) | 32,130 (142.9) | 35,195 (156.6) | 39,205 (174.4) | 40,830 (181.6) |
| | 15 (381) | 28,945 (128.8) | 29,480 (131.1) | 30,340 (135.0) | 31,595 (140.5) | 62,345 (277.3) | 63,490 (282.4) | 65,345 (290.7) | 68,050 (302.7) |
| 7/8 | 3-1/2 (89) | 3,620 (16.1) | 3,965 (17.6) | 4,575 (20.4) | 5,605 (24.9) | 7,790 (34.7) | 8,535 (38.0) | 9,855 (43.8) | 12,070 (53.7) |
| | 7-7/8 (200) | 12,210 (54.3) | 13,375 (59.5) | 15,445 (68.7) | 18,915 (84.1) | 26,300 (117.0) | 28,810 (128.2) | 33,265 (148.0) | 40,740 (181.2) |
| | 10-1/2 (267) | 18,800 (83.6) | 20,590 (91.6) | 23,780 (105.8) | 26,415 (117.5) | 40,490 (180.1) | 44,355 (197.3) | 51,215 (227.8) | 56,895 (253.1) |
| | 17-1/2 (445) | 40,335 (179.4) | 41,080 (182.7) | 42,280 (188.1) | 44,025 (195.8) | 86,880 (386.5) | 88,475 (393.6) | 91,060 (405.1) | 94,830 (421.8) |
| 1 | 4 (102) | 4,420 (19.7) | 4,840 (21.5) | 5,590 (24.9) | 6,845 (30.4) | 9,520 (42.3) | 10,430 (46.4) | 12,040 (53.6) | 14,750 (65.6) |
| | 9 (229) | 14,920 (66.4) | 16,340 (72.7) | 18,870 (83.9) | 23,110 (102.8) | 32,130 (142.9) | 35,195 (156.6) | 40,640 (180.8) | 49,775 (221.4) |
| | 12 (305) | 22,965 (102.2) | 25,160 (111.9) | 29,050 (129.2) | 35,440 (157.6) | 49,465 (220.0) | 54,190 (241.0) | 62,570 (278.3) | 76,330 (339.5) |
| | 20 (508) | 49,415 (219.8) | 54,135 (240.8) | 56,720 (252.3) | 59,065 (262.7) | 106,435 (473.4) | 116,595 (518.6) | 122,160 (543.4) | 127,215 (565.9) |
| 1-1/4 | 5 (127) | 6,175 (27.5) | 6,765 (30.1) | 7,815 (34.8) | 9,570 (42.6) | 13,305 (59.2) | 14,575 (64.8) | 16,830 (74.9) | 20,610 (91.7) |
| | 11-1/4 (286) | 20,850 (92.7) | 22,840 (101.6) | 26,370 (117.3) | 32,295 (143.7) | 44,905 (199.7) | 49,190 (218.8) | 56,800 (252.7) | 69,565 (309.4) |
| | 15 (381) | 32,095 (142.8) | 35,160 (156.4) | 40,600 (180.6) | 49,725 (221.2) | 69,135 (307.5) | 75,730 (336.9) | 87,445 (389.0) | 107,100 (476.4) |
| | 25 (635) | 69,060 (307.2) | 75,655 (336.5) | 87,360 (388.6) | 96,120 (427.6) | 148,750 (661.7) | 162,945 (724.8) | 188,155 (837.0) | 207,030 (920.9) |

1 See section 3.1.8 for explanation on development of load values.
2 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 42 - 55 as necessary to the above values. Compare to the steel values in table 41. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C).
For temperature range C: Max. short term temperature = 248° F (120° C), max. long term temperature = 162° F (72° C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength value by 0.42.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete, multiply design strength (factored resistance) by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors:
3/8-in diameter - $\alpha_{seis}$ = 0.66 1/2-in, 5/8-in, and 1-1/4-in diameter - $\alpha_{seis}$ =0.74
3/4-in and 7/8-in diameter - $\alpha_{seis}$ = 0.75 1-in diameter - $\alpha_{seis}$ = 0.71
See section 3.1.8 for additional information on seismic applications.

## Table 41 — Steel design strength for Hilti HAS threaded rods for use with ACI 318 Chapter 17

| Nominal anchor diameter in. | HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr. 36[4,6] | | | HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6] | | | HAS-B-105 and HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6] | | | HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) |
| 3/8 | 3,370 (15.0) | 1,750 (7.8) | 1,050 (4.7) | 4,360 (19.4) | 2,270 (10.1) | 1,590 (7.1) | 7,270 (32.3) | 3,780 (16.8) | 2,645 (11.8) | 5,040 (22.4) | 2,790 (12.4) | 1,955 (8.7) |
| 1/2 | 6,175 (27.5) | 3,210 (14.3) | 1,925 (8.6) | 7,985 (35.5) | 4,150 (18.5) | 2,905 (12.9) | 13,305 (59.2) | 6,920 (30.8) | 4,845 (21.6) | 9,225 (41.0) | 5,110 (22.7) | 3,575 (15.9) |
| 5/8 | 9,835 (43.7) | 5,110 (22.7) | 3,065 (13.6) | 12,715 (56.6) | 6,610 (29.4) | 4,625 (20.6) | 21,190 (94.3) | 11,020 (49.0) | 7,715 (34.3) | 14,690 (65.3) | 8,135 (36.2) | 5,695 (25.3) |
| 3/4 | 14,550 (64.7) | 7,565 (33.7) | 4,540 (20.2) | 18,820 (83.7) | 9,785 (43.5) | 6,850 (30.5) | 31,360 (139.5) | 16,310 (72.6) | 11,415 (50.8) | 18,485 (82.2) | 10,235 (45.5) | 7,165 (31.9) |
| 7/8 | 20,085 (89.3) | 10,445 (46.5) | 6,265 (27.9) | 25,975 (115.5) | 13,505 (60.1) | 9,455 (42.1) | 43,285 (192.5) | 22,510 (100.1) | 15,755 (70.1) | 25,510 (113.5) | 14,125 (62.8) | 9,890 (44.0) |
| 1 | 26,350 (117.2) | 13,700 (60.9) | 8,220 (36.6) | 34,075 (151.6) | 17,720 (78.8) | 12,405 (55.2) | 56,785 (252.6) | 29,530 (131.4) | 20,670 (91.9) | 33,465 (148.9) | 18,535 (82.4) | 12,975 (57.7) |
| 1-1/4 | 42,160 (187.5) | 21,920 (97.5) | 13,150 (58.5) | 54,515 (242.5) | 28,345 (126.1) | 19,840 (88.3) | 90,855 (404.1) | 47,245 (210.2) | 33,070 (147.1) | 41,430 (184.3) | 21,545 (95.8) | 12,925 (57.5) |

1 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 17.4.1.2
2 Shear = $\phi$ 0.60 $A_{se,V} f_{uta}$ as noted in ACI 318 17.5.1.2b.
3 Seismic Shear = $\alpha_{V,seis} \phi V_{sa}$ : Reduction factor for seismic shear only. See ACI 318 for additional information on seismic applications.
4 HAS-V, HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).
5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.
6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

## Table 42 — Load adjustment factors for 3/8-in. diameter threaded rods in uncracked concrete[1,2,3]

| 3/8-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.35 | 0.28 | 0.22 | 0.13 | n/a | n/a | n/a | n/a | 0.23 | 0.07 | 0.05 | 0.03 | 0.35 | 0.14 | 0.09 | 0.05 | n/a | n/a | n/a | n/a |
| 1-7/8 | (48) | 0.58 | 0.58 | 0.57 | 0.54 | 0.36 | 0.29 | 0.22 | 0.13 | 0.57 | 0.53 | 0.52 | 0.52 | 0.25 | 0.08 | 0.05 | 0.03 | 0.36 | 0.16 | 0.10 | 0.06 | n/a | n/a | n/a | n/a |
| 2 | (51) | 0.59 | 0.59 | 0.57 | 0.54 | 0.37 | 0.30 | 0.23 | 0.13 | 0.57 | 0.53 | 0.52 | 0.52 | 0.28 | 0.09 | 0.06 | 0.03 | 0.37 | 0.17 | 0.11 | 0.07 | n/a | n/a | n/a | n/a |
| 3 | (76) | 0.63 | 0.63 | 0.61 | 0.57 | 0.48 | 0.36 | 0.28 | 0.16 | 0.61 | 0.55 | 0.54 | 0.53 | 0.51 | 0.16 | 0.10 | 0.06 | 0.48 | 0.32 | 0.21 | 0.12 | n/a | n/a | n/a | n/a |
| 3-5/8 | (92) | 0.66 | 0.66 | 0.63 | 0.58 | 0.56 | 0.41 | 0.31 | 0.18 | 0.63 | 0.56 | 0.54 | 0.53 | 0.68 | 0.21 | 0.14 | 0.08 | 0.56 | 0.41 | 0.27 | 0.16 | 0.72 | n/a | n/a | n/a |
| 4 | (102) | 0.68 | 0.68 | 0.65 | 0.59 | 0.62 | 0.44 | 0.33 | 0.19 | 0.64 | 0.57 | 0.55 | 0.53 | 0.79 | 0.24 | 0.16 | 0.09 | 0.62 | 0.44 | 0.32 | 0.19 | 0.75 | n/a | n/a | n/a |
| 4-5/8 | (117) | 0.71 | 0.71 | 0.67 | 0.60 | 0.71 | 0.49 | 0.36 | 0.21 | 0.66 | 0.58 | 0.56 | 0.54 | 0.98 | 0.30 | 0.20 | 0.12 | 0.71 | 0.49 | 0.36 | 0.21 | 0.81 | 0.55 | n/a | n/a |
| 5 | (127) | 0.72 | 0.72 | 0.69 | 0.61 | 0.77 | 0.52 | 0.38 | 0.22 | 0.68 | 0.58 | 0.56 | 0.54 | 1.00 | 0.34 | 0.22 | 0.13 | 0.77 | 0.52 | 0.38 | 0.22 | 0.84 | 0.57 | n/a | n/a |
| 5-3/4 | (146) | 0.76 | 0.76 | 0.71 | 0.63 | 0.89 | 0.59 | 0.43 | 0.25 | 0.70 | 0.59 | 0.57 | 0.55 | | 0.42 | 0.27 | 0.16 | 0.89 | 0.59 | 0.43 | 0.25 | 0.91 | 0.61 | 0.53 | n/a |
| 6 | (152) | 0.77 | 0.77 | 0.72 | 0.63 | 0.93 | 0.62 | 0.45 | 0.26 | 0.71 | 0.60 | 0.57 | 0.55 | | 0.45 | 0.29 | 0.17 | 0.93 | 0.62 | 0.45 | 0.26 | 0.92 | 0.63 | 0.54 | n/a |
| 7 | (178) | 0.81 | 0.81 | 0.76 | 0.66 | 1.00 | 0.72 | 0.53 | 0.30 | 0.75 | 0.61 | 0.59 | 0.56 | | 0.57 | 0.37 | 0.21 | 1.00 | 0.72 | 0.53 | 0.30 | 1.00 | 0.68 | 0.58 | n/a |
| 8 | (203) | 0.86 | 0.86 | 0.80 | 0.68 | | 0.82 | 0.60 | 0.35 | 0.79 | 0.63 | 0.60 | 0.57 | | 0.69 | 0.45 | 0.26 | | 0.82 | 0.60 | 0.35 | | 0.72 | 0.63 | n/a |
| 8-3/4 | (222) | 0.89 | 0.89 | 0.82 | 0.69 | | 0.90 | 0.66 | 0.38 | 0.81 | 0.64 | 0.61 | 0.57 | | 0.79 | 0.51 | 0.30 | | 0.90 | 0.66 | 0.38 | | 0.76 | 0.65 | 0.55 |
| 9 | (229) | 0.90 | 0.90 | 0.83 | 0.70 | | 0.93 | 0.68 | 0.39 | 0.82 | 0.65 | 0.61 | 0.58 | | 0.83 | 0.54 | 0.31 | | 0.93 | 0.68 | 0.39 | | 0.77 | 0.66 | 0.55 |
| 10 | (254) | 0.95 | 0.95 | 0.87 | 0.72 | | 1.00 | 0.75 | 0.43 | 0.86 | 0.66 | 0.62 | 0.59 | | 0.97 | 0.63 | 0.37 | | 1.00 | 0.75 | 0.43 | | 0.81 | 0.70 | 0.58 |
| 11 | (279) | 0.99 | 0.99 | 0.91 | 0.74 | | | 0.83 | 0.48 | 0.89 | 0.68 | 0.63 | 0.59 | | 1.00 | 0.72 | 0.42 | | | 0.83 | 0.48 | | 0.85 | 0.73 | 0.61 |
| 12 | (305) | 1.00 | 1.00 | 0.94 | 0.77 | | | 0.90 | 0.52 | 0.93 | 0.70 | 0.65 | 0.60 | | | 0.83 | 0.48 | | | 0.90 | 0.52 | | 0.88 | 0.77 | 0.64 |
| 14 | (356) | | 1.00 | 1.00 | 0.81 | | | 1.00 | 0.61 | 1.00 | 0.73 | 0.67 | 0.62 | | | 1.00 | 0.61 | | | 1.00 | 0.61 | | 0.96 | 0.83 | 0.69 |
| 16 | (406) | | | | 0.86 | | | | 0.70 | | 0.76 | 0.70 | 0.64 | | | | 0.74 | | | | 0.70 | | 1.00 | 0.88 | 0.74 |
| 18 | (457) | | | | 0.90 | | | | 0.78 | | 0.79 | 0.72 | 0.65 | | | | 0.89 | | | | 0.78 | | | 0.94 | 0.78 |
| 24 | (610) | | | | 1.00 | | | | 1.00 | | 0.89 | 0.79 | 0.70 | | | | 1.00 | | | | 1.00 | | | 1.00 | 0.91 |
| 30 | (762) | | | | | | | | | | 0.99 | 0.87 | 0.76 | | | | | | | | | | | | 1.00 |
| 36 | (914) | | | | | | | | | | 1.00 | 0.94 | 0.81 | | | | | | | | | | | | |
| >48 | (1219) | | | | | | | | | | | 1.00 | 0.91 | | | | | | | | | | | | |

## Table 43 — Load adjustment factors for 3/8-in. diameter threaded rods in cracked concrete[1,2,3]

| 3/8-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.52 | 0.52 | 0.49 | 0.43 | n/a | n/a | n/a | n/a | 0.25 | 0.09 | 0.07 | 0.04 | 0.49 | 0.18 | 0.14 | 0.08 | n/a | n/a | n/a | n/a |
| 1-7/8 | (48) | 0.58 | 0.58 | 0.57 | 0.54 | 0.54 | 0.54 | 0.50 | 0.44 | 0.57 | 0.54 | 0.53 | 0.52 | 0.27 | 0.10 | 0.08 | 0.05 | 0.54 | 0.20 | 0.15 | 0.09 | n/a | n/a | n/a | n/a |
| 2 | (51) | 0.59 | 0.59 | 0.57 | 0.54 | 0.55 | 0.55 | 0.51 | 0.44 | 0.57 | 0.54 | 0.53 | 0.52 | 0.30 | 0.11 | 0.08 | 0.05 | 0.55 | 0.22 | 0.17 | 0.10 | n/a | n/a | n/a | n/a |
| 3 | (76) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.66 | 0.60 | 0.49 | 0.61 | 0.56 | 0.55 | 0.53 | 0.55 | 0.20 | 0.15 | 0.09 | 0.66 | 0.41 | 0.30 | 0.18 | n/a | n/a | n/a | n/a |
| 3-5/8 | (92) | 0.66 | 0.66 | 0.63 | 0.58 | 0.74 | 0.74 | 0.66 | 0.53 | 0.64 | 0.57 | 0.56 | 0.54 | 0.73 | 0.27 | 0.20 | 0.12 | 0.74 | 0.54 | 0.40 | 0.24 | 0.74 | n/a | n/a | n/a |
| 4 | (102) | 0.68 | 0.68 | 0.65 | 0.59 | 0.79 | 0.79 | 0.70 | 0.55 | 0.65 | 0.58 | 0.56 | 0.55 | 0.85 | 0.31 | 0.23 | 0.14 | 0.79 | 0.63 | 0.47 | 0.28 | 0.77 | n/a | n/a | n/a |
| 4-5/8 | (117) | 0.71 | 0.71 | 0.67 | 0.60 | 0.87 | 0.87 | 0.76 | 0.58 | 0.67 | 0.59 | 0.57 | 0.55 | 1.00 | 0.39 | 0.29 | 0.17 | 0.87 | 0.78 | 0.58 | 0.35 | 0.83 | 0.60 | n/a | n/a |
| 5 | (127) | 0.72 | 0.72 | 0.69 | 0.61 | 0.92 | 0.92 | 0.80 | 0.60 | 0.69 | 0.60 | 0.58 | 0.56 | | 0.44 | 0.33 | 0.20 | 0.92 | 0.87 | 0.66 | 0.39 | 0.86 | 0.62 | n/a | n/a |
| 5-3/4 | (146) | 0.76 | 0.76 | 0.71 | 0.63 | 1.00 | 1.00 | 0.88 | 0.64 | 0.71 | 0.61 | 0.59 | 0.56 | | 0.54 | 0.40 | 0.24 | 1.00 | 1.00 | 0.81 | 0.49 | 0.93 | 0.66 | 0.60 | n/a |
| 6 | (152) | 0.77 | 0.77 | 0.72 | 0.63 | | | 0.91 | 0.66 | 0.72 | 0.62 | 0.60 | 0.57 | | 0.57 | 0.43 | 0.26 | | | 0.86 | 0.52 | 0.95 | 0.68 | 0.62 | n/a |
| 7 | (178) | 0.81 | 0.81 | 0.76 | 0.66 | | | 1.00 | 0.72 | 0.76 | 0.63 | 0.61 | 0.58 | | 0.72 | 0.54 | 0.33 | | | 1.00 | 0.65 | 1.00 | 0.73 | 0.67 | n/a |
| 8 | (203) | 0.86 | 0.86 | 0.80 | 0.68 | | | | 0.78 | 0.80 | 0.65 | 0.63 | 0.59 | | 0.88 | 0.66 | 0.40 | | | | 0.78 | | 0.78 | 0.71 | n/a |
| 8-3/4 | (222) | 0.89 | 0.89 | 0.82 | 0.69 | | | | 0.83 | 0.83 | 0.67 | 0.64 | 0.60 | | 1.00 | 0.76 | 0.46 | | | | 0.83 | | 0.82 | 0.74 | 0.63 |
| 9 | (229) | 0.90 | 0.90 | 0.83 | 0.70 | | | | 0.85 | 0.84 | 0.67 | 0.64 | 0.60 | | | 0.79 | 0.47 | | | | 0.85 | | 0.83 | 0.76 | 0.64 |
| 10 | (254) | 0.95 | 0.95 | 0.87 | 0.72 | | | | 0.91 | 0.87 | 0.69 | 0.66 | 0.61 | | | 0.93 | 0.56 | | | | 0.91 | | 0.88 | 0.80 | 0.67 |
| 11 | (279) | 0.99 | 0.99 | 0.91 | 0.74 | | | | 0.98 | 0.91 | 0.71 | 0.67 | 0.62 | | | 1.00 | 0.64 | | | | 0.98 | | 0.92 | 0.84 | 0.70 |
| 12 | (305) | 1.00 | 1.00 | 0.94 | 0.77 | | | | 1.00 | 0.95 | 0.73 | 0.69 | 0.64 | | | | 0.73 | | | | 1.00 | | 0.96 | 0.87 | 0.74 |
| 14 | (356) | | | 1.00 | 0.81 | | | | | 1.00 | 0.77 | 0.72 | 0.66 | | | | 0.92 | | | | | | 1.00 | 0.94 | 0.79 |
| 16 | (406) | | | | 0.86 | | | | | | 0.81 | 0.75 | 0.68 | | | | 1.00 | | | | | | | 1.00 | 0.85 |
| 18 | (457) | | | | 0.90 | | | | | | 0.85 | 0.79 | 0.70 | | | | | | | | | | | | 0.90 |
| 24 | (610) | | | | 1.00 | | | | | | 0.96 | 0.88 | 0.77 | | | | | | | | | | | | 1.00 |
| 30 | (762) | | | | | | | | | | 1.00 | 0.98 | 0.84 | | | | | | | | | | | | |
| 36 | (914) | | | | | | | | | | | 1.00 | 0.91 | | | | | | | | | | | | |
| >48 | (1219) | | | | | | | | | | | | 1.00 | | | | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 44 — Load adjustment factors for 1/2-in. diameter threaded rods in uncracked concrete[1,2,3]

| 1/2-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To and away from edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.34 | 0.25 | 0.19 | 0.11 | n/a | n/a | n/a | n/a | 0.10 | 0.05 | 0.03 | 0.02 | 0.21 | 0.11 | 0.07 | 0.03 | n/a | n/a | n/a | n/a |
| | 2-1/2 (64) | 0.58 | 0.58 | 0.57 | 0.54 | 0.41 | 0.28 | 0.22 | 0.13 | 0.55 | 0.53 | 0.53 | 0.52 | 0.18 | 0.09 | 0.06 | 0.03 | 0.35 | 0.18 | 0.12 | 0.06 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.60 | 0.60 | 0.58 | 0.55 | 0.46 | 0.30 | 0.24 | 0.14 | 0.56 | 0.54 | 0.53 | 0.52 | 0.23 | 0.12 | 0.08 | 0.04 | 0.46 | 0.24 | 0.15 | 0.08 | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.63 | 0.63 | 0.61 | 0.57 | 0.57 | 0.35 | 0.27 | 0.16 | 0.58 | 0.55 | 0.54 | 0.53 | 0.36 | 0.18 | 0.12 | 0.06 | 0.57 | 0.35 | 0.24 | 0.12 | 0.58 | n/a | n/a | n/a |
| | 5 (127) | 0.67 | 0.67 | 0.64 | 0.58 | 0.71 | 0.41 | 0.31 | 0.18 | 0.60 | 0.57 | 0.55 | 0.53 | 0.50 | 0.26 | 0.17 | 0.08 | 0.71 | 0.41 | 0.31 | 0.17 | 0.65 | n/a | n/a | n/a |
| | 5-3/4 (146) | 0.69 | 0.69 | 0.66 | 0.60 | 0.81 | 0.45 | 0.34 | 0.20 | 0.62 | 0.58 | 0.56 | 0.54 | 0.61 | 0.32 | 0.21 | 0.10 | 0.81 | 0.45 | 0.34 | 0.20 | 0.69 | 0.56 | n/a | n/a |
| | 6 (152) | 0.70 | 0.70 | 0.67 | 0.60 | 0.85 | 0.46 | 0.35 | 0.20 | 0.63 | 0.58 | 0.56 | 0.54 | 0.65 | 0.34 | 0.22 | 0.11 | 0.85 | 0.46 | 0.35 | 0.20 | 0.71 | 0.57 | n/a | n/a |
| | 7 (178) | 0.74 | 0.74 | 0.69 | 0.62 | 0.96 | 0.53 | 0.39 | 0.23 | 0.65 | 0.59 | 0.57 | 0.54 | 0.82 | 0.42 | 0.28 | 0.14 | 0.96 | 0.53 | 0.39 | 0.23 | 0.77 | 0.61 | n/a | n/a |
| | 7-1/4 (184) | 0.74 | 0.74 | 0.70 | 0.62 | 0.98 | 0.54 | 0.40 | 0.23 | 0.65 | 0.60 | 0.57 | 0.55 | 0.87 | 0.45 | 0.29 | 0.15 | 0.98 | 0.54 | 0.40 | 0.23 | 0.78 | 0.62 | 0.54 | n/a |
| | 8 (203) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 0.60 | 0.44 | 0.26 | 0.67 | 0.61 | 0.58 | 0.55 | 1.00 | 0.52 | 0.34 | 0.17 | 1.00 | 0.60 | 0.44 | 0.26 | 0.82 | 0.66 | 0.57 | n/a |
| | 9 (229) | 0.80 | 0.80 | 0.75 | 0.65 | | 0.68 | 0.50 | 0.29 | 0.69 | 0.62 | 0.59 | 0.56 | | 0.62 | 0.40 | 0.20 | | 0.68 | 0.50 | 0.29 | 0.87 | 0.70 | 0.60 | n/a |
| | 10 (254) | 0.84 | 0.84 | 0.78 | 0.67 | | 0.75 | 0.55 | 0.32 | 0.71 | 0.63 | 0.60 | 0.56 | | 0.72 | 0.47 | 0.24 | | 0.75 | 0.55 | 0.32 | 0.92 | 0.73 | 0.64 | n/a |
| | 11-1/4 (286) | 0.88 | 0.88 | 0.81 | 0.69 | | 0.84 | 0.62 | 0.36 | 0.74 | 0.65 | 0.61 | 0.57 | | 0.86 | 0.56 | 0.28 | | 0.84 | 0.62 | 0.36 | 0.97 | 0.78 | 0.67 | 0.54 |
| | 12 (305) | 0.90 | 0.90 | 0.83 | 0.70 | | 0.90 | 0.66 | 0.39 | 0.75 | 0.66 | 0.62 | 0.58 | | 0.95 | 0.62 | 0.31 | | 0.90 | 0.66 | 0.39 | 1.00 | 0.80 | 0.70 | 0.55 |
| | 14 (356) | 0.97 | 0.97 | 0.89 | 0.73 | | 1.00 | 0.77 | 0.45 | 0.79 | 0.69 | 0.64 | 0.59 | | 1.00 | 0.78 | 0.39 | | 1.00 | 0.77 | 0.45 | | 0.87 | 0.75 | 0.60 |
| | 16 (406) | 1.00 | 1.00 | 0.94 | 0.77 | | | 0.88 | 0.52 | 0.83 | 0.72 | 0.66 | 0.60 | | | 0.95 | 0.48 | | | 0.88 | 0.52 | | 0.93 | 0.80 | 0.64 |
| | 18 (457) | | | 1.00 | 0.80 | | | 0.99 | 0.58 | 0.88 | 0.74 | 0.68 | 0.62 | | | 1.00 | 0.58 | | | 0.99 | 0.58 | | 0.98 | 0.85 | 0.68 |
| | 20 (508) | | | | 0.83 | | | 1.00 | 0.64 | 0.92 | 0.77 | 0.70 | 0.63 | | | | 0.67 | | | 1.00 | 0.64 | | 1.00 | 0.90 | 0.72 |
| | 22 (559) | | | | 0.87 | | | | 0.71 | 0.96 | 0.80 | 0.72 | 0.64 | | | | 0.78 | | | | 0.71 | | | 0.94 | 0.75 |
| | 24 (610) | | | | 0.90 | | | | 0.77 | 1.00 | 0.82 | 0.74 | 0.65 | | | | 0.89 | | | | 0.77 | | | 0.98 | 0.78 |
| | 30 (762) | | | | 1.00 | | | | 0.97 | | 0.90 | 0.80 | 0.69 | | | | 1.00 | | | | 0.97 | | | 1.00 | 0.88 |
| | 36 (914) | | | | | | | | 1.00 | | 0.98 | 0.86 | 0.73 | | | | | | | | 1.00 | | | | 0.96 |
| | >48 (1219) | | | | | | | | | | 1.00 | 0.98 | 0.81 | | | | | | | | | | | | 1.00 |

## Table 45 — Load adjustment factors for 1/2-in. diameter threaded rods in cracked concrete[1,2,3]

| 1/2-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To and away from edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.48 | 0.48 | 0.45 | 0.41 | n/a | n/a | n/a | n/a | 0.10 | 0.05 | 0.04 | 0.02 | 0.21 | 0.11 | 0.08 | 0.05 | n/a | n/a | n/a | n/a |
| | 2-1/2 (64) | 0.58 | 0.58 | 0.57 | 0.54 | 0.54 | 0.54 | 0.50 | 0.44 | 0.55 | 0.53 | 0.53 | 0.52 | 0.18 | 0.09 | 0.07 | 0.04 | 0.35 | 0.19 | 0.14 | 0.08 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.60 | 0.60 | 0.58 | 0.55 | 0.58 | 0.58 | 0.53 | 0.46 | 0.56 | 0.54 | 0.53 | 0.52 | 0.23 | 0.12 | 0.09 | 0.06 | 0.47 | 0.25 | 0.18 | 0.11 | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.66 | 0.60 | 0.49 | 0.58 | 0.55 | 0.55 | 0.53 | 0.36 | 0.19 | 0.14 | 0.09 | 0.66 | 0.38 | 0.28 | 0.17 | 0.58 | n/a | n/a | n/a |
| | 5 (127) | 0.67 | 0.67 | 0.64 | 0.58 | 0.76 | 0.76 | 0.67 | 0.53 | 0.61 | 0.57 | 0.56 | 0.54 | 0.50 | 0.26 | 0.20 | 0.12 | 0.76 | 0.53 | 0.40 | 0.24 | 0.65 | n/a | n/a | n/a |
| | 5-3/4 (146) | 0.69 | 0.69 | 0.66 | 0.60 | 0.83 | 0.83 | 0.73 | 0.56 | 0.62 | 0.58 | 0.57 | 0.55 | 0.62 | 0.33 | 0.24 | 0.15 | 0.83 | 0.65 | 0.49 | 0.29 | 0.70 | 0.56 | n/a | n/a |
| | 6 (152) | 0.70 | 0.70 | 0.67 | 0.60 | 0.85 | 0.85 | 0.75 | 0.57 | 0.63 | 0.58 | 0.57 | 0.55 | 0.66 | 0.35 | 0.26 | 0.16 | 0.85 | 0.70 | 0.52 | 0.31 | 0.71 | 0.57 | n/a | n/a |
| | 7 (178) | 0.74 | 0.74 | 0.69 | 0.62 | 0.96 | 0.96 | 0.83 | 0.62 | 0.65 | 0.60 | 0.58 | 0.56 | 0.83 | 0.44 | 0.33 | 0.20 | 0.96 | 0.88 | 0.66 | 0.39 | 0.77 | 0.62 | n/a | n/a |
| | 7-1/4 (184) | 0.74 | 0.74 | 0.70 | 0.62 | 0.98 | 0.98 | 0.85 | 0.63 | 0.65 | 0.60 | 0.58 | 0.56 | 0.88 | 0.46 | 0.35 | 0.21 | 0.98 | 0.92 | 0.69 | 0.42 | 0.78 | 0.63 | 0.57 | n/a |
| | 8 (203) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 1.00 | 0.91 | 0.66 | 0.67 | 0.61 | 0.59 | 0.56 | 1.00 | 0.54 | 0.40 | 0.24 | 1.00 | 1.00 | 0.80 | 0.48 | 0.82 | 0.66 | 0.60 | n/a |
| | 9 (229) | 0.80 | 0.80 | 0.75 | 0.65 | | | 1.00 | 0.70 | 0.69 | 0.62 | 0.60 | 0.57 | | 0.64 | 0.48 | 0.29 | | | 0.96 | 0.58 | 0.87 | 0.70 | 0.64 | n/a |
| | 10 (254) | 0.84 | 0.84 | 0.78 | 0.67 | | | | 0.75 | 0.71 | 0.64 | 0.61 | 0.58 | | 0.75 | 0.56 | 0.34 | | | 1.00 | 0.67 | 0.92 | 0.74 | 0.67 | n/a |
| | 11-1/4 (286) | 0.88 | 0.88 | 0.81 | 0.69 | | | | 0.81 | 0.74 | 0.65 | 0.63 | 0.59 | | 0.89 | 0.67 | 0.40 | | | | 0.80 | 0.97 | 0.79 | 0.71 | 0.60 |
| | 12 (305) | 0.90 | 0.90 | 0.83 | 0.70 | | | | 0.85 | 0.75 | 0.66 | 0.64 | 0.60 | | 0.98 | 0.74 | 0.44 | | | | 0.85 | 1.00 | 0.81 | 0.74 | 0.62 |
| | 14 (356) | 0.97 | 0.97 | 0.89 | 0.73 | | | | 0.95 | 0.79 | 0.69 | 0.66 | 0.61 | | 1.00 | 0.93 | 0.56 | | | | 0.95 | | 0.88 | 0.80 | 0.67 |
| | 16 (406) | 1.00 | 1.00 | 0.94 | 0.77 | | | | 1.00 | 0.84 | 0.72 | 0.68 | 0.63 | | | 1.00 | 0.68 | | | | 1.00 | | 0.94 | 0.85 | 0.72 |
| | 18 (457) | | | 1.00 | 0.80 | | | | | 0.88 | 0.75 | 0.70 | 0.65 | | | | 0.81 | | | | | | 0.99 | 0.90 | 0.76 |
| | 20 (508) | | | | 0.83 | | | | | 0.92 | 0.77 | 0.73 | 0.66 | | | | 0.95 | | | | | | 1.00 | 0.95 | 0.80 |
| | 22 (559) | | | | 0.87 | | | | | 0.96 | 0.80 | 0.75 | 0.68 | | | | 1.00 | | | | | | | 1.00 | 0.84 |
| | 24 (610) | | | | 0.90 | | | | | 1.00 | 0.83 | 0.77 | 0.69 | | | | | | | | | | | | 0.88 |
| | 30 (762) | | | | 1.00 | | | | | | 0.91 | 0.84 | 0.74 | | | | | | | | | | | | 0.98 |
| | 36 (914) | | | | | | | | | | 0.99 | 0.91 | 0.79 | | | | | | | | | | | | 1.00 |
| | >48 (1219) | | | | | | | | | | 1.00 | 1.00 | 0.89 | | | | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 46 — Load adjustment factors for 5/8-in. diameter threaded rods in uncracked concrete[1,2,3]

| 5/8-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.35 | 0.24 | 0.18 | 0.11 | n/a | n/a | n/a | n/a | 0.09 | 0.04 | 0.03 | 0.01 | 0.19 | 0.08 | 0.06 | 0.03 | n/a | n/a | n/a | n/a |
| 2 | (51) | n/a | n/a | n/a | n/a | 0.37 | 0.25 | 0.19 | 0.11 | n/a | n/a | n/a | n/a | 0.11 | 0.05 | 0.03 | 0.02 | 0.23 | 0.10 | 0.07 | 0.03 | n/a | n/a | n/a | n/a |
| 3-1/8 | (79) | 0.58 | 0.58 | 0.57 | 0.54 | 0.47 | 0.29 | 0.22 | 0.13 | 0.56 | 0.54 | 0.53 | 0.52 | 0.22 | 0.10 | 0.07 | 0.03 | 0.45 | 0.20 | 0.13 | 0.06 | n/a | n/a | n/a | n/a |
| 4 | (102) | 0.61 | 0.61 | 0.59 | 0.55 | 0.56 | 0.32 | 0.24 | 0.14 | 0.58 | 0.55 | 0.53 | 0.52 | 0.32 | 0.15 | 0.10 | 0.04 | 0.56 | 0.29 | 0.19 | 0.09 | n/a | n/a | n/a | n/a |
| 4-5/8 | (117) | 0.62 | 0.62 | 0.60 | 0.56 | 0.62 | 0.35 | 0.26 | 0.15 | 0.59 | 0.55 | 0.54 | 0.52 | 0.40 | 0.18 | 0.12 | 0.06 | 0.62 | 0.35 | 0.24 | 0.11 | 0.60 | n/a | n/a | n/a |
| 5 | (127) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.36 | 0.27 | 0.16 | 0.60 | 0.56 | 0.54 | 0.53 | 0.45 | 0.21 | 0.13 | 0.06 | 0.66 | 0.36 | 0.27 | 0.12 | 0.63 | n/a | n/a | n/a |
| 6 | (152) | 0.66 | 0.66 | 0.63 | 0.58 | 0.74 | 0.41 | 0.30 | 0.18 | 0.62 | 0.57 | 0.55 | 0.53 | 0.59 | 0.27 | 0.18 | 0.08 | 0.74 | 0.41 | 0.30 | 0.16 | 0.69 | n/a | n/a | n/a |
| 7 | (178) | 0.69 | 0.69 | 0.66 | 0.59 | 0.81 | 0.45 | 0.33 | 0.19 | 0.64 | 0.58 | 0.56 | 0.54 | 0.75 | 0.34 | 0.22 | 0.10 | 0.81 | 0.45 | 0.33 | 0.19 | 0.74 | n/a | n/a | n/a |
| 7-1/8 | (181) | 0.69 | 0.69 | 0.66 | 0.60 | 0.82 | 0.46 | 0.34 | 0.20 | 0.64 | 0.58 | 0.56 | 0.54 | 0.77 | 0.35 | 0.23 | 0.11 | 0.82 | 0.46 | 0.34 | 0.20 | 0.75 | 0.57 | n/a | n/a |
| 8 | (203) | 0.72 | 0.72 | 0.68 | 0.61 | 0.89 | 0.50 | 0.36 | 0.21 | 0.66 | 0.59 | 0.57 | 0.54 | 0.91 | 0.41 | 0.27 | 0.13 | 0.89 | 0.50 | 0.36 | 0.21 | 0.79 | 0.61 | n/a | n/a |
| 9 | (229) | 0.74 | 0.74 | 0.70 | 0.62 | 0.98 | 0.56 | 0.40 | 0.23 | 0.68 | 0.60 | 0.58 | 0.55 | 1.00 | 0.50 | 0.32 | 0.15 | 0.98 | 0.56 | 0.40 | 0.23 | 0.84 | 0.65 | 0.56 | n/a |
| 10 | (254) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 0.62 | 0.44 | 0.26 | 0.70 | 0.62 | 0.59 | 0.55 | | 0.58 | 0.38 | 0.18 | 1.00 | 0.62 | 0.44 | 0.26 | 0.89 | 0.68 | 0.59 | n/a |
| 11 | (279) | 0.80 | 0.80 | 0.74 | 0.65 | | 0.68 | 0.48 | 0.28 | 0.72 | 0.63 | 0.60 | 0.56 | | 0.67 | 0.43 | 0.20 | | 0.68 | 0.48 | 0.28 | 0.93 | 0.71 | 0.62 | n/a |
| 12 | (305) | 0.82 | 0.82 | 0.77 | 0.66 | | 0.74 | 0.53 | 0.31 | 0.74 | 0.64 | 0.60 | 0.56 | | 0.76 | 0.50 | 0.23 | | 0.74 | 0.53 | 0.31 | 0.97 | 0.75 | 0.65 | n/a |
| 14 | (356) | 0.88 | 0.88 | 0.81 | 0.69 | | 0.86 | 0.62 | 0.36 | 0.77 | 0.66 | 0.62 | 0.57 | | 0.96 | 0.62 | 0.29 | | 0.86 | 0.62 | 0.36 | 1.00 | 0.81 | 0.70 | 0.54 |
| 16 | (406) | 0.93 | 0.93 | 0.86 | 0.71 | | 0.99 | 0.70 | 0.41 | 0.81 | 0.69 | 0.64 | 0.58 | | 1.00 | 0.76 | 0.35 | | 0.99 | 0.70 | 0.41 | | 0.86 | 0.75 | 0.58 |
| 18 | (457) | 0.99 | 0.99 | 0.90 | 0.74 | | 1.00 | 0.79 | 0.46 | 0.85 | 0.71 | 0.66 | 0.59 | | | 0.91 | 0.42 | | 1.00 | 0.79 | 0.46 | | 0.91 | 0.79 | 0.61 |
| 20 | (508) | 1.00 | 1.00 | 0.94 | 0.77 | | | 0.88 | 0.51 | 0.89 | 0.73 | 0.67 | 0.60 | | | 1.00 | 0.50 | | | 0.88 | 0.51 | | 0.96 | 0.83 | 0.65 |
| 22 | (559) | | | 0.99 | 0.79 | | | 0.97 | 0.57 | 0.93 | 0.75 | 0.69 | 0.61 | | | | 0.57 | | | 0.97 | 0.57 | | 1.00 | 0.87 | 0.68 |
| 24 | (610) | | | 1.00 | 0.82 | | | 1.00 | 0.62 | 0.97 | 0.78 | 0.71 | 0.63 | | | | 0.65 | | | 1.00 | 0.62 | | | 0.91 | 0.71 |
| 26 | (660) | | | | 0.85 | | | | 0.67 | 1.00 | 0.80 | 0.73 | 0.64 | | | | 0.73 | | | | 0.67 | | | 0.95 | 0.74 |
| 28 | (711) | | | | 0.87 | | | | 0.72 | | 0.82 | 0.74 | 0.65 | | | | 0.82 | | | | 0.72 | | | 0.99 | 0.76 |
| 30 | (762) | | | | 0.90 | | | | 0.77 | | 0.85 | 0.76 | 0.66 | | | | 0.91 | | | | 0.77 | | | 1.00 | 0.79 |
| 36 | (914) | | | | 0.98 | | | | 0.93 | | 0.92 | 0.81 | 0.69 | | | | 1.00 | | | | 0.93 | | | | 0.87 |
| > 48 | (1219) | | | | 1.00 | | | | 1.00 | | 1.00 | 0.92 | 0.75 | | | | | | | | 1.00 | | | | 1.00 |

Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm)

## Table 47 — Load adjustment factors for 5/8-in. diameter threaded rods in cracked concrete[1,2,3]

| 5/8-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.45 | 0.45 | 0.43 | 0.40 | n/a | n/a | n/a | n/a | 0.09 | 0.04 | 0.03 | 0.02 | 0.19 | 0.09 | 0.06 | 0.03 | n/a | n/a | n/a | n/a |
| 2 | (51) | n/a | n/a | n/a | n/a | 0.46 | 0.46 | 0.44 | 0.41 | n/a | n/a | n/a | n/a | 0.11 | 0.05 | 0.03 | 0.02 | 0.23 | 0.10 | 0.07 | 0.04 | n/a | n/a | n/a | n/a |
| 3-1/8 | (79) | 0.58 | 0.58 | 0.57 | 0.54 | 0.54 | 0.54 | 0.50 | 0.44 | 0.56 | 0.54 | 0.53 | 0.52 | 0.22 | 0.10 | 0.07 | 0.04 | 0.45 | 0.20 | 0.13 | 0.08 | n/a | n/a | n/a | n/a |
| 4 | (102) | 0.61 | 0.61 | 0.59 | 0.55 | 0.59 | 0.59 | 0.55 | 0.46 | 0.58 | 0.55 | 0.53 | 0.52 | 0.33 | 0.15 | 0.10 | 0.06 | 0.59 | 0.30 | 0.19 | 0.12 | n/a | n/a | n/a | n/a |
| 4-5/8 | (117) | 0.62 | 0.62 | 0.60 | 0.56 | 0.64 | 0.64 | 0.58 | 0.48 | 0.59 | 0.55 | 0.54 | 0.53 | 0.40 | 0.18 | 0.12 | 0.07 | 0.64 | 0.37 | 0.24 | 0.14 | 0.60 | n/a | n/a | n/a |
| 5 | (127) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.66 | 0.60 | 0.49 | 0.60 | 0.56 | 0.54 | 0.53 | 0.45 | 0.21 | 0.13 | 0.08 | 0.66 | 0.41 | 0.27 | 0.16 | 0.63 | n/a | n/a | n/a |
| 6 | (152) | 0.66 | 0.66 | 0.63 | 0.58 | 0.74 | 0.74 | 0.66 | 0.53 | 0.62 | 0.57 | 0.55 | 0.54 | 0.60 | 0.27 | 0.18 | 0.11 | 0.74 | 0.54 | 0.35 | 0.21 | 0.69 | n/a | n/a | n/a |
| 7 | (178) | 0.69 | 0.69 | 0.66 | 0.59 | 0.81 | 0.81 | 0.72 | 0.56 | 0.64 | 0.58 | 0.56 | 0.54 | 0.75 | 0.34 | 0.22 | 0.13 | 0.81 | 0.68 | 0.45 | 0.27 | 0.74 | n/a | n/a | n/a |
| 7-1/8 | (181) | 0.69 | 0.69 | 0.66 | 0.60 | 0.82 | 0.82 | 0.73 | 0.56 | 0.64 | 0.58 | 0.56 | 0.54 | 0.77 | 0.35 | 0.23 | 0.14 | 0.82 | 0.70 | 0.46 | 0.27 | 0.75 | 0.58 | n/a | n/a |
| 8 | (203) | 0.72 | 0.72 | 0.68 | 0.61 | 0.89 | 0.89 | 0.78 | 0.59 | 0.66 | 0.59 | 0.57 | 0.55 | 0.92 | 0.42 | 0.27 | 0.16 | 0.89 | 0.84 | 0.54 | 0.33 | 0.79 | 0.61 | n/a | n/a |
| 9 | (229) | 0.74 | 0.74 | 0.70 | 0.62 | 0.98 | 0.98 | 0.85 | 0.62 | 0.68 | 0.60 | 0.58 | 0.56 | 1.00 | 0.50 | 0.32 | 0.19 | 0.98 | 0.98 | 0.65 | 0.39 | 0.84 | 0.65 | 0.56 | n/a |
| 10 | (254) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 1.00 | 0.91 | 0.66 | 0.70 | 0.62 | 0.59 | 0.56 | | 0.58 | 0.38 | 0.23 | 1.00 | 1.00 | 0.76 | 0.46 | 0.89 | 0.68 | 0.59 | n/a |
| 11 | (279) | 0.80 | 0.80 | 0.74 | 0.65 | | | 0.98 | 0.69 | 0.72 | 0.63 | 0.60 | 0.57 | | 0.67 | 0.44 | 0.26 | | | 0.88 | 0.53 | 0.93 | 0.72 | 0.62 | n/a |
| 12 | (305) | 0.82 | 0.82 | 0.77 | 0.66 | | | 1.00 | 0.73 | 0.74 | 0.64 | 0.60 | 0.57 | | 0.77 | 0.50 | 0.30 | | | 1.00 | 0.60 | 0.97 | 0.75 | 0.65 | n/a |
| 14 | (356) | 0.88 | 0.88 | 0.81 | 0.69 | | | | 0.81 | 0.78 | 0.66 | 0.62 | 0.59 | | 0.97 | 0.63 | 0.38 | | | | 0.76 | 1.00 | 0.81 | 0.70 | 0.59 |
| 16 | (406) | 0.93 | 0.93 | 0.86 | 0.71 | | | | 0.89 | 0.82 | 0.69 | 0.64 | 0.60 | | 1.00 | 0.77 | 0.46 | | | | 0.89 | | 0.86 | 0.75 | 0.63 |
| 18 | (457) | 0.99 | 0.99 | 0.90 | 0.74 | | | | 0.97 | 0.85 | 0.71 | 0.66 | 0.61 | | | 0.92 | 0.55 | | | | 0.97 | | 0.92 | 0.79 | 0.67 |
| 20 | (508) | 1.00 | 1.00 | 0.94 | 0.77 | | | | 1.00 | 0.89 | 0.73 | 0.67 | 0.62 | | | 1.00 | 0.64 | | | | 1.00 | | 0.97 | 0.84 | 0.71 |
| 22 | (559) | 1.00 | | 0.99 | 0.79 | | | | | 0.93 | 0.76 | 0.69 | 0.64 | | | | 0.74 | | | | | | 1.00 | 0.88 | 0.74 |
| 24 | (610) | 1.00 | | 1.00 | 0.82 | | | | | 0.97 | 0.78 | 0.71 | 0.65 | | | | 0.85 | | | | | | | 0.92 | 0.77 |
| 26 | (660) | 1.00 | | | 0.85 | | | | | 1.00 | 0.80 | 0.73 | 0.66 | | | | 0.96 | | | | | | | 0.95 | 0.80 |
| 28 | (711) | 1.00 | | | 0.87 | | | | | | 0.83 | 0.74 | 0.67 | | | | 1.00 | | | | | | | 0.99 | 0.83 |
| 30 | (762) | 1.00 | | | 0.90 | | | | | | 0.85 | 0.76 | 0.69 | | | | | | | | | | | 1.00 | 0.86 |
| 36 | (914) | 1.00 | | | 0.98 | | | | | | 0.92 | 0.81 | 0.72 | | | | | | | | | | | 1.00 | 0.95 |
| > 48 | (1219) | 1.00 | | | 1.00 | | | | | | 1.00 | 0.92 | 0.80 | | | | | | | | | | | | 1.00 |

Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm)

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 48 — Load adjustment factors for 3/4-in. diameter threaded rods in uncracked concrete[1,2,3]

| 3/4-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To and away from edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.35 | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | n/a | 0.09 | 0.03 | 0.02 | 0.01 | 0.17 | 0.07 | 0.05 | 0.02 | n/a | n/a | n/a | n/a |
| 2-1/8 | (54) | n/a | n/a | n/a | n/a | 0.38 | 0.25 | 0.19 | 0.11 | n/a | n/a | n/a | n/a | 0.11 | 0.05 | 0.03 | 0.01 | 0.23 | 0.09 | 0.06 | 0.03 | n/a | n/a | n/a | n/a |
| 3-3/4 | (95) | 0.58 | 0.58 | 0.57 | 0.54 | 0.52 | 0.30 | 0.22 | 0.13 | 0.57 | 0.54 | 0.53 | 0.52 | 0.27 | 0.11 | 0.07 | 0.03 | 0.52 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| 4 | (102) | 0.59 | 0.59 | 0.57 | 0.54 | 0.54 | 0.31 | 0.23 | 0.13 | 0.57 | 0.54 | 0.53 | 0.52 | 0.29 | 0.12 | 0.08 | 0.04 | 0.54 | 0.24 | 0.16 | 0.07 | n/a | n/a | n/a | n/a |
| 5 | (127) | 0.61 | 0.61 | 0.59 | 0.56 | 0.60 | 0.34 | 0.25 | 0.14 | 0.59 | 0.55 | 0.54 | 0.52 | 0.41 | 0.17 | 0.11 | 0.05 | 0.60 | 0.33 | 0.22 | 0.10 | n/a | n/a | n/a | n/a |
| 5-1/4 | (133) | 0.62 | 0.62 | 0.60 | 0.56 | 0.62 | 0.35 | 0.25 | 0.15 | 0.60 | 0.55 | 0.54 | 0.52 | 0.44 | 0.18 | 0.12 | 0.05 | 0.62 | 0.35 | 0.23 | 0.11 | 0.62 | n/a | n/a | n/a |
| 6 | (152) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.38 | 0.27 | 0.16 | 0.61 | 0.56 | 0.55 | 0.53 | 0.54 | 0.22 | 0.14 | 0.07 | 0.66 | 0.38 | 0.27 | 0.13 | 0.66 | n/a | n/a | n/a |
| 7 | (178) | 0.66 | 0.66 | 0.63 | 0.58 | 0.72 | 0.41 | 0.30 | 0.17 | 0.63 | 0.57 | 0.55 | 0.53 | 0.68 | 0.28 | 0.18 | 0.08 | 0.72 | 0.41 | 0.30 | 0.17 | 0.72 | n/a | n/a | n/a |
| 8 | (203) | 0.68 | 0.68 | 0.65 | 0.59 | 0.79 | 0.45 | 0.32 | 0.19 | 0.65 | 0.58 | 0.56 | 0.54 | 0.83 | 0.34 | 0.22 | 0.10 | 0.79 | 0.45 | 0.32 | 0.19 | 0.77 | n/a | n/a | n/a |
| 8-1/2 | (216) | 0.69 | 0.69 | 0.66 | 0.59 | 0.82 | 0.47 | 0.34 | 0.20 | 0.66 | 0.59 | 0.56 | 0.54 | 0.91 | 0.37 | 0.24 | 0.11 | 0.82 | 0.47 | 0.34 | 0.20 | 0.79 | 0.59 | n/a | n/a |
| 9 | (229) | 0.70 | 0.70 | 0.67 | 0.60 | 0.85 | 0.49 | 0.35 | 0.20 | 0.67 | 0.59 | 0.57 | 0.54 | 0.99 | 0.40 | 0.26 | 0.12 | 0.85 | 0.49 | 0.35 | 0.20 | 0.81 | 0.60 | n/a | n/a |
| 10 | (254) | 0.72 | 0.72 | 0.69 | 0.61 | 0.92 | 0.53 | 0.38 | 0.22 | 0.68 | 0.60 | 0.58 | 0.55 | 1.00 | 0.47 | 0.31 | 0.14 | 0.92 | 0.53 | 0.38 | 0.22 | 0.86 | 0.64 | n/a | n/a |
| 10-3/4 | (273) | 0.74 | 0.74 | 0.70 | 0.62 | 0.97 | 0.57 | 0.40 | 0.23 | 0.70 | 0.61 | 0.58 | 0.55 | | 0.53 | 0.34 | 0.16 | 0.97 | 0.57 | 0.40 | 0.23 | 0.89 | 0.66 | 0.57 | n/a |
| 12 | (305) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 0.64 | 0.44 | 0.26 | 0.72 | 0.62 | 0.59 | 0.55 | | 0.62 | 0.40 | 0.19 | 1.00 | 0.64 | 0.44 | 0.26 | 0.94 | 0.70 | 0.60 | n/a |
| 14 | (356) | 0.81 | 0.81 | 0.76 | 0.66 | | 0.74 | 0.52 | 0.30 | 0.76 | 0.64 | 0.61 | 0.56 | | 0.78 | 0.51 | 0.24 | | 0.74 | 0.52 | 0.30 | 1.00 | 0.75 | 0.65 | n/a |
| 16 | (406) | 0.86 | 0.86 | 0.80 | 0.68 | | 0.85 | 0.59 | 0.34 | 0.79 | 0.66 | 0.62 | 0.57 | | 0.96 | 0.62 | 0.29 | | 0.85 | 0.59 | 0.34 | | 0.80 | 0.70 | n/a |
| 16-3/4 | (425) | 0.88 | 0.88 | 0.81 | 0.69 | | 0.89 | 0.62 | 0.36 | 0.81 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.67 | 0.31 | | 0.89 | 0.62 | 0.36 | | 0.82 | 0.71 | 0.55 |
| 18 | (457) | 0.90 | 0.90 | 0.83 | 0.70 | | 0.96 | 0.66 | 0.39 | 0.83 | 0.68 | 0.64 | 0.58 | | | 0.74 | 0.35 | | 0.96 | 0.66 | 0.39 | | 0.85 | 0.74 | 0.57 |
| 20 | (508) | 0.95 | 0.95 | 0.87 | 0.72 | | 1.00 | 0.74 | 0.43 | 0.87 | 0.70 | 0.65 | 0.59 | | | 0.87 | 0.40 | | 1.00 | 0.74 | 0.43 | | 0.90 | 0.78 | 0.60 |
| 22 | (559) | 0.99 | 0.99 | 0.91 | 0.74 | | | 0.81 | 0.47 | 0.91 | 0.72 | 0.67 | 0.60 | | | 1.00 | 0.47 | | | 0.81 | 0.47 | | 0.94 | 0.82 | 0.63 |
| 24 | (610) | 1.00 | 1.00 | 0.94 | 0.77 | | | 0.89 | 0.51 | 0.94 | 0.74 | 0.68 | 0.61 | | | | 0.53 | | | 0.89 | 0.51 | | 0.99 | 0.85 | 0.66 |
| 26 | (660) | | | 0.98 | 0.79 | | | 0.96 | 0.56 | 0.98 | 0.76 | 0.70 | 0.62 | | | | 0.60 | | | 0.96 | 0.56 | | 1.00 | 0.89 | 0.69 |
| 28 | (711) | | | 1.00 | 0.81 | | | 1.00 | 0.60 | 1.00 | 0.78 | 0.71 | 0.63 | | | | 0.67 | | | 1.00 | 0.60 | | | 0.92 | 0.71 |
| 30 | (762) | | | | 0.83 | | | | 0.64 | | 0.80 | 0.73 | 0.64 | | | | 0.74 | | | | 0.64 | | | 0.95 | 0.74 |
| 36 | (914) | | | | 0.90 | | | | 0.77 | | 0.86 | 0.77 | 0.66 | | | | 0.98 | | | | 0.77 | | | 1.00 | 0.81 |
| > 48 | (1219) | | | | 1.00 | | | | 1.00 | | 0.99 | 0.86 | 0.72 | | | | 1.00 | | | | 1.00 | | | 1.00 | 0.94 |

## Table 49 — Load adjustment factors for 3/4-in. diameter threaded rods in cracked concrete[1,2,3]

| 3/4-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To and away from edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.43 | 0.43 | 0.42 | 0.39 | n/a | n/a | n/a | n/a | 0.09 | 0.03 | 0.02 | 0.01 | 0.17 | 0.07 | 0.05 | 0.02 | n/a | n/a | n/a | n/a |
| 2-1/8 | (54) | n/a | n/a | n/a | n/a | 0.45 | 0.45 | 0.43 | 0.40 | n/a | n/a | n/a | n/a | 0.11 | 0.05 | 0.03 | 0.02 | 0.23 | 0.09 | 0.06 | 0.03 | n/a | n/a | n/a | n/a |
| 3-3/4 | (95) | 0.58 | 0.58 | 0.57 | 0.54 | 0.54 | 0.54 | 0.50 | 0.44 | 0.57 | 0.54 | 0.53 | 0.52 | 0.27 | 0.11 | 0.07 | 0.04 | 0.54 | 0.22 | 0.14 | 0.08 | n/a | n/a | n/a | n/a |
| 4 | (102) | 0.59 | 0.59 | 0.57 | 0.54 | 0.55 | 0.55 | 0.51 | 0.44 | 0.57 | 0.54 | 0.53 | 0.52 | 0.30 | 0.12 | 0.08 | 0.04 | 0.55 | 0.24 | 0.16 | 0.08 | n/a | n/a | n/a | n/a |
| 5 | (127) | 0.61 | 0.61 | 0.59 | 0.56 | 0.60 | 0.60 | 0.56 | 0.47 | 0.59 | 0.55 | 0.54 | 0.53 | 0.41 | 0.17 | 0.11 | 0.06 | 0.60 | 0.34 | 0.22 | 0.12 | n/a | n/a | n/a | n/a |
| 5-1/4 | (133) | 0.62 | 0.62 | 0.60 | 0.56 | 0.62 | 0.62 | 0.57 | 0.47 | 0.60 | 0.55 | 0.54 | 0.53 | 0.45 | 0.18 | 0.12 | 0.06 | 0.62 | 0.36 | 0.24 | 0.13 | 0.62 | n/a | n/a | n/a |
| 6 | (152) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.66 | 0.60 | 0.49 | 0.61 | 0.56 | 0.55 | 0.53 | 0.54 | 0.22 | 0.14 | 0.08 | 0.66 | 0.44 | 0.29 | 0.15 | 0.67 | n/a | n/a | n/a |
| 7 | (178) | 0.66 | 0.66 | 0.63 | 0.58 | 0.72 | 0.72 | 0.65 | 0.52 | 0.63 | 0.57 | 0.55 | 0.54 | 0.69 | 0.28 | 0.18 | 0.10 | 0.72 | 0.56 | 0.36 | 0.19 | 0.72 | n/a | n/a | n/a |
| 8 | (203) | 0.68 | 0.68 | 0.65 | 0.59 | 0.79 | 0.79 | 0.70 | 0.55 | 0.65 | 0.58 | 0.56 | 0.54 | 0.84 | 0.34 | 0.22 | 0.12 | 0.79 | 0.68 | 0.44 | 0.24 | 0.77 | n/a | n/a | n/a |
| 8-1/2 | (216) | 0.69 | 0.69 | 0.66 | 0.59 | 0.82 | 0.82 | 0.72 | 0.56 | 0.66 | 0.59 | 0.56 | 0.54 | 0.92 | 0.37 | 0.24 | 0.13 | 0.82 | 0.75 | 0.49 | 0.26 | 0.79 | 0.59 | n/a | n/a |
| 9 | (229) | 0.70 | 0.70 | 0.67 | 0.60 | 0.85 | 0.85 | 0.75 | 0.57 | 0.67 | 0.59 | 0.57 | 0.55 | 1.00 | 0.41 | 0.26 | 0.14 | 0.85 | 0.82 | 0.53 | 0.28 | 0.82 | 0.61 | n/a | n/a |
| 10 | (254) | 0.72 | 0.72 | 0.69 | 0.61 | 0.92 | 0.92 | 0.80 | 0.60 | 0.69 | 0.60 | 0.58 | 0.55 | | 0.48 | 0.31 | 0.17 | 0.92 | 0.92 | 0.62 | 0.33 | 0.86 | 0.64 | n/a | n/a |
| 10-3/4 | (273) | 0.74 | 0.74 | 0.70 | 0.62 | 0.97 | 0.97 | 0.84 | 0.62 | 0.70 | 0.61 | 0.58 | 0.55 | | 0.53 | 0.35 | 0.18 | 0.97 | 0.97 | 0.69 | 0.37 | 0.89 | 0.66 | 0.57 | n/a |
| 12 | (305) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 1.00 | 0.91 | 0.66 | 0.72 | 0.62 | 0.59 | 0.56 | | 0.63 | 0.41 | 0.22 | 1.00 | 1.00 | 0.82 | 0.44 | 0.94 | 0.70 | 0.61 | n/a |
| 14 | (356) | 0.81 | 0.81 | 0.76 | 0.66 | | | 1.00 | 0.72 | 0.76 | 0.64 | 0.61 | 0.57 | | 0.79 | 0.51 | 0.27 | | 1.00 | 1.00 | 0.55 | 1.00 | 0.76 | 0.65 | n/a |
| 16 | (406) | 0.86 | 0.86 | 0.80 | 0.68 | | | | 0.78 | 0.80 | 0.66 | 0.62 | 0.58 | | 0.97 | 0.63 | 0.34 | | | | 0.67 | | 0.81 | 0.70 | n/a |
| 16-3/4 | (425) | 0.88 | 0.88 | 0.81 | 0.69 | | | | 0.81 | 0.81 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.67 | 0.36 | | | | 0.72 | | 0.83 | 0.72 | 0.58 |
| 18 | (457) | 0.90 | 0.90 | 0.83 | 0.70 | | | | 0.85 | 0.83 | 0.68 | 0.64 | 0.59 | | | 0.75 | 0.40 | | | | 0.80 | | 0.86 | 0.74 | 0.60 |
| 20 | (508) | 0.95 | 0.95 | 0.87 | 0.72 | | | | 0.91 | 0.87 | 0.70 | 0.65 | 0.60 | | | 0.88 | 0.47 | | | | 0.91 | | 0.90 | 0.78 | 0.63 |
| 22 | (559) | 0.99 | 0.99 | 0.91 | 0.74 | | | | 0.98 | 0.91 | 0.72 | 0.67 | 0.61 | | | 1.00 | 0.54 | | | | 0.98 | | 0.95 | 0.82 | 0.67 |
| 24 | (610) | 1.00 | 1.00 | 0.94 | 0.77 | | | | 1.00 | 0.94 | 0.74 | 0.68 | 0.62 | | | | 0.62 | | | | 1.00 | | 0.99 | 0.86 | 0.69 |
| 26 | (660) | | | 0.98 | 0.79 | | | | | 0.98 | 0.76 | 0.70 | 0.63 | | | | 0.69 | | | | | | 1.00 | 0.89 | 0.72 |
| 28 | (711) | | | 1.00 | 0.81 | | | | | 1.00 | 0.79 | 0.71 | 0.64 | | | | 0.78 | | | | | | | 0.92 | 0.75 |
| 30 | (762) | | | | 0.83 | | | | | | 0.81 | 0.73 | 0.65 | | | | 0.86 | | | | | | | 0.96 | 0.78 |
| 36 | (914) | | | | 0.90 | | | | | | 0.87 | 0.77 | 0.68 | | | | 1.00 | | | | | | | 1.00 | 0.85 |
| > 48 | (1219) | | | | 1.00 | | | | | | 0.99 | 0.87 | 0.74 | | | | | | | | | | | | 0.98 |

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 50 — Load adjustment factors for 7/8-in. diameter threaded rods in uncracked concrete[1,2,3]

| 7/8-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.39 | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | n/a | 0.09 | 0.03 | 0.02 | 0.01 | 0.18 | 0.05 | 0.04 | 0.02 | n/a | n/a | n/a | n/a |
| 2-1/4 | (57) | n/a | n/a | n/a | n/a | 0.43 | 0.25 | 0.19 | 0.11 | n/a | n/a | n/a | n/a | 0.13 | 0.04 | 0.03 | 0.01 | 0.26 | 0.08 | 0.05 | 0.02 | n/a | n/a | n/a | n/a |
| 4-3/8 | (111) | 0.58 | 0.58 | 0.57 | 0.54 | 0.54 | 0.31 | 0.23 | 0.13 | 0.58 | 0.54 | 0.53 | 0.52 | 0.35 | 0.11 | 0.07 | 0.03 | 0.54 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| 5 | (127) | 0.60 | 0.60 | 0.58 | 0.55 | 0.56 | 0.33 | 0.24 | 0.13 | 0.59 | 0.54 | 0.53 | 0.52 | 0.43 | 0.13 | 0.09 | 0.04 | 0.56 | 0.27 | 0.17 | 0.08 | n/a | n/a | n/a | n/a |
| 5-1/2 | (140) | 0.61 | 0.61 | 0.59 | 0.55 | 0.59 | 0.34 | 0.25 | 0.14 | 0.60 | 0.55 | 0.54 | 0.52 | 0.50 | 0.15 | 0.10 | 0.05 | 0.59 | 0.31 | 0.20 | 0.09 | 0.65 | n/a | n/a | n/a |
| 6 | (152) | 0.62 | 0.62 | 0.60 | 0.56 | 0.61 | 0.36 | 0.26 | 0.15 | 0.61 | 0.55 | 0.54 | 0.52 | 0.57 | 0.17 | 0.11 | 0.05 | 0.61 | 0.35 | 0.23 | 0.11 | 0.68 | n/a | n/a | n/a |
| 7 | (178) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.39 | 0.28 | 0.16 | 0.63 | 0.56 | 0.55 | 0.53 | 0.71 | 0.22 | 0.14 | 0.07 | 0.66 | 0.39 | 0.28 | 0.13 | 0.73 | n/a | n/a | n/a |
| 8 | (203) | 0.65 | 0.65 | 0.63 | 0.58 | 0.72 | 0.42 | 0.30 | 0.17 | 0.65 | 0.57 | 0.55 | 0.53 | 0.87 | 0.27 | 0.17 | 0.08 | 0.72 | 0.42 | 0.30 | 0.16 | 0.78 | n/a | n/a | n/a |
| 9 | (229) | 0.67 | 0.67 | 0.64 | 0.59 | 0.77 | 0.45 | 0.33 | 0.18 | 0.67 | 0.58 | 0.56 | 0.54 | 1.00 | 0.32 | 0.21 | 0.10 | 0.77 | 0.45 | 0.33 | 0.18 | 0.83 | n/a | n/a | n/a |
| 9-7/8 | (251) | 0.69 | 0.69 | 0.66 | 0.59 | 0.82 | 0.48 | 0.35 | 0.19 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.11 | 0.82 | 0.48 | 0.35 | 0.19 | 0.87 | 0.59 | n/a | n/a |
| 10 | (254) | 0.69 | 0.69 | 0.66 | 0.60 | 0.82 | 0.49 | 0.35 | 0.20 | 0.69 | 0.59 | 0.57 | 0.54 | | 0.38 | 0.24 | 0.11 | 0.82 | 0.49 | 0.35 | 0.20 | 0.87 | 0.59 | n/a | n/a |
| 11 | (279) | 0.71 | 0.71 | 0.67 | 0.60 | 0.88 | 0.52 | 0.37 | 0.21 | 0.71 | 0.60 | 0.57 | 0.54 | | 0.43 | 0.28 | 0.13 | 0.88 | 0.52 | 0.37 | 0.21 | 0.91 | 0.62 | n/a | n/a |
| 12 | (305) | 0.73 | 0.73 | 0.69 | 0.61 | 0.94 | 0.56 | 0.40 | 0.22 | 0.73 | 0.60 | 0.58 | 0.55 | | 0.49 | 0.32 | 0.15 | 0.94 | 0.56 | 0.40 | 0.22 | 0.95 | 0.65 | n/a | n/a |
| 12-1/2 | (318) | 0.74 | 0.74 | 0.70 | 0.62 | 0.97 | 0.59 | 0.41 | 0.23 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.52 | 0.34 | 0.16 | 0.97 | 0.59 | 0.41 | 0.23 | 0.97 | 0.66 | 0.57 | n/a |
| 14 | (356) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 0.66 | 0.46 | 0.26 | 0.77 | 0.62 | 0.59 | 0.55 | | 0.62 | 0.40 | 0.19 | 1.00 | 0.66 | 0.46 | 0.26 | 1.00 | 0.70 | 0.60 | n/a |
| 16 | (406) | 0.81 | 0.81 | 0.75 | 0.65 | | 0.75 | 0.52 | 0.29 | 0.80 | 0.64 | 0.60 | 0.56 | | 0.76 | 0.49 | 0.23 | 1.00 | 0.75 | 0.52 | 0.29 | | 0.75 | 0.65 | n/a |
| 18 | (457) | 0.85 | 0.85 | 0.79 | 0.67 | | 0.84 | 0.59 | 0.33 | 0.84 | 0.66 | 0.62 | 0.57 | | 0.91 | 0.59 | 0.27 | 1.00 | 0.84 | 0.59 | 0.33 | | 0.79 | 0.68 | n/a |
| 19-1/2 | (495) | 0.88 | 0.88 | 0.81 | 0.69 | | 0.92 | 0.64 | 0.36 | 0.87 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.66 | 0.31 | 1.00 | 0.92 | 0.64 | 0.36 | | 0.82 | 0.71 | 0.55 |
| 20 | (508) | 0.89 | 0.89 | 0.82 | 0.69 | | 0.94 | 0.65 | 0.37 | 0.88 | 0.67 | 0.63 | 0.58 | | | 0.69 | 0.32 | 1.00 | 0.94 | 0.65 | 0.37 | | 0.83 | 0.72 | 0.56 |
| 22 | (559) | 0.92 | 0.92 | 0.85 | 0.71 | | 1.00 | 0.72 | 0.40 | 0.92 | 0.69 | 0.64 | 0.59 | | | 0.80 | 0.37 | | 1.00 | 0.72 | 0.40 | | 0.87 | 0.76 | 0.59 |
| 24 | (610) | 0.96 | 0.96 | 0.88 | 0.73 | | | 0.78 | 0.44 | 0.96 | 0.71 | 0.66 | 0.59 | | | 0.91 | 0.42 | | | 0.78 | 0.44 | | 0.91 | 0.79 | 0.61 |
| 26 | (660) | 1.00 | 1.00 | 0.91 | 0.75 | | | 0.85 | 0.48 | 0.99 | 0.73 | 0.67 | 0.60 | | | 1.00 | 0.48 | | | 0.85 | 0.48 | | 0.95 | 0.82 | 0.64 |
| 28 | (711) | | | 0.94 | 0.77 | | | 0.91 | 0.51 | 1.00 | 0.74 | 0.68 | 0.61 | | | | 0.53 | | | 0.91 | 0.51 | | 0.99 | 0.85 | 0.66 |
| 30 | (762) | | | 0.98 | 0.79 | | | 0.98 | 0.55 | | 0.76 | 0.70 | 0.62 | | | | 0.59 | | | 0.98 | 0.55 | | 1.00 | 0.88 | 0.68 |
| 36 | (914) | | | 1.00 | 0.84 | | | 1.00 | 0.66 | | 0.81 | 0.73 | 0.64 | | | | 0.77 | | | 1.00 | 0.66 | | | 0.97 | 0.75 |
| > 48 | (1219) | | | | 0.96 | | | | 0.88 | | 0.92 | 0.81 | 0.69 | | | | 1.00 | | | | 0.88 | | | 1.00 | 0.87 |

## Table 51 — Load adjustment factors for 7/8-in. diameter threaded rods in cracked concrete[1,2,3]

| 7/8-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.42 | 0.42 | 0.41 | 0.38 | n/a | n/a | n/a | n/a | 0.09 | 0.03 | 0.02 | 0.01 | 0.18 | 0.06 | 0.04 | 0.02 | n/a | n/a | n/a | n/a |
| 2-1/4 | (57) | n/a | n/a | n/a | n/a | 0.44 | 0.44 | 0.42 | 0.39 | n/a | n/a | n/a | n/a | 0.13 | 0.04 | 0.03 | 0.01 | 0.26 | 0.08 | 0.05 | 0.03 | n/a | n/a | n/a | n/a |
| 4-3/8 | (111) | 0.58 | 0.58 | 0.57 | 0.54 | 0.54 | 0.54 | 0.50 | 0.44 | 0.58 | 0.54 | 0.53 | 0.52 | 0.36 | 0.11 | 0.07 | 0.03 | 0.54 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| 5 | (127) | 0.60 | 0.60 | 0.58 | 0.55 | 0.56 | 0.56 | 0.52 | 0.45 | 0.60 | 0.54 | 0.53 | 0.52 | 0.43 | 0.13 | 0.09 | 0.04 | 0.56 | 0.27 | 0.17 | 0.08 | n/a | n/a | n/a | n/a |
| 5-1/2 | (140) | 0.61 | 0.61 | 0.59 | 0.55 | 0.59 | 0.59 | 0.54 | 0.46 | 0.61 | 0.55 | 0.54 | 0.52 | 0.50 | 0.15 | 0.10 | 0.05 | 0.59 | 0.31 | 0.20 | 0.10 | 0.65 | n/a | n/a | n/a |
| 6 | (152) | 0.62 | 0.62 | 0.60 | 0.56 | 0.61 | 0.61 | 0.56 | 0.47 | 0.61 | 0.55 | 0.54 | 0.52 | 0.57 | 0.18 | 0.11 | 0.06 | 0.61 | 0.35 | 0.23 | 0.11 | 0.68 | n/a | n/a | n/a |
| 7 | (178) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.66 | 0.60 | 0.49 | 0.63 | 0.56 | 0.55 | 0.53 | 0.72 | 0.22 | 0.14 | 0.07 | 0.66 | 0.44 | 0.29 | 0.14 | 0.73 | n/a | n/a | n/a |
| 8 | (203) | 0.65 | 0.65 | 0.63 | 0.58 | 0.72 | 0.72 | 0.64 | 0.52 | 0.65 | 0.57 | 0.55 | 0.53 | 0.88 | 0.27 | 0.18 | 0.09 | 0.72 | 0.54 | 0.35 | 0.17 | 0.78 | n/a | n/a | n/a |
| 9 | (229) | 0.67 | 0.67 | 0.64 | 0.59 | 0.77 | 0.77 | 0.68 | 0.54 | 0.67 | 0.58 | 0.56 | 0.54 | 1.00 | 0.32 | 0.21 | 0.10 | 0.77 | 0.65 | 0.42 | 0.20 | 0.83 | n/a | n/a | n/a |
| 9-7/8 | (251) | 0.69 | 0.69 | 0.66 | 0.59 | 0.82 | 0.82 | 0.72 | 0.56 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.12 | 0.82 | 0.74 | 0.48 | 0.23 | 0.87 | 0.59 | n/a | n/a |
| 10 | (254) | 0.69 | 0.69 | 0.66 | 0.60 | 0.82 | 0.82 | 0.73 | 0.56 | 0.69 | 0.59 | 0.57 | 0.54 | | 0.38 | 0.25 | 0.12 | 0.82 | 0.76 | 0.49 | 0.24 | 0.87 | 0.59 | n/a | n/a |
| 11 | (279) | 0.71 | 0.71 | 0.67 | 0.60 | 0.88 | 0.88 | 0.77 | 0.59 | 0.71 | 0.60 | 0.57 | 0.54 | | 0.44 | 0.28 | 0.14 | 0.88 | 0.87 | 0.57 | 0.28 | 0.92 | 0.62 | n/a | n/a |
| 12 | (305) | 0.73 | 0.73 | 0.69 | 0.61 | 0.94 | 0.94 | 0.82 | 0.61 | 0.73 | 0.60 | 0.58 | 0.55 | | 0.50 | 0.32 | 0.16 | 0.94 | 0.94 | 0.65 | 0.31 | 0.96 | 0.65 | n/a | n/a |
| 12-1/2 | (318) | 0.74 | 0.74 | 0.70 | 0.62 | 0.97 | 0.97 | 0.84 | 0.62 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.53 | 0.34 | 0.17 | 0.97 | 0.97 | 0.69 | 0.33 | 0.98 | 0.66 | 0.57 | n/a |
| 14 | (356) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 1.00 | 0.91 | 0.66 | 0.77 | 0.62 | 0.59 | 0.56 | | 0.63 | 0.41 | 0.20 | 1.00 | 1.00 | 0.82 | 0.40 | 1.00 | 0.70 | 0.61 | n/a |
| 16 | (406) | 0.81 | 0.81 | 0.75 | 0.65 | | | 1.00 | 0.71 | 0.81 | 0.64 | 0.60 | 0.56 | | 0.77 | 0.50 | 0.24 | | | 1.00 | 0.48 | | 0.75 | 0.65 | n/a |
| 18 | (457) | 0.85 | 0.85 | 0.79 | 0.67 | | | | 0.76 | 0.84 | 0.66 | 0.62 | 0.57 | | 0.91 | 0.59 | 0.29 | | | | 0.58 | | 0.79 | 0.69 | n/a |
| 19-1/2 | (495) | 0.88 | 0.88 | 0.81 | 0.69 | | | | 0.80 | 0.87 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.67 | 0.32 | | | | 0.65 | | 0.82 | 0.71 | 0.56 |
| 20 | (508) | 0.89 | 0.89 | 0.82 | 0.69 | | | | 0.82 | 0.88 | 0.67 | 0.63 | 0.58 | | | 0.70 | 0.34 | | | | 0.67 | | 0.84 | 0.72 | 0.57 |
| 22 | (559) | 0.92 | 0.92 | 0.85 | 0.71 | | | | 0.87 | 0.92 | 0.69 | 0.64 | 0.59 | | | 0.80 | 0.39 | | | | 0.78 | | 0.88 | 0.76 | 0.60 |
| 24 | (610) | 0.96 | 0.96 | 0.88 | 0.73 | | | | 0.93 | 0.96 | 0.71 | 0.66 | 0.60 | | | 0.91 | 0.44 | | | | 0.89 | | 0.92 | 0.79 | 0.62 |
| 26 | (660) | 1.00 | 1.00 | 0.91 | 0.75 | | | | 0.99 | 1.00 | 0.73 | 0.67 | 0.61 | | | 1.00 | 0.50 | | | | 0.99 | | 0.95 | 0.82 | 0.65 |
| 28 | (711) | | | 0.94 | 0.77 | | | | 1.00 | | 0.74 | 0.68 | 0.61 | | | | 0.56 | | | | 1.00 | | 0.99 | 0.86 | 0.67 |
| 30 | (762) | | | 0.98 | 0.79 | | | | | | 0.76 | 0.70 | 0.62 | | | | 0.62 | | | | | | 1.00 | 0.89 | 0.70 |
| 36 | (914) | | | 1.00 | 0.84 | | | | | | 0.81 | 0.74 | 0.65 | | | | 0.81 | | | | | | | 0.97 | 0.76 |
| > 48 | (1219) | | | | 0.96 | | | | | | 0.92 | 0.81 | 0.69 | | | | 1.00 | | | | | | | 1.00 | 0.88 |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 52 — Load adjustment factors for 1-in. diameter threaded rods in uncracked concrete[1,2,3]

| 1-in. threaded rods uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To and away from edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.38 | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | n/a | 0.08 | 0.02 | 0.01 | 0.01 | 0.15 | 0.05 | 0.03 | 0.01 | n/a | n/a | n/a | n/a |
| | 2-3/4 | (70) | n/a | n/a | n/a | n/a | 0.45 | 0.26 | 0.19 | 0.11 | n/a | n/a | n/a | n/a | 0.15 | 0.04 | 0.03 | 0.01 | 0.30 | 0.09 | 0.06 | 0.03 | n/a | n/a | n/a | n/a |
| | 5 | (127) | 0.58 | 0.58 | 0.57 | 0.54 | 0.54 | 0.32 | 0.23 | 0.13 | 0.59 | 0.54 | 0.53 | 0.52 | 0.37 | 0.11 | 0.07 | 0.03 | 0.54 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 6 | (152) | 0.60 | 0.60 | 0.58 | 0.55 | 0.58 | 0.34 | 0.25 | 0.14 | 0.60 | 0.55 | 0.53 | 0.52 | 0.48 | 0.14 | 0.09 | 0.04 | 0.58 | 0.29 | 0.19 | 0.09 | n/a | n/a | n/a | n/a |
| | 6-1/4 | (159) | 0.61 | 0.61 | 0.59 | 0.55 | 0.59 | 0.35 | 0.25 | 0.14 | 0.61 | 0.55 | 0.54 | 0.52 | 0.51 | 0.15 | 0.10 | 0.05 | 0.59 | 0.30 | 0.20 | 0.09 | 0.65 | n/a | n/a | n/a |
| | 7 | (178) | 0.62 | 0.62 | 0.60 | 0.56 | 0.62 | 0.37 | 0.27 | 0.15 | 0.62 | 0.55 | 0.54 | 0.52 | 0.61 | 0.18 | 0.12 | 0.05 | 0.62 | 0.36 | 0.23 | 0.11 | 0.69 | n/a | n/a | n/a |
| | 8 | (203) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.40 | 0.29 | 0.16 | 0.64 | 0.56 | 0.55 | 0.53 | 0.74 | 0.22 | 0.14 | 0.07 | 0.66 | 0.40 | 0.29 | 0.13 | 0.74 | n/a | n/a | n/a |
| | 9 | (229) | 0.65 | 0.65 | 0.63 | 0.58 | 0.71 | 0.43 | 0.31 | 0.17 | 0.65 | 0.57 | 0.55 | 0.53 | 0.89 | 0.26 | 0.17 | 0.08 | 0.71 | 0.43 | 0.31 | 0.16 | 0.78 | n/a | n/a | n/a |
| | 10 | (254) | 0.67 | 0.67 | 0.64 | 0.58 | 0.76 | 0.46 | 0.33 | 0.18 | 0.67 | 0.58 | 0.56 | 0.53 | 1.00 | 0.31 | 0.20 | 0.09 | 0.76 | 0.46 | 0.33 | 0.18 | 0.83 | n/a | n/a | n/a |
| | 11 | (279) | 0.69 | 0.69 | 0.65 | 0.59 | 0.80 | 0.49 | 0.35 | 0.19 | 0.69 | 0.58 | 0.56 | 0.54 | | 0.35 | 0.23 | 0.11 | 0.80 | 0.49 | 0.35 | 0.19 | 0.87 | n/a | n/a | n/a |
| | 11-1/4 | (286) | 0.69 | 0.69 | 0.66 | 0.59 | 0.82 | 0.50 | 0.35 | 0.19 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.11 | 0.82 | 0.50 | 0.35 | 0.19 | 0.88 | 0.58 | n/a | n/a |
| | 12 | (305) | 0.70 | 0.70 | 0.67 | 0.60 | 0.85 | 0.52 | 0.37 | 0.20 | 0.70 | 0.59 | 0.57 | 0.54 | | 0.40 | 0.26 | 0.12 | 0.85 | 0.52 | 0.37 | 0.20 | 0.91 | 0.60 | n/a | n/a |
| | 13 | (330) | 0.72 | 0.72 | 0.68 | 0.61 | 0.90 | 0.55 | 0.39 | 0.22 | 0.72 | 0.60 | 0.57 | 0.54 | | 0.46 | 0.30 | 0.14 | 0.90 | 0.55 | 0.39 | 0.22 | 0.94 | 0.63 | n/a | n/a |
| | 14 | (356) | 0.74 | 0.74 | 0.69 | 0.62 | 0.96 | 0.59 | 0.41 | 0.23 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.51 | 0.33 | 0.15 | 0.96 | 0.59 | 0.41 | 0.23 | 0.98 | 0.65 | n/a | n/a |
| | 14-1/4 | (362) | 0.74 | 0.74 | 0.70 | 0.62 | 0.97 | 0.60 | 0.42 | 0.23 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.52 | 0.34 | 0.16 | 0.97 | 0.60 | 0.42 | 0.23 | 0.99 | 0.66 | 0.57 | n/a |
| | 16 | (406) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 0.67 | 0.47 | 0.26 | 0.77 | 0.62 | 0.59 | 0.55 | | 0.62 | 0.40 | 0.19 | 1.00 | 0.67 | 0.47 | 0.26 | 1.00 | 0.70 | 0.60 | n/a |
| | 18 | (457) | 0.80 | 0.80 | 0.75 | 0.65 | | 0.76 | 0.53 | 0.29 | 0.81 | 0.64 | 0.60 | 0.56 | | 0.74 | 0.48 | 0.22 | | 0.76 | 0.53 | 0.29 | | 0.74 | 0.64 | n/a |
| | 20 | (508) | 0.84 | 0.84 | 0.78 | 0.67 | | 0.84 | 0.58 | 0.32 | 0.84 | 0.65 | 0.61 | 0.57 | | 0.87 | 0.56 | 0.26 | | 0.84 | 0.58 | 0.32 | | 0.78 | 0.67 | n/a |
| | 22 | (559) | 0.87 | 0.87 | 0.81 | 0.68 | | 0.93 | 0.64 | 0.35 | 0.88 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.65 | 0.30 | | 0.93 | 0.64 | 0.35 | | 0.82 | 0.71 | n/a |
| | 22-1/4 | (565) | 0.87 | 0.87 | 0.81 | 0.69 | | 0.94 | 0.65 | 0.36 | 0.88 | 0.67 | 0.63 | 0.58 | | | 0.66 | 0.31 | | 0.94 | 0.65 | 0.36 | | 0.82 | 0.71 | 0.55 |
| | 24 | (610) | 0.90 | 0.90 | 0.83 | 0.70 | | 1.00 | 0.70 | 0.39 | 0.91 | 0.68 | 0.64 | 0.58 | | | 0.74 | 0.35 | | 1.00 | 0.70 | 0.39 | | 0.85 | 0.74 | 0.57 |
| | 26 | (660) | 0.94 | 0.94 | 0.86 | 0.72 | | | 0.76 | 0.42 | 0.94 | 0.70 | 0.65 | 0.59 | | | 0.84 | 0.39 | | | 0.76 | 0.42 | | 0.89 | 0.77 | 0.60 |
| | 28 | (711) | 0.97 | 0.97 | 0.89 | 0.73 | | | 0.82 | 0.45 | 0.98 | 0.71 | 0.66 | 0.60 | | | 0.94 | 0.43 | | | 0.82 | 0.45 | | 0.92 | 0.80 | 0.62 |
| | 30 | (762) | 1.00 | 1.00 | 0.92 | 0.75 | | | 0.88 | 0.48 | 1.00 | 0.73 | 0.67 | 0.60 | | | 1.00 | 0.48 | | | 0.88 | 0.48 | | 0.95 | 0.83 | 0.64 |
| | 36 | (914) | | | 1.00 | 0.80 | | | 1.00 | 0.58 | | 0.77 | 0.70 | 0.62 | | | | 0.63 | | | 1.00 | 0.58 | | 1.00 | 0.91 | 0.70 |
| | > 48 | (1219) | | | | 0.90 | | | | 0.77 | | 0.86 | 0.77 | 0.66 | | | | 0.98 | | | | 0.77 | | | 1.00 | 0.81 |

## Table 53 — Load adjustment factors for 1-in. diameter threaded rods in cracked concrete[1,2,3]

| 1-in. threaded rods cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To and away from edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.41 | 0.41 | 0.40 | 0.38 | n/a | n/a | n/a | n/a | 0.08 | 0.02 | 0.01 | 0.01 | 0.15 | 0.05 | 0.03 | 0.01 | n/a | n/a | n/a | n/a |
| | 2-3/4 | (70) | n/a | n/a | n/a | n/a | 0.45 | 0.45 | 0.43 | 0.40 | n/a | n/a | n/a | n/a | 0.15 | 0.04 | 0.03 | 0.01 | 0.30 | 0.09 | 0.06 | 0.03 | n/a | n/a | n/a | n/a |
| | 5 | (127) | 0.58 | 0.58 | 0.57 | 0.54 | 0.54 | 0.54 | 0.50 | 0.44 | 0.59 | 0.54 | 0.53 | 0.52 | 0.37 | 0.11 | 0.07 | 0.03 | 0.54 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 6 | (152) | 0.60 | 0.60 | 0.58 | 0.55 | 0.58 | 0.58 | 0.53 | 0.46 | 0.60 | 0.55 | 0.53 | 0.52 | 0.49 | 0.14 | 0.09 | 0.04 | 0.58 | 0.29 | 0.19 | 0.09 | n/a | n/a | n/a | n/a |
| | 6-1/4 | (159) | 0.61 | 0.61 | 0.59 | 0.55 | 0.59 | 0.59 | 0.54 | 0.46 | 0.61 | 0.55 | 0.54 | 0.52 | 0.52 | 0.15 | 0.10 | 0.05 | 0.59 | 0.31 | 0.20 | 0.09 | 0.66 | n/a | n/a | n/a |
| | 7 | (178) | 0.62 | 0.62 | 0.60 | 0.56 | 0.62 | 0.62 | 0.57 | 0.47 | 0.62 | 0.55 | 0.54 | 0.52 | 0.61 | 0.18 | 0.12 | 0.05 | 0.62 | 0.36 | 0.24 | 0.11 | 0.69 | n/a | n/a | n/a |
| | 8 | (203) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.66 | 0.60 | 0.49 | 0.64 | 0.56 | 0.55 | 0.53 | 0.75 | 0.22 | 0.14 | 0.07 | 0.66 | 0.44 | 0.29 | 0.13 | 0.74 | n/a | n/a | n/a |
| | 9 | (229) | 0.65 | 0.65 | 0.63 | 0.58 | 0.71 | 0.71 | 0.64 | 0.51 | 0.65 | 0.57 | 0.55 | 0.53 | 0.89 | 0.26 | 0.17 | 0.08 | 0.71 | 0.53 | 0.34 | 0.16 | 0.79 | n/a | n/a | n/a |
| | 10 | (254) | 0.67 | 0.67 | 0.64 | 0.58 | 0.76 | 0.76 | 0.67 | 0.53 | 0.67 | 0.58 | 0.56 | 0.53 | 1.00 | 0.31 | 0.20 | 0.09 | 0.76 | 0.62 | 0.40 | 0.19 | 0.83 | n/a | n/a | n/a |
| | 11 | (279) | 0.69 | 0.69 | 0.65 | 0.59 | 0.80 | 0.80 | 0.71 | 0.55 | 0.69 | 0.58 | 0.56 | 0.54 | | 0.36 | 0.23 | 0.11 | 0.80 | 0.72 | 0.46 | 0.22 | 0.87 | n/a | n/a | n/a |
| | 11-1/4 | (286) | 0.69 | 0.69 | 0.66 | 0.59 | 0.82 | 0.82 | 0.72 | 0.56 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.11 | 0.82 | 0.74 | 0.48 | 0.22 | 0.88 | 0.59 | n/a | n/a |
| | 12 | (305) | 0.70 | 0.70 | 0.67 | 0.60 | 0.85 | 0.85 | 0.75 | 0.57 | 0.71 | 0.59 | 0.57 | 0.54 | | 0.41 | 0.26 | 0.12 | 0.85 | 0.82 | 0.53 | 0.25 | 0.91 | 0.61 | n/a | n/a |
| | 13 | (330) | 0.72 | 0.72 | 0.68 | 0.61 | 0.90 | 0.90 | 0.79 | 0.59 | 0.72 | 0.60 | 0.57 | 0.54 | | 0.46 | 0.30 | 0.14 | 0.90 | 0.90 | 0.60 | 0.28 | 0.95 | 0.63 | n/a | n/a |
| | 14 | (356) | 0.74 | 0.74 | 0.69 | 0.62 | 0.96 | 0.96 | 0.83 | 0.62 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.51 | 0.33 | 0.16 | 0.96 | 0.96 | 0.67 | 0.31 | 0.98 | 0.65 | n/a | n/a |
| | 14-1/4 | (362) | 0.74 | 0.74 | 0.70 | 0.62 | 0.97 | 0.97 | 0.84 | 0.62 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.53 | 0.34 | 0.16 | 0.97 | 0.97 | 0.69 | 0.32 | 0.99 | 0.66 | 0.57 | n/a |
| | 16 | (406) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 1.00 | 0.91 | 0.66 | 0.77 | 0.62 | 0.59 | 0.55 | | 0.63 | 0.41 | 0.19 | 1.00 | 1.00 | 0.82 | 0.38 | 1.00 | 0.70 | 0.61 | n/a |
| | 18 | (457) | 0.80 | 0.80 | 0.75 | 0.65 | | | 1.00 | 0.70 | 0.81 | 0.64 | 0.60 | 0.56 | | 0.75 | 0.49 | 0.23 | | | 0.97 | 0.45 | | 0.74 | 0.64 | n/a |
| | 20 | (508) | 0.84 | 0.84 | 0.78 | 0.67 | | | | 0.75 | 0.84 | 0.65 | 0.61 | 0.57 | | 0.88 | 0.57 | 0.26 | | | 1.00 | 0.53 | | 0.78 | 0.68 | n/a |
| | 22 | (559) | 0.87 | 0.87 | 0.81 | 0.68 | | | | 0.80 | 0.88 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.66 | 0.31 | | | | 0.61 | | 0.82 | 0.71 | n/a |
| | 22-1/4 | (565) | 0.87 | 0.87 | 0.81 | 0.69 | | | | 0.80 | 0.88 | 0.67 | 0.63 | 0.58 | | | 0.67 | 0.31 | | | | 0.62 | | 0.82 | 0.71 | 0.55 |
| | 24 | (610) | 0.90 | 0.90 | 0.83 | 0.70 | | | | 0.85 | 0.91 | 0.68 | 0.64 | 0.58 | | | 0.75 | 0.35 | | | | 0.70 | | 0.86 | 0.74 | 0.57 |
| | 26 | (660) | 0.94 | 0.94 | 0.86 | 0.72 | | | | 0.90 | 0.95 | 0.70 | 0.65 | 0.59 | | | 0.84 | 0.39 | | | | 0.78 | | 0.89 | 0.77 | 0.60 |
| | 28 | (711) | 0.97 | 0.97 | 0.89 | 0.73 | | | | 0.95 | 0.98 | 0.71 | 0.66 | 0.60 | | | 0.94 | 0.44 | | | | 0.88 | | 0.92 | 0.80 | 0.62 |
| | 30 | (762) | 1.00 | 1.00 | 0.92 | 0.75 | | | | 1.00 | 1.00 | 0.73 | 0.67 | 0.60 | | | 1.00 | 0.49 | | | | 0.97 | | 0.96 | 0.83 | 0.64 |
| | 36 | (914) | | | 1.00 | 0.80 | | | | | | 0.77 | 0.71 | 0.62 | | | | 0.64 | | | | 1.00 | | 1.00 | 0.91 | 0.70 |
| | > 48 | (1219) | | | | 0.90 | | | | | | 0.87 | 0.77 | 0.66 | | | | 0.98 | | | | | | | 1.00 | 0.81 |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$ is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 54 — Load adjustment factors for 1-1/4-in. diameter threaded rods in uncracked concrete[1,2,3]

| 1-1/4-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 11-1/4 (286) | 25 (635) |
| Spacing (s) / Edge distance ($c_{ef}$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.37 | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | n/a | 0.05 | 0.02 | 0.01 | 0.00 | 0.11 | 0.03 | 0.02 | 0.01 | n/a | n/a | n/a | n/a |
| | 3-1/8 (79) | n/a | n/a | n/a | n/a | 0.44 | 0.27 | 0.20 | 0.11 | n/a | n/a | n/a | n/a | 0.13 | 0.04 | 0.02 | 0.01 | 0.26 | 0.08 | 0.05 | 0.02 | n/a | n/a | n/a | n/a |
| | 6-1/4 (159) | 0.58 | 0.58 | 0.57 | 0.54 | 0.54 | 0.33 | 0.24 | 0.13 | 0.59 | 0.54 | 0.53 | 0.52 | 0.37 | 0.11 | 0.07 | 0.03 | 0.54 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 7 (178) | 0.59 | 0.59 | 0.58 | 0.55 | 0.56 | 0.35 | 0.25 | 0.13 | 0.60 | 0.54 | 0.53 | 0.52 | 0.43 | 0.13 | 0.08 | 0.04 | 0.56 | 0.26 | 0.17 | 0.08 | n/a | n/a | n/a | n/a |
| | 8 (203) | 0.61 | 0.61 | 0.59 | 0.55 | 0.59 | 0.37 | 0.27 | 0.14 | 0.61 | 0.55 | 0.54 | 0.52 | 0.53 | 0.16 | 0.10 | 0.05 | 0.59 | 0.31 | 0.20 | 0.10 | 0.66 | n/a | n/a | n/a |
| | 9 (229) | 0.62 | 0.62 | 0.60 | 0.56 | 0.63 | 0.39 | 0.28 | 0.15 | 0.62 | 0.55 | 0.54 | 0.52 | 0.63 | 0.19 | 0.12 | 0.06 | 0.63 | 0.38 | 0.24 | 0.11 | 0.70 | n/a | n/a | n/a |
| | 10 (254) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.41 | 0.30 | 0.16 | 0.64 | 0.56 | 0.55 | 0.53 | 0.74 | 0.22 | 0.14 | 0.07 | 0.66 | 0.41 | 0.29 | 0.13 | 0.74 | n/a | n/a | n/a |
| | 11 (279) | 0.65 | 0.65 | 0.62 | 0.57 | 0.70 | 0.44 | 0.32 | 0.17 | 0.65 | 0.57 | 0.55 | 0.53 | 0.86 | 0.25 | 0.16 | 0.08 | 0.70 | 0.44 | 0.32 | 0.15 | 0.78 | n/a | n/a | n/a |
| | 12 (305) | 0.66 | 0.66 | 0.63 | 0.58 | 0.74 | 0.46 | 0.33 | 0.18 | 0.66 | 0.57 | 0.55 | 0.53 | 0.98 | 0.29 | 0.19 | 0.09 | 0.74 | 0.46 | 0.33 | 0.17 | 0.81 | n/a | n/a | n/a |
| | 13 (330) | 0.68 | 0.68 | 0.64 | 0.59 | 0.77 | 0.49 | 0.35 | 0.19 | 0.68 | 0.58 | 0.56 | 0.54 | 1.00 | 0.33 | 0.21 | 0.10 | 0.77 | 0.49 | 0.35 | 0.19 | 0.84 | n/a | n/a | n/a |
| | 14 (356) | 0.69 | 0.69 | 0.66 | 0.59 | 0.81 | 0.52 | 0.37 | 0.20 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.36 | 0.24 | 0.11 | 0.81 | 0.52 | 0.37 | 0.20 | 0.87 | 0.58 | n/a | n/a |
| | 14-1/4 (362) | 0.69 | 0.69 | 0.66 | 0.60 | 0.82 | 0.52 | 0.37 | 0.20 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.11 | 0.82 | 0.52 | 0.37 | 0.20 | 0.88 | 0.59 | n/a | n/a |
| | 15 (381) | 0.70 | 0.70 | 0.67 | 0.60 | 0.85 | 0.54 | 0.39 | 0.20 | 0.70 | 0.59 | 0.57 | 0.54 | | 0.40 | 0.26 | 0.12 | 0.85 | 0.54 | 0.39 | 0.20 | 0.91 | 0.60 | n/a | n/a |
| | 16 (406) | 0.72 | 0.72 | 0.68 | 0.61 | 0.89 | 0.57 | 0.40 | 0.21 | 0.72 | 0.60 | 0.57 | 0.54 | | 0.45 | 0.29 | 0.13 | 0.89 | 0.57 | 0.40 | 0.21 | 0.94 | 0.62 | n/a | n/a |
| | 17 (432) | 0.73 | 0.73 | 0.69 | 0.61 | 0.93 | 0.60 | 0.42 | 0.22 | 0.73 | 0.60 | 0.58 | 0.55 | | 0.49 | 0.32 | 0.15 | 0.93 | 0.60 | 0.42 | 0.22 | 0.96 | 0.64 | n/a | n/a |
| | 18 (457) | 0.74 | 0.74 | 0.70 | 0.62 | 0.98 | 0.63 | 0.44 | 0.23 | 0.75 | 0.61 | 0.58 | 0.55 | | 0.53 | 0.35 | 0.16 | 0.98 | 0.63 | 0.44 | 0.23 | 0.99 | 0.66 | 0.57 | n/a |
| | 20 (508) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 0.70 | 0.49 | 0.26 | 0.77 | 0.62 | 0.59 | 0.55 | | 0.62 | 0.40 | 0.19 | 1.00 | 0.70 | 0.49 | 0.26 | 1.00 | 0.70 | 0.60 | n/a |
| | 22 (559) | 0.80 | 0.80 | 0.74 | 0.65 | | 0.77 | 0.54 | 0.28 | 0.80 | 0.63 | 0.60 | 0.56 | | 0.72 | 0.47 | 0.22 | | 0.77 | 0.54 | 0.28 | | 0.73 | 0.63 | n/a |
| | 24 (610) | 0.82 | 0.82 | 0.77 | 0.66 | | 0.84 | 0.59 | 0.31 | 0.83 | 0.65 | 0.61 | 0.57 | | 0.82 | 0.53 | 0.25 | | 0.84 | 0.59 | 0.31 | | 0.76 | 0.66 | n/a |
| | 26 (660) | 0.85 | 0.85 | 0.79 | 0.67 | | 0.91 | 0.64 | 0.34 | 0.86 | 0.66 | 0.62 | 0.57 | | 0.92 | 0.60 | 0.28 | | 0.91 | 0.64 | 0.34 | | 0.79 | 0.69 | n/a |
| | 28 (711) | 0.88 | 0.88 | 0.81 | 0.69 | | 0.98 | 0.68 | 0.36 | 0.88 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.67 | 0.31 | | 0.98 | 0.68 | 0.36 | | 0.82 | 0.71 | 0.55 |
| | 30 (762) | 0.90 | 0.90 | 0.83 | 0.70 | | 1.00 | 0.73 | 0.39 | 0.91 | 0.68 | 0.64 | 0.58 | | | 0.74 | 0.35 | | 1.00 | 0.73 | 0.39 | | 0.85 | 0.74 | 0.57 |
| | 36 (914) | 0.99 | 0.99 | 0.90 | 0.74 | | | 0.88 | 0.47 | 0.99 | 0.72 | 0.66 | 0.60 | | | 0.98 | 0.45 | | | 0.88 | 0.47 | | 0.94 | 0.81 | 0.63 |
| | > 48 (1219) | 1.00 | 1.00 | 1.00 | 0.82 | | | 1.00 | 0.62 | 1.00 | 0.79 | 0.72 | 0.63 | | | 1.00 | 0.70 | | | 1.00 | 0.62 | | 1.00 | 0.94 | 0.72 |

## Table 55 — Load adjustment factors for 1-1/4-in. diameter threaded rods in cracked concrete[1,2,3]

| 1-1/4-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 11-1/4 (286) | 25 (635) |
| Spacing (s) / Edge distance ($c_{ef}$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.40 | 0.40 | 0.39 | 0.37 | n/a | n/a | n/a | n/a | 0.05 | 0.02 | 0.01 | 0.00 | 0.11 | 0.03 | 0.02 | 0.01 | n/a | n/a | n/a | n/a |
| | 3-1/8 (79) | n/a | n/a | n/a | n/a | 0.44 | 0.44 | 0.42 | 0.39 | n/a | n/a | n/a | n/a | 0.13 | 0.04 | 0.03 | 0.01 | 0.26 | 0.08 | 0.05 | 0.02 | n/a | n/a | n/a | n/a |
| | 6-1/4 (159) | 0.58 | 0.58 | 0.57 | 0.54 | 0.54 | 0.54 | 0.50 | 0.44 | 0.59 | 0.54 | 0.53 | 0.52 | 0.37 | 0.11 | 0.07 | 0.03 | 0.54 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 7 (178) | 0.59 | 0.59 | 0.58 | 0.55 | 0.56 | 0.56 | 0.52 | 0.45 | 0.60 | 0.54 | 0.53 | 0.52 | 0.44 | 0.13 | 0.08 | 0.04 | 0.56 | 0.26 | 0.17 | 0.08 | n/a | n/a | n/a | n/a |
| | 8 (203) | 0.61 | 0.61 | 0.59 | 0.55 | 0.59 | 0.59 | 0.55 | 0.46 | 0.61 | 0.55 | 0.54 | 0.52 | 0.54 | 0.16 | 0.10 | 0.05 | 0.59 | 0.32 | 0.21 | 0.10 | 0.66 | n/a | n/a | n/a |
| | 9 (229) | 0.62 | 0.62 | 0.60 | 0.56 | 0.63 | 0.63 | 0.57 | 0.48 | 0.62 | 0.55 | 0.54 | 0.52 | 0.64 | 0.19 | 0.12 | 0.06 | 0.63 | 0.38 | 0.25 | 0.11 | 0.70 | n/a | n/a | n/a |
| | 10 (254) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.66 | 0.60 | 0.49 | 0.64 | 0.56 | 0.55 | 0.53 | 0.75 | 0.22 | 0.14 | 0.07 | 0.66 | 0.44 | 0.29 | 0.13 | 0.74 | n/a | n/a | n/a |
| | 11 (279) | 0.65 | 0.65 | 0.62 | 0.57 | 0.70 | 0.70 | 0.63 | 0.51 | 0.65 | 0.57 | 0.55 | 0.53 | 0.86 | 0.26 | 0.17 | 0.08 | 0.70 | 0.51 | 0.33 | 0.15 | 0.78 | n/a | n/a | n/a |
| | 12 (305) | 0.66 | 0.66 | 0.63 | 0.58 | 0.74 | 0.74 | 0.66 | 0.53 | 0.66 | 0.57 | 0.55 | 0.53 | 0.98 | 0.29 | 0.19 | 0.09 | 0.74 | 0.58 | 0.38 | 0.18 | 0.81 | n/a | n/a | n/a |
| | 13 (330) | 0.68 | 0.68 | 0.64 | 0.59 | 0.77 | 0.77 | 0.69 | 0.54 | 0.68 | 0.58 | 0.56 | 0.54 | 1.00 | 0.33 | 0.21 | 0.10 | 0.77 | 0.66 | 0.43 | 0.20 | 0.85 | n/a | n/a | n/a |
| | 14 (356) | 0.69 | 0.69 | 0.66 | 0.59 | 0.81 | 0.81 | 0.72 | 0.56 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.11 | 0.81 | 0.73 | 0.48 | 0.22 | 0.88 | 0.58 | n/a | n/a |
| | 14-1/4 (362) | 0.69 | 0.69 | 0.66 | 0.60 | 0.82 | 0.82 | 0.73 | 0.56 | 0.70 | 0.59 | 0.57 | 0.54 | | 0.38 | 0.25 | 0.11 | 0.82 | 0.75 | 0.49 | 0.23 | 0.89 | 0.59 | n/a | n/a |
| | 15 (381) | 0.70 | 0.70 | 0.67 | 0.60 | 0.85 | 0.85 | 0.75 | 0.57 | 0.71 | 0.59 | 0.57 | 0.54 | | 0.41 | 0.26 | 0.12 | 0.85 | 0.82 | 0.53 | 0.25 | 0.91 | 0.61 | n/a | n/a |
| | 16 (406) | 0.72 | 0.72 | 0.68 | 0.61 | 0.89 | 0.89 | 0.78 | 0.59 | 0.72 | 0.60 | 0.57 | 0.54 | | 0.45 | 0.29 | 0.14 | 0.89 | 0.89 | 0.58 | 0.27 | 0.94 | 0.63 | n/a | n/a |
| | 17 (432) | 0.73 | 0.73 | 0.69 | 0.61 | 0.93 | 0.93 | 0.81 | 0.61 | 0.73 | 0.60 | 0.58 | 0.55 | | 0.49 | 0.32 | 0.15 | 0.93 | 0.93 | 0.64 | 0.30 | 0.97 | 0.64 | n/a | n/a |
| | 18 (457) | 0.74 | 0.74 | 0.70 | 0.62 | 0.98 | 0.98 | 0.85 | 0.62 | 0.75 | 0.61 | 0.58 | 0.55 | | 0.54 | 0.35 | 0.16 | 0.98 | 0.98 | 0.70 | 0.32 | 0.99 | 0.66 | 0.57 | n/a |
| | 20 (508) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 1.00 | 0.91 | 0.66 | 0.77 | 0.62 | 0.59 | 0.55 | | 0.63 | 0.41 | 0.19 | 1.00 | 1.00 | 0.82 | 0.38 | 1.00 | 0.70 | 0.61 | n/a |
| | 22 (559) | 0.80 | 0.80 | 0.74 | 0.65 | | | 0.98 | 0.69 | 0.80 | 0.63 | 0.60 | 0.56 | | 0.72 | 0.47 | 0.22 | | | 0.94 | 0.44 | | 0.73 | 0.63 | n/a |
| | 24 (610) | 0.82 | 0.82 | 0.77 | 0.66 | | | 1.00 | 0.73 | 0.83 | 0.65 | 0.61 | 0.57 | | 0.82 | 0.54 | 0.25 | | | 1.00 | 0.50 | | 0.77 | 0.66 | n/a |
| | 26 (660) | 0.85 | 0.85 | 0.79 | 0.67 | | | | 0.77 | 0.86 | 0.66 | 0.62 | 0.57 | | 0.93 | 0.60 | 0.28 | | | | 0.56 | | 0.80 | 0.69 | n/a |
| | 28 (711) | 0.88 | 0.88 | 0.81 | 0.69 | | | | 0.81 | 0.88 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.68 | 0.31 | | | | 0.63 | | 0.83 | 0.72 | 0.55 |
| | 30 (762) | 0.90 | 0.90 | 0.83 | 0.70 | | | | 0.85 | 0.91 | 0.68 | 0.64 | 0.58 | | | 0.75 | 0.35 | | | | 0.70 | | 0.86 | 0.74 | 0.57 |
| | 36 (914) | 0.99 | 0.99 | 0.90 | 0.74 | | | | 0.97 | 0.99 | 0.72 | 0.66 | 0.60 | | | 0.98 | 0.46 | | | | 0.91 | | 0.94 | 0.81 | 0.63 |
| | > 48 (1219) | 1.00 | 1.00 | 1.00 | 0.82 | | | | 1.00 | 1.00 | 0.79 | 0.72 | 0.63 | | | 1.00 | 0.70 | | | | 1.00 | | 1.00 | 0.94 | 0.73 |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

**HIT-HY 200 V3 with HIS-N Inserts**



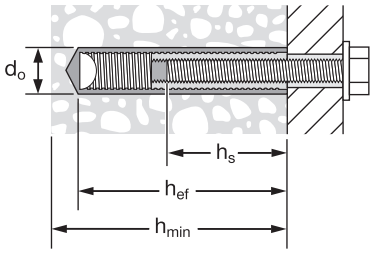
**Figure 12 — Hilti HIS-N and HIS-RN internally threaded insert installation conditions**

| | | | | | |
|---|---|---|---|---|---|
| Permissible concrete conditions | Uncracked concrete | Dry concrete | Permissible Drilling Method | Hammer drilling with carbide tipped drill bit | |
| | Cracked concrete | Water saturated concrete | | Hilti TE-CD or TE-YD Hollow Drill Bit | |

**Table 56 — Hilti HIS-N and HIS-RN specifications**

| Setting information | | Symbol | Units | Thread size | | | |
|---|---|---|---|---|---|---|---|
| | | | | 3/8-16 UNC | 1/2-13 UNC | 5/8-11 UNC | 3/4-10 UNC |
| Outside diameter of insert | | | in. | 0.65 | 0.81 | 1.00 | 1.09 |
| Nominal bit diameter | | $d_o$ | in. | 11/16 | 7/8 | 1-1/8 | 1-1/4 |
| Effective embedment | | $h_{ef}$ | in.<br>(mm) | 4-3/8<br>(110) | 5<br>(125) | 6-3/4<br>(170) | 8-1/8<br>(205) |
| Thread engagement | minimum<br>maximum | $h_s$ | in.<br>in. | 3/8<br>15/16 | 1/2<br>1-3/16 | 5/8<br>1-1/2 | 3/4<br>1-7/8 |
| Installation torque | | $T_{inst}$ | ft-lb<br>(Nm) | 15<br>(20) | 30<br>(40) | 60<br>(81) | 100<br>(136) |
| Minimum concrete thickness | | $h_{min}$ | in.<br>(mm) | 5.9<br>(150) | 6.7<br>(170) | 9.1<br>(230) | 10.6<br>(270) |
| Minimum edge distance | | $c_{min}$ | in<br>(mm) | 3-1/4<br>(83) | 4<br>(102) | 5<br>(127) | 5-1/2<br>(140) |
| Minimum anchor spacing | | $s_{min}$ | in<br>(mm) | 3-1/4<br>(83) | 4<br>(102) | 5<br>(127) | 5-1/2<br>(140) |

**Figure 13 — Hilti HIS-N and HIS-RN specifications**



### Table 57 — Hilti HIT-HY 200 V3 adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2,3,4,5,6,7,8,9]

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8-16 UNC | 4-3/8 (111) | 7,140 (31.8) | 7,820 (34.8) | 9,030 (40.2) | 11,060 (49.2) | 15,375 (68.4) | 16,840 (74.9) | 19,445 (86.5) | 23,815 (105.9) |
| 1/2-13 UNC | 5 (127) | 8,720 (38.8) | 9,555 (42.5) | 11,030 (49.1) | 13,510 (60.1) | 18,785 (83.6) | 20,575 (91.5) | 23,760 (105.7) | 29,100 (129.4) |
| 5/8-11 UNC | 6-3/4 (171) | 13,680 (60.9) | 14,985 (66.7) | 17,305 (77.0) | 21,190 (94.3) | 29,460 (131.0) | 32,275 (143.6) | 37,265 (165.8) | 45,645 (203.0) |
| 3/4-10 UNC | 8-1/8 (206) | 18,065 (80.4) | 19,790 (88.0) | 22,850 (101.6) | 27,985 (124.5) | 38,910 (173.1) | 42,620 (189.6) | 49,215 (218.9) | 60,275 (268.1) |

### Table 58 — Hilti HIT-HY 200 V3 adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2,3,4,5,6,7,8,9]

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8-16 UNC | 4-3/8 (111) | 5,050 (22.5) | 5,335 (23.7) | 5,815 (25.9) | 6,570 (29.2) | 10,880 (48.4) | 11,495 (51.1) | 12,530 (55.7) | 14,150 (62.9) |
| 1/2-13 UNC | 5 (127) | 6,175 (27.5) | 6,765 (30.1) | 7,815 (34.8) | 9,570 (42.6) | 13,305 (59.2) | 14,575 (64.8) | 16,830 (74.9) | 20,610 (91.7) |
| 5/8-11 UNC | 6-3/4 (171) | 9,690 (43.1) | 10,615 (47.2) | 12,255 (54.5) | 15,010 (66.8) | 20,870 (92.8) | 22,860 (101.7) | 26,395 (117.4) | 32,330 (143.8) |
| 3/4-10 UNC | 8-1/8 (206) | 12,795 (56.9) | 14,015 (62.3) | 16,185 (72.0) | 19,825 (88.2) | 27,560 (122.6) | 30,190 (134.3) | 34,860 (155.1) | 42,695 (189.9) |

1 See section 3.1.8 for explanation on development of load values.
2 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 60 - 61 as necessary to the above values. Compare to the steel values in table 59. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C) multiply above values by 0.92.
For temperature range C: Max. short term temperature = 248° F (120° C), max. long term temperature = 162° F (72° C) multiply above values by 0.78.
Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength (factored resistance) by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.69. See section 3.1.8 for additional information on seismic applications.

### Table 59 — Steel design strength for steel bolt and cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

| Thread size | ASTM A193 B7 | | | ASTM A193 Grade B8M stainless steel | | |
|---|---|---|---|---|---|---|
| | Tensile[4] $\phi N_{sa}$ lb (kN) | Shear[5] $\phi V_{sa}$ lb (kN) | Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN) | Tensile[4] $\phi N_{sa}$ lb (kN) | Shear[5] $\phi V_{sa}$ lb (kN) | Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN) |
| 3/8-16 UNC | 6,300 (28.0) | 3,490 (15.5) | 2,445 (10.9) | 5,540 (24.6) | 3,070 (13.7) | 2,150 (9.6) |
| 1/2-13 UNC | 11,530 (51.3) | 6,385 (28.4) | 4,470 (19.9) | 10,145 (45.1) | 5,620 (25.0) | 3,935 (17.5) |
| 5/8-11 UNC | 18,365 (81.7) | 10,170 (45.2) | 7,120 (31.6) | 16,160 (71.9) | 8,950 (39.8) | 6,265 (27.9) |
| 3/4-10 UNC | 27,180 (120.9) | 15,055 (67.0) | 10,540 (46.9) | 23,915 (106.4) | 13,245 (58.9) | 9,270 (41.2) |

1 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.
2 Hilti HIS-N and HIS-RN inserts with steel bolts are to be considered brittle steel elements.
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.
4 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
5 Shear values determined by static shear tests with $\phi V_{sa} \le \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.
6 Seismic Shear = $\alpha_{V,seis}\ \Phi_{Vsa}$ : Reduction for seismic shear only. See section 3.1.8 for additional information on seismic applications.

## Table 60 — Load adjustment Factors for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3]

| HIS-N and HIS-RN all diameters uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ∥ To and away from edge $f_{RV}$ | | | | | | | |
| Thread Size | | in. | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 |
| Embedment $h_{ef}$ | | in. | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 |
| | | (mm) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) |
| Spacing (s) / Edge distanc ($c_a$) / Concrete thickness (h), - in. (mm) | 3-1/4 | (83) | 0.59 | n/a | n/a | n/a | 0.36 | n/a | n/a | n/a | 0.55 | n/a | n/a | n/a | 0.15 | n/a | n/a | n/a | 0.31 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4 | (102) | 0.61 | 0.59 | n/a | n/a | 0.41 | 0.40 | n/a | n/a | 0.56 | 0.55 | n/a | n/a | 0.21 | 0.19 | n/a | n/a | 0.41 | 0.38 | n/a | n/a | n/a | n/a | n/a | n/a |
| | 5 | (127) | 0.64 | 0.61 | 0.59 | n/a | 0.47 | 0.45 | 0.39 | n/a | 0.57 | 0.57 | 0.55 | n/a | 0.29 | 0.26 | 0.17 | n/a | 0.47 | 0.45 | 0.33 | n/a | n/a | n/a | n/a | n/a |
| | 5-1/2 | (140) | 0.65 | 0.62 | 0.60 | 0.59 | 0.50 | 0.48 | 0.41 | 0.37 | 0.58 | 0.58 | 0.56 | 0.55 | 0.34 | 0.30 | 0.19 | 0.15 | 0.50 | 0.48 | 0.39 | 0.29 | n/a | n/a | n/a | n/a |
| | 6 | (152) | 0.67 | 0.63 | 0.61 | 0.60 | 0.53 | 0.51 | 0.43 | 0.39 | 0.59 | 0.58 | 0.56 | 0.55 | 0.39 | 0.35 | 0.22 | 0.17 | 0.53 | 0.51 | 0.43 | 0.33 | 0.60 | n/a | n/a | n/a |
| | 7 | (178) | 0.69 | 0.66 | 0.63 | 0.62 | 0.61 | 0.57 | 0.48 | 0.42 | 0.60 | 0.60 | 0.57 | 0.56 | 0.49 | 0.43 | 0.28 | 0.21 | 0.61 | 0.57 | 0.48 | 0.42 | 0.64 | 0.62 | n/a | n/a |
| | 8 | (203) | 0.72 | 0.68 | 0.64 | 0.63 | 0.70 | 0.65 | 0.52 | 0.45 | 0.62 | 0.61 | 0.58 | 0.57 | 0.60 | 0.53 | 0.34 | 0.26 | 0.70 | 0.65 | 0.52 | 0.45 | 0.69 | 0.66 | n/a | n/a |
| | 9 | (229) | 0.75 | 0.70 | 0.66 | 0.65 | 0.78 | 0.73 | 0.57 | 0.49 | 0.63 | 0.62 | 0.59 | 0.58 | 0.71 | 0.63 | 0.40 | 0.31 | 0.78 | 0.73 | 0.57 | 0.49 | 0.73 | 0.70 | n/a | n/a |
| | 10 | (254) | 0.78 | 0.72 | 0.68 | 0.66 | 0.87 | 0.81 | 0.62 | 0.53 | 0.65 | 0.64 | 0.60 | 0.58 | 0.83 | 0.74 | 0.47 | 0.36 | 0.87 | 0.81 | 0.62 | 0.53 | 0.77 | 0.74 | 0.64 | n/a |
| | 11 | (279) | 0.80 | 0.74 | 0.70 | 0.68 | 0.96 | 0.89 | 0.68 | 0.56 | 0.66 | 0.65 | 0.61 | 0.59 | 0.96 | 0.86 | 0.55 | 0.41 | 0.96 | 0.89 | 0.68 | 0.56 | 0.81 | 0.78 | 0.67 | 0.61 |
| | 12 | (305) | 0.83 | 0.77 | 0.72 | 0.70 | 1.00 | 0.97 | 0.74 | 0.60 | 0.68 | 0.66 | 0.62 | 0.60 | 1.00 | 0.98 | 0.62 | 0.47 | 1.00 | 0.97 | 0.74 | 0.60 | 0.84 | 0.81 | 0.70 | 0.64 |
| | 14 | (356) | 0.89 | 0.81 | 0.75 | 0.73 | | 1.00 | 0.86 | 0.70 | 0.71 | 0.69 | 0.64 | 0.62 | | 1.00 | 0.78 | 0.59 | | 1.00 | 0.86 | 0.70 | 0.91 | 0.87 | 0.75 | 0.69 |
| | 16 | (406) | 0.94 | 0.86 | 0.79 | 0.76 | | | 0.98 | 0.80 | 0.74 | 0.72 | 0.66 | 0.63 | | | 0.96 | 0.73 | | | 0.98 | 0.80 | 0.97 | 0.94 | 0.80 | 0.73 |
| | 18 | (457) | 1.00 | 0.90 | 0.82 | 0.80 | | | 1.00 | 0.90 | 0.77 | 0.75 | 0.68 | 0.65 | | | 1.00 | 0.87 | | | 1.00 | 0.90 | 1.00 | 0.99 | 0.85 | 0.78 |
| | 24 | (610) | | 1.00 | 0.93 | 0.90 | | | | 1.00 | 0.85 | 0.83 | 0.74 | 0.70 | | | | 1.00 | | | | 1.00 | | 1.00 | 0.99 | 0.90 |
| | 30 | (762) | | | 1.00 | 0.99 | | | | | 0.94 | 0.91 | 0.80 | 0.75 | | | | | | | | | | | 1.00 | 1.00 |
| | 36 | (914) | | | | 1.00 | | | | | 1.00 | 0.99 | 0.86 | 0.80 | | | | | | | | | | | | 1.00 |
| | > 48 | (1219) | | | | | | | | | | 1.00 | 0.99 | 0.90 | | | | | | | | | | | | |

## Table 61 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3]

| HIS-N and HIS-RN all diameters cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ∥ To and away from edge $f_{RV}$ | | | | | | | |
| Thread Size | | in. | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 |
| Embedment $h_{ef}$ | | in. | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 |
| | | (mm) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) |
| Spacing (s) / Edge distanc ($c_a$) / Concrete thickness (h), - in. (mm) | 3-1/4 | (83) | 0.59 | n/a | n/a | n/a | 0.55 | n/a | n/a | n/a | 0.55 | n/a | n/a | n/a | 0.16 | n/a | n/a | n/a | 0.31 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4 | (102) | 0.61 | 0.59 | n/a | n/a | 0.60 | 0.55 | n/a | n/a | 0.56 | 0.55 | n/a | n/a | 0.21 | 0.19 | n/a | n/a | 0.43 | 0.38 | n/a | n/a | n/a | n/a | n/a | n/a |
| | 5 | (127) | 0.64 | 0.61 | 0.59 | n/a | 0.67 | 0.60 | 0.55 | n/a | 0.57 | 0.57 | 0.55 | n/a | 0.30 | 0.26 | 0.17 | n/a | 0.59 | 0.53 | 0.34 | n/a | n/a | n/a | n/a | n/a |
| | 5-1/2 | (140) | 0.65 | 0.62 | 0.60 | 0.59 | 0.71 | 0.63 | 0.57 | 0.55 | 0.58 | 0.58 | 0.56 | 0.55 | 0.34 | 0.31 | 0.19 | 0.15 | 0.69 | 0.61 | 0.39 | 0.29 | n/a | n/a | n/a | n/a |
| | 6 | (152) | 0.67 | 0.63 | 0.61 | 0.60 | 0.75 | 0.66 | 0.59 | 0.57 | 0.59 | 0.58 | 0.56 | 0.55 | 0.39 | 0.35 | 0.22 | 0.17 | 0.75 | 0.66 | 0.44 | 0.34 | 0.60 | n/a | n/a | n/a |
| | 7 | (178) | 0.69 | 0.66 | 0.63 | 0.62 | 0.83 | 0.72 | 0.64 | 0.61 | 0.60 | 0.60 | 0.57 | 0.56 | 0.49 | 0.44 | 0.28 | 0.21 | 0.83 | 0.72 | 0.56 | 0.42 | 0.64 | 0.62 | n/a | n/a |
| | 8 | (203) | 0.72 | 0.68 | 0.64 | 0.63 | 0.91 | 0.78 | 0.69 | 0.66 | 0.62 | 0.61 | 0.58 | 0.57 | 0.60 | 0.54 | 0.34 | 0.26 | 0.91 | 0.78 | 0.68 | 0.52 | 0.69 | 0.66 | n/a | n/a |
| | 9 | (229) | 0.75 | 0.70 | 0.66 | 0.65 | 1.00 | 0.85 | 0.74 | 0.70 | 0.63 | 0.62 | 0.59 | 0.58 | 0.72 | 0.64 | 0.41 | 0.31 | 1.00 | 0.85 | 0.74 | 0.62 | 0.73 | 0.70 | n/a | n/a |
| | 10 | (254) | 0.78 | 0.72 | 0.68 | 0.66 | | 0.91 | 0.79 | 0.75 | 0.65 | 0.64 | 0.60 | 0.58 | 0.84 | 0.75 | 0.48 | 0.36 | | 0.91 | 0.79 | 0.72 | 0.77 | 0.74 | 0.64 | n/a |
| | 11 | (279) | 0.80 | 0.74 | 0.70 | 0.68 | | 0.98 | 0.84 | 0.79 | 0.66 | 0.65 | 0.61 | 0.59 | 0.97 | 0.86 | 0.55 | 0.42 | | 0.98 | 0.84 | 0.79 | 0.81 | 0.78 | 0.67 | 0.61 |
| | 12 | (305) | 0.83 | 0.77 | 0.72 | 0.70 | | 1.00 | 0.89 | 0.84 | 0.68 | 0.66 | 0.62 | 0.60 | 1.00 | 0.98 | 0.63 | 0.48 | | 1.00 | 0.89 | 0.84 | 0.84 | 0.81 | 0.70 | 0.64 |
| | 14 | (356) | 0.89 | 0.81 | 0.75 | 0.73 | | | 1.00 | 0.94 | 0.71 | 0.69 | 0.64 | 0.62 | | 1.00 | 0.79 | 0.60 | | | 1.00 | 0.94 | 0.91 | 0.88 | 0.76 | 0.69 |
| | 16 | (406) | 0.94 | 0.86 | 0.79 | 0.76 | | | | 1.00 | 0.74 | 0.72 | 0.66 | 0.64 | | | 0.97 | 0.73 | | | | 1.00 | 0.97 | 0.94 | 0.81 | 0.74 |
| | 18 | (457) | 1.00 | 0.90 | 0.82 | 0.80 | | | | | 0.77 | 0.75 | 0.68 | 0.65 | | | 1.00 | 0.87 | | | | | 1.00 | 0.99 | 0.86 | 0.78 |
| | 24 | (610) | | 1.00 | 0.93 | 0.90 | | | | | 0.86 | 0.83 | 0.74 | 0.70 | | | | 1.00 | | | | | | 1.00 | 0.99 | 0.90 |
| | 30 | (762) | | | 1.00 | 0.99 | | | | | 0.95 | 0.91 | 0.81 | 0.75 | | | | | | | | | | | 1.00 | 1.00 |
| | 36 | (914) | | | | 1.00 | | | | | 1.00 | 0.99 | 0.87 | 0.80 | | | | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | | | 1.00 | 0.99 | 0.91 | | | | | | | | | | | | |

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

# DESIGN DATA IN CONCRETE PER CSA A23.



### CSA A23.3 Annex D design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-4868 and ELC-4868. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

**Table 62 — Steel factored resistance for Hilti HIT-Z and HIT-Z-R anchor rods[1]**

| Nominal anchor diameter in. | HIT-Z Carbon Steel Rod[2] | | | HIT-Z-R Stainless Steel Rod[2] | | |
|---|---|---|---|---|---|---|
| | Tensile $N_{sar}$[3] lb (kN) | Shear $V_{sar}$[4] lb (kN) | Seismic shear $V_{sar,eq}$[5] lb (kN) | Tensile $N_{sar}$[3] lb (kN) | Shear $V_{sar}$[4] lb (kN) | Seismic shear $V_{sar,eq}$[5] lb (kN) |
| 3/8 | 4,345 (19.3) | 1,775 (7.9) | 1,155 (5.1) | 4,345 (19.3) | 2,420 (10.8) | 1,910 (8.5) |
| 1/2 | 7,960 (35.4) | 3,250 (14.5) | 2,115 (9.4) | 7,960 (35.4) | 4,435 (19.7) | 3,325 (14.8) |
| 5/8 | 12,675 (56.4) | 5,180 (23.0) | 3,365 (15.0) | 12,675 (56.4) | 7,065 (31.4) | 4,590 (20.4) |
| 3/4 | 18,725 (83.3) | 7,650 (34.0) | 4,975 (22.1) | 18,725 (83.3) | 10,435 (46.4) | 6,785 (30.2) |

1 See section 3.1.8 to convert design strength value to ASD value.
2 HIT-Z and HIT-Z-R anchor rods are considered brittle steel elements.
3 Tensile = $A_{se,N}$ $\phi_s$ $f_{uta}$ R as noted in CSA A23.3 Annex D.
4 Shear values determined by static shear tests with $V_{sar} \leq A_{se,V}$ $\phi_s$ 0.60 $f_{uta}$ R as noted in CSA A23.3 Annex D.
5 Seismic Shear = $\alpha_{V,seis}$ $V_{sar}$ : Reduction factor for seismic shear only. See section 3.1.8 for additional information on seismic applications.

## HIT-HY 200 A/R V3 Adhesive with Hilti HIT-Z anchor rods



### Table 63 — Hilti HIT-HY 200 A/R V3 design information with Hilti HIT-Z and HIT-R-Z anchor rods in hammer drilled holes or diamond core drilled holes in accordance with CSA A23.3[1]

| Design parameter | | Symbol | Units | Nominal rod diameter (in.) | | | | Ref |
|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | A23.3-14 |
| Nominal anchor diameter | | $d_a$ | mm | 9.5 | 12.7 | 15.9 | 19.1 | |
| Effective minimum embedment[2] | | $h_{ef}$ | mm | 60 | 70 | 95 | 102 | |
| Effective maximum embedment[2] | | $h_{ef}$ | mm | 114 | 152 | 190 | 216 | |
| Minimum concrete thickness[3] | | $h_{min}$ | mm | See tables 6 to 9 of this section or table 8 of ESR-4868 | | | | |
| Critical edge distance | | $c_{ac}$ | – | See section 4.1.10.1 of ESR-4868 | | | | |
| Minimum edge distance[4] | | $c_{ac}$ | – | See tables 6 to 9 of this section or table 8 of ESR-4868 | | | | |
| Minimum anchor spacing[4] | | $s_{min}$ | – | | | | | |
| Coeff. for factored concrete breakout resistance, uncracked concrete[5] | | $k_{c,uncr}$ | – | 10 | | | | D.6.2.2 |
| Coeff. for factored concrete breakout resistance, cracked concrete[5] | | $k_{c,cr}$ | – | 7 | | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_c$ | – | 0.65 | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[4] | | $R_{conc}$ | – | 1.00 | | | | D.5.3(c) |
| Temp range A[7] | Characteristic pullout resistance in cracked concrete | $N_{p,cr}$ | lb<br>(kN) | 7,952<br>(35.4) | 10,936<br>(48.6) | 21,391<br>(95.2) | 27,930<br>(124.2) | D.6.3.1 |
| | Characteristic pullout resistance in uncracked concrete | $N_{p,uncr}$ | lb<br>(kN) | 7,952<br>(35.4) | 11,719<br>(52.1) | 21,391<br>(95.2) | 28,460<br>(126.6) | D.6.3.1 |
| Temp range B[7] | Characteristic pullout resistance in cracked concrete | $N_{p,cr}$ | lb<br>(kN) | 7,952<br>(35.4) | 10,936<br>(48.6) | 21,391<br>(95.2) | 27,930<br>(124.2) | D.6.3.1 |
| | Characteristic pullout resistance in uncracked concrete | $N_{p,uncr}$ | lb<br>(kN) | 7,952<br>(35.4) | 11,719<br>(52.1) | 21,391<br>(95.2) | 28,460<br>(126.6) | D.6.3.1 |
| Temp range C[7] | Characteristic pullout resistance in cracked concrete | $N_{p,cr}$ | lb<br>(kN) | 7,182<br>(31.9) | 9,877<br>(43.9) | 19,321<br>(85.9) | 25,277<br>(112.4) | D.6.3.1 |
| | Characteristic pullout resistance in uncracked concrete | $N_{p,uncr}$ | lb<br>(kN) | 7,182<br>(31.9) | 10,585<br>(47.1) | 19,321<br>(85.9) | 25,705<br>(114.3) | D.6.3.1 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | – | 0.94 | 1.0 | | | |
| Permissible installation conditions | Resistance modification factor tension and shear, pullout failure dry concrete | Anchor category | – | 1 | | | | D.5.3 (c ) |
| | | $R_{dry}$ | – | 1.00 | | | | |
| | Resistance modification factor tension and shear, pullout failure water-saturated concrete | Anchor category | – | 1 | | | | D.5.3 (c ) |
| | | $R_{ws}$ | – | 1.00 | | | | |

1 Design information in this table is taken from ICC-ES ESR-4868, tables 8 and 10, and converted for use with CSA A23.3 Annex D.
2 See figure 2 of this section.
3 See figure 5 of this section.
4 See figure 6 of this section.
5 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
6 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
7 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

## Table 64 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/pullout failure for Hilti HIT-Z and HIT-Z-R anchor rods in uncracked concrete[1,2,3,4,5,6,7,8, 9,10]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 2-3/8 (60) | 3,060 (13.6) | 3,425 (15.2) | 3,750 (16.7) | 4,330 (19.3) | 3,060 (13.6) | 3,425 (15.2) | 3,750 (16.7) | 4,330 (19.3) |
| | 3-3/8 (86) | 5,175 (23.0) | 5,175 (23.0) | 5,175 (23.0) | 5,175 (23.0) | 10,375 (46.1) | 11,600 (51.6) | 12,705 (56.5) | 14,670 (65.3) |
| | 4-1/2 (114) | 5,175 (23.0) | 5,175 (23.0) | 5,175 (23.0) | 5,175 (23.0) | 15,970 (71.0) | 17,855 (79.4) | 19,560 (87.0) | 22,585 (100.5) |
| 1/2 | 2-3/4 (70) | 3,815 (17.0) | 4,265 (19.0) | 4,670 (20.8) | 5,395 (24.0) | 7,630 (33.9) | 8,530 (37.9) | 9,345 (41.6) | 10,790 (48.0) |
| | 4-1/2 (114) | 7,615 (33.9) | 7,615 (33.9) | 7,615 (33.9) | 7,615 (33.9) | 15,970 (71.0) | 17,855 (79.4) | 19,560 (87.0) | 22,585 (100.5) |
| | 6 (152) | 7,615 (33.9) | 7,615 (33.9) | 7,615 (33.9) | 7,615 (33.9) | 24,590 (109.4) | 27,490 (122.3) | 30,115 (134.0) | 34,775 (154.7) |
| 5/8 | 3-3/4 (95) | 6,075 (27.0) | 6,790 (30.2) | 7,440 (33.1) | 8,590 (38.2) | 12,150 (54.0) | 13,585 (60.4) | 14,880 (66.2) | 17,185 (76.4) |
| | 5-5/8 (143) | 11,160 (49.6) | 12,480 (55.5) | 13,670 (60.8) | 13,895 (61.8) | 22,320 (99.3) | 24,955 (111.0) | 27,335 (121.6) | 31,565 (140.4) |
| | 7-1/2 (191) | 13,895 (61.8) | 13,895 (61.8) | 13,895 (61.8) | 13,895 (61.8) | 34,365 (152.9) | 38,420 (170.9) | 42,090 (187.2) | 48,600 (216.2) |
| 3/4 | 4 (102) | 6,690 (29.8) | 7,480 (33.3) | 8,195 (36.5) | 9,465 (42.1) | 13,385 (59.5) | 14,965 (66.6) | 16,395 (72.9) | 18,930 (84.2) |
| | 6-3/4 (171) | 14,670 (65.3) | 16,400 (73.0) | 17,970 (79.9) | 18,500 (82.3) | 29,340 (130.5) | 32,805 (145.9) | 35,935 (159.8) | 41,495 (184.6) |
| | 8-1/2 (216) | 18,500 (82.3) | 18,500 (82.3) | 18,500 (82.3) | 18,500 (82.3) | 41,460 (184.4) | 46,355 (206.2) | 50,780 (225.9) | 58,635 (260.8) |

## Table 65 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/pullout failure for Hilti HIT-Z and HIT-Z-R anchor rods in cracked concrete[1,2,3,4,5,6,7,8,9,10]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 2-3/8 (60) | 2,145 (9.5) | 2,395 (10.7) | 2,625 (11.7) | 3,030 (13.5) | 2,145 (9.5) | 2,395 (10.7) | 2,625 (11.7) | 3,030 (13.5) |
| | 3-3/8 (86) | 3,630 (16.2) | 4,060 (18.1) | 4,445 (19.8) | 5,135 (22.8) | 7,260 (32.3) | 8,120 (36.1) | 8,895 (39.6) | 10,270 (45.7) |
| | 4-1/2 (114) | 5,175 (23.0) | 5,175 (23.0) | 5,175 (23.0) | 5,175 (23.0) | 11,180 (49.7) | 12,500 (55.6) | 13,695 (60.9) | 15,810 (70.3) |
| 1/2 | 2-3/4 (70) | 2,670 (11.9) | 2,985 (13.3) | 3,270 (14.5) | 3,775 (16.8) | 5,340 (23.8) | 5,970 (26.6) | 6,540 (29.1) | 7,555 (33.6) |
| | 4-1/2 (114) | 5,590 (24.9) | 6,250 (27.8) | 6,845 (30.5) | 7,100 (31.6) | 11,180 (49.7) | 12,500 (55.6) | 13,695 (60.9) | 15,810 (70.3) |
| | 6 (152) | 7,100 (31.6) | 7,100 (31.6) | 7,100 (31.6) | 7,100 (31.6) | 17,215 (76.6) | 19,245 (85.6) | 21,080 (93.8) | 24,340 (108.3) |
| 5/8 | 3-3/4 (95) | 4,250 (18.9) | 4,755 (21.1) | 5,210 (23.2) | 6,015 (26.8) | 8,505 (37.8) | 9,510 (42.3) | 10,415 (46.3) | 12,030 (53.5) |
| | 5-5/8 (143) | 7,810 (34.8) | 8,735 (38.9) | 9,570 (42.6) | 11,050 (49.1) | 15,625 (69.5) | 17,470 (77.7) | 19,135 (85.1) | 22,095 (98.3) |
| | 7-1/2 (191) | 12,030 (53.5) | 13,445 (59.8) | 13,895 (61.8) | 13,895 (61.8) | 24,055 (107.0) | 26,895 (119.6) | 29,460 (131.1) | 34,020 (151.3) |
| 3/4 | 4 (102) | 4,685 (20.8) | 5,240 (23.3) | 5,740 (25.5) | 6,625 (29.5) | 9,370 (41.7) | 10,475 (46.6) | 11,475 (51.0) | 13,250 (58.9) |
| | 6-3/4 (171) | 10,270 (45.7) | 11,480 (51.1) | 12,575 (55.9) | 14,525 (64.6) | 20,540 (91.4) | 22,965 (102.1) | 25,155 (111.9) | 29,045 (129.2) |
| | 8-1/2 (216) | 14,510 (64.6) | 16,225 (72.2) | 17,775 (79.1) | 18,150 (80.7) | 29,025 (129.1) | 32,450 (144.3) | 35,545 (158.1) | 41,045 (182.6) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 10 - 17 as necessary to the above values. Compare to the steel values in table 62. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C). For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 1.00. For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.90. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by la as follows: For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension only by the following reduction factors:
3/8-in diameter - $\alpha_{N,seis}$ = 0.705 1/2-in to 3/4-in diameter - $\alpha_{N,seis}$ = 0.75
See section 3.1.8 for additional information on seismic applications.
10 Hilti HIT-Z(-R) rods may be installed in diamond cored holes with no reduction in published data above.

## HIT-HY 200 A/R V3 Adhesive with Deformed Reinforcing Bars (Rebar)



### Table 66 — Steel factored resistance for CA rebar[1]

| Rebar size | CSA-G30.18 Grade 400[2] | | |
|---|---|---|---|
| | Tensile $N_{sar}$[3] lb (kN) | Shear $V_{sar}$[4] lb (kN) | Seismic shear $V_{sar,eq}$[5] lb (kN) |
| 10M | 7,245 (32.2) | 4,035 (17.9) | 2,825 (12.6) |
| 15M | 14,525 (64.6) | 8,090 (36.0) | 5,665 (25.2) |
| 20M | 21,570 (95.9) | 12,020 (53.5) | 8,415 (37.4) |
| 25M | 36,025 (160.2) | 20,070 (89.3) | 14,050 (62.5) |
| 30M | 50,715 (225.6) | 28,255 (125.7) | 19,780 (88.0) |

1 See section 3.1.8 to convert design strength value to ASD value.
2 CSA-G30.18 Grade 400 rebar are considered ductile steel elements.
3 Tensile = $A_{se,N}$ $\phi_s$ $f_{uta}$ R as noted in CSA A23.3 Annex D.
4 Shear = $A_{se,V}$ $\phi_s$ 0.60 $f_{uta}$ R as noted in CSA A23.3 Annex D.
5 Seismic Shear = $\alpha_{V,seis}$ $V_{sar}$ : Reduction factor for seismic shear only. See CSA A23.3 Annex D for additional information on seismic applications.

### Table 67 — Specifications for CA rebar installed with Hilti HIT-HY 200 A/R V3 adhesive

| Setting information | | Symbol | Units | Rebar size | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 10M | 15M | 20M | 25M | 30M |
| Nominal bit size | | $d_o$ | in. | 9/16 | 3/4 | 1 | 1-1/4 | 1-1/2 |
| Effective embedment | minimum | $h_{ef,min}$ | mm | 70 | 80 | 90 | 101 | 120 |
| | maximum | $h_{ef,max}$ | mm | 226 | 320 | 390 | 504 | 598 |
| Minimum concrete member thickness | | $h_{min}$ | mm | $h_{ef}$ + 30 | $h_{ef}$ + $2d_o$ | | | |

Note: The installation specifications in table 67 above and the data in tables 66 through 80 pertain to the use of Hilti HIT-HY 200 V3 with rebar designed as a post-installed anchor using the provisions of CSA A23.3 Annex D. For the use of Hilti HIT-HY 200 V3 with rebar for typical development calculations according to CSA A23.3 Chapter 12, refer to section 3.1.8 for the design method and tables 94 through 98 at the end of this section.

## Table 68 — Hilti HIT-HY 200 A/R V3 adhesive design information with CA rebar in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Rebar size | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 10M | 15M | 20M | 25M | 30M | A23.3-14 |
| Rebar diameter | | $d_a$ | mm | 11.3 | 16.0 | 19.5 | 25.2 | 29.9 | |
| Effective minimum embedment[2] | | $h_{ef,min}$ | mm | 70 | 80 | 90 | 101 | 120 | |
| Effective maximum embedment[2] | | $h_{ef,max}$ | mm | 226 | 320 | 390 | 504 | 598 | |
| Minimum concrete thickness[2] | | $h_{min}$ | mm | $h_{ef}$ + 30 | $h_{ef}$ + $2d_o$ | | | | |
| Critical edge distance | | $c_{ac}$ | – | $2h_{ef}$ | | | | | |
| Minimum edge distance[3] | | $c_{min}$ | mm | 57 | 80 | 98 | 126 | 150 | |
| Minimum rebar spacing | | $s_{min}$ | mm | 57 | 80 | 98 | 126 | 150 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete[4] | | $k_{c,uncr}$ | – | 10 | | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete[4] | | $k_{c,cr}$ | – | 7 | | | | | D.6.2.2 |
| Concrete material resistance factor | | $A_{se,N}$ | – | 0.65 | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $\Phi_s$ | – | 1.00 | | | | | D.5.3(c) |
| Temp range A[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 1,075 (7.4) | 1,085 (7.5) | 1,095 (7.6) | 840 (5.8) | 850 (5.9) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 1,560 (10.8) | 1,560 (10.8) | 1,560 (10.8) | 1,560 (10.8) | 1,560 (10.8) | D.6.5.2 |
| Temp range B[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 990 (6.8) | 995 (6.9) | 1,005 (6.9) | 775 (5.3) | 780 (5.4) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 1,435 (9.9) | 1,435 (9.9) | 1,435 (9.9) | 1,435 (9.9) | 1,435 (9.9) | D.6.5.2 |
| Temp range C[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 845 (5.8) | 850 (5.9) | 860 (5.9) | 660 (4.6) | 670 (4.6) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 1,230 (8.5) | 1,230 (8.5) | 1,230 (8.5) | 1,230 (8.5) | 1,230 (8.5) | D.6.5.2 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | – | | 0.80 | | 0.85 | 0.97 | |
| Permissible installation conditions[5] | Resistance modification factor tension & shear, bond failure dry and water saturated concrete | Anchor category | – | 1 | | | | | D.5.3 (c ) |
| | | $R_{dry}$, $R_{ws}$ | – | 1.00 | | | | | |
| | Resistance modification factor tension & shear, bond failure water-filled concrete | Anchor category | – | 3 | | | | | D.5.3 (c ) |
| | | $R_{wf}$ | – | 0.75 | | | | | |

1 Design information in this table is taken from ELC-4868, tables 16 and 17, for use with CSA A23.3 Annex D.
2 See figure 8 of this section.
3 Minimum edge distance may be reduced to 45mm provided rebar remains untorqued. See ELC-4868 Installation Torque Subject to Edge Distance section.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 Temperature range A: Max. short term temperature = 130°F 55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
7 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].
8 For water-filled holes, multiply characteristic bond stress by 0.97.

## Table 69 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/bond failure for CA rebar in uncracked concrete[1,2,3,4,5,6,7,8,9]

| Rebar size | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 10M | 4-1/2 (115) | 6,515 (29.0) | 6,665 (29.6) | 6,785 (30.2) | 6,985 (31.1) | 13,030 (58.0) | 13,325 (59.3) | 13,570 (60.4) | 13,965 (62.1) |
| | 7-1/16 (180) | 10,200 (45.4) | 10,430 (46.4) | 10,620 (47.2) | 10,930 (48.6) | 20,395 (90.7) | 20,855 (92.8) | 21,240 (94.5) | 21,860 (97.2) |
| | 8-7/8 (226) | 12,805 (57.0) | 13,095 (58.2) | 13,335 (59.3) | 13,725 (61.0) | 25,610 (113.9) | 26,185 (116.5) | 26,670 (118.6) | 27,450 (122.1) |
| 15M | 5-11/16 (145) | 11,410 (50.8) | 11,895 (52.9) | 12,115 (53.9) | 12,465 (55.5) | 22,820 (101.5) | 23,790 (105.8) | 24,230 (107.8) | 24,935 (110.9) |
| | 9-13/16 (250) | 20,055 (89.2) | 20,510 (91.2) | 20,885 (92.9) | 21,495 (95.6) | 40,110 (178.4) | 41,015 (182.5) | 41,770 (185.8) | 42,990 (191.2) |
| | 12-5/8 (320) | 25,670 (114.2) | 26,250 (116.8) | 26,735 (118.9) | 27,515 (122.4) | 51,345 (228.4) | 52,500 (233.5) | 53,470 (237.8) | 55,030 (244.8) |
| 20M | 7-7/8 (200) | 18,485 (82.2) | 19,995 (88.9) | 20,365 (90.6) | 20,960 (93.2) | 36,965 (164.4) | 39,990 (177.9) | 40,730 (181.2) | 41,915 (186.5) |
| | 14 (355) | 34,710 (154.4) | 35,495 (157.9) | 36,145 (160.8) | 37,200 (165.5) | 69,420 (308.8) | 70,985 (315.8) | 72,290 (321.6) | 74,400 (331.0) |
| | 15-3/8 (390) | 38,130 (169.6) | 38,990 (173.4) | 39,710 (176.6) | 40,870 (181.8) | 76,265 (339.2) | 77,985 (346.9) | 79,420 (353.3) | 81,735 (363.6) |
| 25M | 9-1/16 (230) | 22,795 (101.4) | 25,485 (113.4) | 27,920 (124.2) | 31,145 (138.5) | 45,590 (202.8) | 50,970 (226.7) | 55,835 (248.4) | 62,295 (277.1) |
| | 15-15/16 (405) | 51,175 (227.6) | 52,330 (232.8) | 53,290 (237.0) | 54,845 (244.0) | 102,345 (455.3) | 104,655 (465.5) | 106,580 (474.1) | 109,690 (487.9) |
| | 19-13/16 (504) | 63,680 (283.3) | 65,120 (289.7) | 66,315 (295.0) | 68,255 (303.6) | 127,365 (566.5) | 130,240 (579.3) | 132,635 (590.0) | 136,505 (607.2) |
| 30M | 10-1/4 (260) | 27,395 (121.9) | 30,630 (136.3) | 33,555 (149.3) | 38,745 (172.3) | 54,795 (243.7) | 61,260 (272.5) | 67,110 (298.5) | 77,490 (344.7) |
| | 17-15/16 (455) | 63,425 (282.1) | 69,750 (310.3) | 71,035 (316.0) | 73,110 (325.2) | 126,850 (564.3) | 139,505 (620.5) | 142,070 (632.0) | 146,220 (650.4) |
| | 23-9/16 (598) | 89,650 (398.8) | 91,675 (407.8) | 93,360 (415.3) | 96,085 (427.4) | 179,305 (797.6) | 183,350 (815.6) | 186,725 (830.6) | 192,170 (854.8) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 71 - 80 as necessary to the above values. Compare to the steel values in table 66. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.82. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength (factored resistance) by 0.73.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 70 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/bond failure for CA rebar in cracked concrete[1,2,3,4,5,6,7,8,9]

| Rebar size | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 10M | 4-1/2 (115) | 4,490 (20.0) | 4,590 (20.4) | 4,675 (20.8) | 4,810 (21.4) | 8,980 (39.9) | 9,185 (40.8) | 9,350 (41.6) | 9,625 (42.8) |
| | 7-1/16 (180) | 7,030 (31.3) | 7,185 (32.0) | 7,320 (32.6) | 7,530 (33.5) | 14,055 (62.5) | 14,375 (63.9) | 14,635 (65.1) | 15,065 (67.0) |
| | 8-7/8 (226) | 8,825 (39.3) | 9,025 (40.1) | 9,190 (40.9) | 9,455 (42.1) | 17,650 (78.5) | 18,045 (80.3) | 18,380 (81.7) | 18,915 (84.1) |
| 15M | 5-11/16 (145) | 7,985 (35.5) | 8,275 (36.8) | 8,425 (37.5) | 8,670 (38.6) | 15,975 (71.1) | 16,545 (73.6) | 16,850 (75.0) | 17,345 (77.1) |
| | 9-13/16 (250) | 13,950 (62.0) | 14,265 (63.4) | 14,525 (64.6) | 14,950 (66.5) | 27,900 (124.1) | 28,530 (126.9) | 29,055 (129.2) | 29,900 (133.0) |
| | 12-5/8 (320) | 17,855 (79.4) | 18,260 (81.2) | 18,595 (82.7) | 19,135 (85.1) | 35,710 (158.8) | 36,515 (162.4) | 37,190 (165.4) | 38,275 (170.2) |
| 20M | 7-7/8 (200) | 12,940 (57.6) | 14,035 (62.4) | 14,295 (63.6) | 14,710 (65.4) | 25,875 (115.1) | 28,070 (124.9) | 28,590 (127.2) | 29,420 (130.9) |
| | 14 (355) | 24,365 (108.4) | 24,915 (110.8) | 25,370 (112.9) | 26,110 (116.2) | 48,725 (216.7) | 49,825 (221.6) | 50,745 (225.7) | 52,225 (232.3) |
| | 15-3/8 (390) | 26,765 (119.1) | 27,370 (121.7) | 27,875 (124.0) | 28,685 (127.6) | 53,530 (238.1) | 54,740 (243.5) | 55,745 (248.0) | 57,375 (255.2) |
| 25M | 9-1/16 (230) | 15,650 (69.6) | 16,000 (71.2) | 16,295 (72.5) | 16,770 (74.6) | 31,295 (139.2) | 32,005 (142.4) | 32,590 (145.0) | 33,545 (149.2) |
| | 15-15/16 (405) | 27,555 (122.6) | 28,175 (125.3) | 28,695 (127.6) | 29,530 (131.4) | 55,110 (245.1) | 56,355 (250.7) | 57,390 (255.3) | 59,065 (262.7) |
| | 19-13/16 (504) | 34,290 (152.5) | 35,065 (156.0) | 35,710 (158.8) | 36,750 (163.5) | 68,580 (305.1) | 70,130 (311.9) | 71,420 (317.7) | 73,505 (327.0) |
| 30M | 10-1/4 (260) | 19,180 (85.3) | 21,440 (95.4) | 22,115 (98.4) | 22,765 (101.3) | 38,355 (170.6) | 42,885 (190.8) | 44,235 (196.8) | 45,525 (202.5) |
| | 17-15/16 (455) | 37,165 (165.3) | 38,005 (169.1) | 38,705 (172.2) | 39,835 (177.2) | 74,335 (330.7) | 76,010 (338.1) | 77,410 (344.3) | 79,670 (354.4) |
| | 23-9/16 (598) | 48,850 (217.3) | 49,950 (222.2) | 50,870 (226.3) | 52,355 (232.9) | 97,695 (434.6) | 99,900 (444.4) | 101,740 (452.6) | 104,710 (465.8) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 71 - 80 as necessary to the above values. Compare to the steel values in table 66. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.82. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength (factored resistance) by 0.73.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors:
10M to 20M - $\alpha_{seis}$ = 0.60, 25M - $\alpha_{seis}$ = 0.64, 30M - $\alpha_{seis}$ = 0.73
See section 3.1.8 for additional information on seismic applications.

## Table 71 — Load adjustment factors for 10M rebar in uncracked concrete[1,2,3]

| 10M Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-8/9 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) |
| Spacing (s) / edge distance ($c_{a1}$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.25 | 0.15 | 0.12 | n/a | n/a | n/a | 0.06 | 0.04 | 0.03 | 0.12 | 0.08 | 0.06 | n/a | n/a | n/a |
| | 2-3/16 | (55) | 0.58 | 0.55 | 0.54 | 0.27 | 0.17 | 0.13 | 0.53 | 0.52 | 0.52 | 0.09 | 0.05 | 0.04 | 0.17 | 0.11 | 0.09 | n/a | n/a | n/a |
| | 3 | (76) | 0.61 | 0.57 | 0.56 | 0.31 | 0.20 | 0.15 | 0.54 | 0.53 | 0.53 | 0.14 | 0.09 | 0.07 | 0.28 | 0.18 | 0.14 | n/a | n/a | n/a |
| | 4 | (102) | 0.65 | 0.59 | 0.57 | 0.37 | 0.23 | 0.18 | 0.56 | 0.54 | 0.54 | 0.22 | 0.14 | 0.11 | 0.40 | 0.28 | 0.22 | n/a | n/a | n/a |
| | 5 | (127) | 0.68 | 0.62 | 0.59 | 0.44 | 0.27 | 0.21 | 0.57 | 0.56 | 0.55 | 0.30 | 0.19 | 0.15 | 0.46 | 0.35 | 0.31 | n/a | n/a | n/a |
| | 5-11/16 | (145) | 0.71 | 0.63 | 0.61 | 0.49 | 0.30 | 0.24 | 0.59 | 0.56 | 0.55 | 0.37 | 0.23 | 0.19 | 0.51 | 0.37 | 0.33 | 0.58 | n/a | n/a |
| | 6 | (152) | 0.72 | 0.64 | 0.61 | 0.51 | 0.32 | 0.25 | 0.59 | 0.57 | 0.56 | 0.40 | 0.25 | 0.20 | 0.53 | 0.38 | 0.34 | 0.60 | n/a | n/a |
| | 7 | (178) | 0.76 | 0.66 | 0.63 | 0.60 | 0.37 | 0.29 | 0.60 | 0.58 | 0.57 | 0.50 | 0.32 | 0.25 | 0.60 | 0.42 | 0.36 | 0.65 | n/a | n/a |
| | 8 | (203) | 0.79 | 0.69 | 0.65 | 0.68 | 0.42 | 0.33 | 0.62 | 0.59 | 0.58 | 0.61 | 0.39 | 0.31 | 0.68 | 0.46 | 0.39 | 0.69 | n/a | n/a |
| | 8-1/4 | (210) | 0.80 | 0.69 | 0.65 | 0.71 | 0.44 | 0.35 | 0.62 | 0.59 | 0.58 | 0.64 | 0.41 | 0.33 | 0.71 | 0.47 | 0.40 | 0.70 | 0.61 | n/a |
| | 9 | (229) | 0.83 | 0.71 | 0.67 | 0.77 | 0.48 | 0.38 | 0.63 | 0.60 | 0.59 | 0.73 | 0.47 | 0.37 | 0.77 | 0.50 | 0.42 | 0.73 | 0.63 | n/a |
| | 10-1/16 | (256) | 0.87 | 0.74 | 0.69 | 0.86 | 0.53 | 0.42 | 0.65 | 0.61 | 0.60 | 0.86 | 0.55 | 0.44 | 0.86 | 0.54 | 0.45 | 0.78 | 0.67 | 0.62 |
| | 11 | (279) | 0.90 | 0.76 | 0.71 | 0.94 | 0.58 | 0.46 | 0.66 | 0.62 | 0.61 | 0.98 | 0.63 | 0.50 | 0.94 | 0.58 | 0.48 | 0.81 | 0.70 | 0.65 |
| | 12 | (305) | 0.94 | 0.78 | 0.72 | 1.00 | 0.64 | 0.50 | 0.68 | 0.63 | 0.61 | 1.00 | 0.72 | 0.57 | 1.00 | 0.64 | 0.51 | 0.85 | 0.73 | 0.68 |
| | 14 | (356) | 1.00 | 0.83 | 0.76 | | 0.74 | 0.59 | 0.71 | 0.66 | 0.63 | | 0.90 | 0.72 | | 0.74 | 0.59 | 0.92 | 0.79 | 0.73 |
| | 16 | (406) | | 0.88 | 0.80 | | 0.85 | 0.67 | 0.74 | 0.68 | 0.65 | | 1.00 | 0.88 | | 0.85 | 0.67 | 0.98 | 0.84 | 0.78 |
| | 18 | (457) | | 0.92 | 0.84 | | 0.96 | 0.75 | 0.77 | 0.70 | 0.67 | | | 1.00 | | 0.96 | 0.75 | 1.00 | 0.89 | 0.83 |
| | 24 | (610) | | 1.00 | 0.95 | | 1.00 | 1.00 | 0.86 | 0.77 | 0.73 | | | | | 1.00 | 1.00 | | 1.00 | 0.96 |
| | 30 | (762) | | | 1.00 | | | | 0.95 | 0.83 | 0.79 | | | | | | | | | 1.00 |
| | 36 | (914) | | | | | | | 1.00 | 0.90 | 0.84 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | 1.00 | 0.96 | | | | | | | | | |

## Table 72 — Load adjustment factors for 10M rebar in cracked concrete[1,2,3]

| 10M Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-8/9 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) |
| Spacing (s) / edge distance ($c_{a1}$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.49 | 0.44 | 0.42 | n/a | n/a | n/a | 0.06 | 0.04 | 0.03 | 0.13 | 0.08 | 0.07 | n/a | n/a | n/a |
| | 2-3/16 | (55) | 0.58 | 0.55 | 0.54 | 0.52 | 0.46 | 0.43 | 0.53 | 0.52 | 0.52 | 0.09 | 0.06 | 0.05 | 0.18 | 0.11 | 0.09 | n/a | n/a | n/a |
| | 3 | (76) | 0.61 | 0.57 | 0.56 | 0.60 | 0.50 | 0.47 | 0.55 | 0.53 | 0.53 | 0.15 | 0.09 | 0.07 | 0.29 | 0.19 | 0.15 | n/a | n/a | n/a |
| | 4 | (102) | 0.65 | 0.59 | 0.57 | 0.70 | 0.56 | 0.51 | 0.56 | 0.55 | 0.54 | 0.22 | 0.14 | 0.11 | 0.45 | 0.29 | 0.23 | n/a | n/a | n/a |
| | 5 | (127) | 0.68 | 0.62 | 0.59 | 0.80 | 0.62 | 0.56 | 0.58 | 0.56 | 0.55 | 0.31 | 0.20 | 0.16 | 0.62 | 0.40 | 0.32 | n/a | n/a | n/a |
| | 5-11/16 | (145) | 0.71 | 0.63 | 0.61 | 0.88 | 0.66 | 0.59 | 0.59 | 0.56 | 0.56 | 0.38 | 0.24 | 0.19 | 0.76 | 0.49 | 0.39 | 0.59 | n/a | n/a |
| | 6 | (152) | 0.72 | 0.64 | 0.61 | 0.91 | 0.68 | 0.61 | 0.59 | 0.57 | 0.56 | 0.41 | 0.26 | 0.21 | 0.82 | 0.52 | 0.42 | 0.61 | n/a | n/a |
| | 7 | (178) | 0.76 | 0.66 | 0.63 | 1.00 | 0.74 | 0.65 | 0.61 | 0.58 | 0.57 | 0.52 | 0.33 | 0.26 | 1.00 | 0.66 | 0.53 | 0.66 | n/a | n/a |
| | 8 | (203) | 0.79 | 0.69 | 0.65 | | 0.81 | 0.70 | 0.62 | 0.59 | 0.58 | 0.63 | 0.40 | 0.32 | | 0.81 | 0.64 | 0.70 | n/a | n/a |
| | 8-1/4 | (210) | 0.80 | 0.69 | 0.65 | | 0.83 | 0.72 | 0.63 | 0.59 | 0.58 | 0.66 | 0.42 | 0.34 | | 0.83 | 0.68 | 0.71 | 0.61 | n/a |
| | 9 | (229) | 0.83 | 0.71 | 0.67 | | 0.88 | 0.76 | 0.64 | 0.60 | 0.59 | 0.75 | 0.48 | 0.38 | | 0.88 | 0.76 | 0.74 | 0.64 | n/a |
| | 10-1/16 | (256) | 0.87 | 0.74 | 0.69 | | 0.96 | 0.81 | 0.65 | 0.61 | 0.60 | 0.89 | 0.57 | 0.46 | | 0.96 | 0.81 | 0.79 | 0.68 | 0.63 |
| | 11 | (279) | 0.90 | 0.76 | 0.71 | | 1.00 | 0.86 | 0.67 | 0.63 | 0.61 | 1.00 | 0.65 | 0.52 | | 1.00 | 0.86 | 0.82 | 0.71 | 0.66 |
| | 12 | (305) | 0.94 | 0.78 | 0.72 | | | 0.92 | 0.68 | 0.64 | 0.62 | | 0.74 | 0.59 | | | 0.92 | 0.86 | 0.74 | 0.69 |
| | 14 | (356) | 1.00 | 0.83 | 0.76 | | | 1.00 | 0.71 | 0.66 | 0.64 | | 0.94 | 0.74 | | | 1.00 | 0.93 | 0.80 | 0.74 |
| | 16 | (406) | | 0.88 | 0.80 | | | | 0.75 | 0.68 | 0.66 | | 1.00 | 0.91 | | | | 0.99 | 0.85 | 0.79 |
| | 18 | (457) | | 0.92 | 0.84 | | | | 0.78 | 0.70 | 0.68 | | | 1.00 | | | | 1.00 | 0.91 | 0.84 |
| | 24 | (610) | | 1.00 | 0.95 | | | | 0.87 | 0.77 | 0.73 | | | | | | | | 1.00 | 0.97 |
| | 30 | (762) | | | 1.00 | | | | 0.96 | 0.84 | 0.79 | | | | | | | | | 1.00 |
| | 36 | (914) | | | | | | | 1.00 | 0.91 | 0.85 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | 1.00 | 0.97 | | | | | | | | | |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 73 — Load adjustment factors for 15M rebar in uncracked concrete[1,2,3]

| 15M Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 |
| in. | | (mm) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | | n/a | n/a | n/a | 0.25 | 0.14 | 0.11 | n/a | n/a | n/a | 0.04 | 0.02 | 0.02 | 0.08 | 0.05 | 0.04 | n/a | n/a | n/a |
| 3-1/8 | (80) | | 0.59 | 0.55 | 0.54 | 0.31 | 0.17 | 0.13 | 0.54 | 0.53 | 0.52 | 0.10 | 0.06 | 0.05 | 0.20 | 0.12 | 0.09 | n/a | n/a | n/a |
| 4 | (102) | | 0.62 | 0.57 | 0.55 | 0.35 | 0.19 | 0.15 | 0.55 | 0.53 | 0.53 | 0.14 | 0.08 | 0.07 | 0.29 | 0.17 | 0.13 | n/a | n/a | n/a |
| 5 | (127) | | 0.65 | 0.58 | 0.57 | 0.39 | 0.22 | 0.17 | 0.56 | 0.54 | 0.53 | 0.20 | 0.12 | 0.09 | 0.40 | 0.23 | 0.18 | n/a | n/a | n/a |
| 6 | (152) | | 0.68 | 0.60 | 0.58 | 0.44 | 0.25 | 0.19 | 0.57 | 0.55 | 0.54 | 0.27 | 0.15 | 0.12 | 0.45 | 0.31 | 0.24 | n/a | n/a | n/a |
| 7 | (178) | | 0.70 | 0.62 | 0.59 | 0.49 | 0.27 | 0.21 | 0.58 | 0.56 | 0.55 | 0.33 | 0.19 | 0.15 | 0.50 | 0.35 | 0.30 | n/a | n/a | n/a |
| 7-1/4 | (184) | | 0.71 | 0.62 | 0.60 | 0.50 | 0.28 | 0.22 | 0.58 | 0.56 | 0.55 | 0.35 | 0.20 | 0.16 | 0.51 | 0.35 | 0.31 | 0.58 | n/a | n/a |
| 8 | (203) | | 0.73 | 0.64 | 0.61 | 0.54 | 0.30 | 0.24 | 0.59 | 0.56 | 0.55 | 0.41 | 0.24 | 0.18 | 0.55 | 0.37 | 0.33 | 0.61 | n/a | n/a |
| 9 | (229) | | 0.76 | 0.65 | 0.62 | 0.61 | 0.34 | 0.26 | 0.60 | 0.57 | 0.56 | 0.49 | 0.28 | 0.22 | 0.61 | 0.40 | 0.35 | 0.64 | n/a | n/a |
| 10 | (254) | | 0.79 | 0.67 | 0.63 | 0.68 | 0.38 | 0.29 | 0.61 | 0.58 | 0.57 | 0.57 | 0.33 | 0.26 | 0.68 | 0.43 | 0.37 | 0.68 | n/a | n/a |
| 11-3/8 | (289) | | 0.83 | 0.69 | 0.65 | 0.77 | 0.43 | 0.33 | 0.63 | 0.59 | 0.58 | 0.69 | 0.40 | 0.31 | 0.77 | 0.46 | 0.39 | 0.72 | 0.60 | n/a |
| 12 | (305) | | 0.85 | 0.70 | 0.66 | 0.81 | 0.46 | 0.35 | 0.64 | 0.60 | 0.58 | 0.75 | 0.43 | 0.34 | 0.81 | 0.48 | 0.40 | 0.74 | 0.62 | n/a |
| 14-1/8 | (359) | | 0.91 | 0.74 | 0.69 | 0.96 | 0.54 | 0.42 | 0.66 | 0.61 | 0.60 | 0.96 | 0.55 | 0.43 | 0.96 | 0.54 | 0.45 | 0.81 | 0.67 | 0.62 |
| 16 | (406) | | 0.97 | 0.77 | 0.71 | 1.00 | 0.61 | 0.47 | 0.68 | 0.63 | 0.61 | 1.00 | 0.67 | 0.52 | 1.00 | 0.61 | 0.49 | 0.86 | 0.71 | 0.66 |
| 18 | (457) | | 1.00 | 0.80 | 0.74 | | 0.68 | 0.53 | 0.71 | 0.64 | 0.62 | | 0.80 | 0.62 | | 0.68 | 0.54 | 0.91 | 0.76 | 0.70 |
| 20 | (508) | | | 0.84 | 0.76 | | 0.76 | 0.59 | 0.73 | 0.66 | 0.63 | | 0.93 | 0.73 | | 0.76 | 0.59 | 0.96 | 0.80 | 0.73 |
| 22 | (559) | | | 0.87 | 0.79 | | 0.84 | 0.65 | 0.75 | 0.67 | 0.65 | | 1.00 | 0.84 | | 0.84 | 0.65 | 1.00 | 0.84 | 0.77 |
| 24 | (610) | | | 0.91 | 0.82 | | 0.91 | 0.71 | 0.78 | 0.69 | 0.66 | | | 0.96 | | 0.91 | 0.71 | | 0.87 | 0.80 |
| 30 | (762) | | | 1.00 | 0.90 | | 1.00 | 0.88 | 0.84 | 0.74 | 0.70 | | | 1.00 | | 1.00 | 0.88 | | 0.98 | 0.90 |
| 36 | (914) | | | | 0.98 | | | 1.00 | 0.91 | 0.79 | 0.74 | | | | | | 1.00 | | 1.00 | 0.99 |
| > 48 | (1219) | | | | 1.00 | | | | 1.00 | 0.88 | 0.82 | | | | | | | | | 1.00 |

## Table 74 — Load adjustment factors for 15M rebar in cracked concrete[1,2,3]

| 15M Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 |
| in. | | (mm) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | | n/a | n/a | n/a | 0.46 | 0.41 | 0.40 | n/a | n/a | n/a | 0.04 | 0.02 | 0.02 | 0.09 | 0.05 | 0.04 | n/a | n/a | n/a |
| 3-1/8 | (80) | | 0.59 | 0.55 | 0.54 | 0.55 | 0.46 | 0.44 | 0.54 | 0.53 | 0.52 | 0.10 | 0.06 | 0.05 | 0.21 | 0.12 | 0.09 | n/a | n/a | n/a |
| 4 | (102) | | 0.62 | 0.57 | 0.55 | 0.62 | 0.50 | 0.46 | 0.55 | 0.53 | 0.53 | 0.15 | 0.09 | 0.07 | 0.30 | 0.17 | 0.13 | n/a | n/a | n/a |
| 5 | (127) | | 0.65 | 0.58 | 0.57 | 0.69 | 0.54 | 0.49 | 0.56 | 0.54 | 0.53 | 0.21 | 0.12 | 0.09 | 0.41 | 0.24 | 0.19 | n/a | n/a | n/a |
| 6 | (152) | | 0.68 | 0.60 | 0.58 | 0.77 | 0.58 | 0.52 | 0.57 | 0.55 | 0.54 | 0.27 | 0.16 | 0.12 | 0.54 | 0.31 | 0.25 | n/a | n/a | n/a |
| 7 | (178) | | 0.70 | 0.62 | 0.59 | 0.86 | 0.62 | 0.56 | 0.58 | 0.56 | 0.55 | 0.34 | 0.20 | 0.15 | 0.68 | 0.40 | 0.31 | n/a | n/a | n/a |
| 7-1/4 | (184) | | 0.71 | 0.62 | 0.60 | 0.88 | 0.63 | 0.56 | 0.58 | 0.56 | 0.55 | 0.36 | 0.21 | 0.16 | 0.72 | 0.42 | 0.33 | 0.58 | n/a | n/a |
| 8 | (203) | | 0.73 | 0.64 | 0.61 | 0.95 | 0.66 | 0.59 | 0.59 | 0.56 | 0.55 | 0.42 | 0.24 | 0.19 | 0.84 | 0.48 | 0.38 | 0.61 | n/a | n/a |
| 9 | (229) | | 0.76 | 0.65 | 0.62 | 1.00 | 0.71 | 0.62 | 0.60 | 0.57 | 0.56 | 0.50 | 0.29 | 0.23 | 1.00 | 0.58 | 0.45 | 0.65 | n/a | n/a |
| 10 | (254) | | 0.79 | 0.67 | 0.63 | | 0.76 | 0.66 | 0.62 | 0.58 | 0.57 | 0.58 | 0.34 | 0.26 | | 0.68 | 0.53 | 0.68 | n/a | n/a |
| 11-3/8 | (289) | | 0.83 | 0.69 | 0.65 | | 0.82 | 0.71 | 0.63 | 0.59 | 0.58 | 0.71 | 0.41 | 0.32 | | 0.82 | 0.64 | 0.73 | 0.61 | n/a |
| 12 | (305) | | 0.85 | 0.70 | 0.66 | | 0.86 | 0.73 | 0.64 | 0.60 | 0.58 | 0.77 | 0.44 | 0.35 | | 0.86 | 0.70 | 0.75 | 0.62 | n/a |
| 14-1/8 | (359) | | 0.91 | 0.74 | 0.69 | | 0.97 | 0.81 | 0.66 | 0.61 | 0.60 | 0.98 | 0.57 | 0.44 | | 0.97 | 0.81 | 0.81 | 0.68 | 0.62 |
| 16 | (406) | | 0.97 | 0.77 | 0.71 | | 1.00 | 0.88 | 0.69 | 0.63 | 0.61 | 1.00 | 0.69 | 0.54 | | 1.00 | 0.88 | 0.86 | 0.72 | 0.66 |
| 18 | (457) | | 1.00 | 0.80 | 0.74 | | | 0.96 | 0.71 | 0.65 | 0.62 | | 0.82 | 0.64 | | | 0.96 | 0.92 | 0.76 | 0.70 |
| 20 | (508) | | | 0.84 | 0.76 | | | 1.00 | 0.73 | 0.66 | 0.64 | | 0.96 | 0.75 | | | 1.00 | 0.96 | 0.80 | 0.74 |
| 22 | (559) | | | 0.87 | 0.79 | | | | 0.76 | 0.68 | 0.65 | | 1.00 | 0.86 | | | | 1.00 | 0.84 | 0.78 |
| 24 | (610) | | | 0.91 | 0.82 | | | | 0.78 | 0.69 | 0.66 | | | 0.98 | | | | | 0.88 | 0.81 |
| 30 | (762) | | | 1.00 | 0.90 | | | | 0.85 | 0.74 | 0.71 | | | 1.00 | | | | | 0.99 | 0.91 |
| 36 | (914) | | | | 0.98 | | | | 0.92 | 0.79 | 0.75 | | | | | | | | 1.00 | 0.99 |
| > 48 | (1219) | | | | 1.00 | | | | 1.00 | 0.89 | 0.83 | | | | | | | | | 1.00 |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 75 — Load adjustment factors for 20M rebar in uncracked concrete[1,2,3]

| 20M Rebar uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 |
| in. | (mm) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) |
| 1-3/4 | (44) | n/a | n/a | n/a | 0.21 | 0.11 | 0.10 | n/a | n/a | n/a | 0.03 | 0.01 | 0.01 | 0.06 | 0.03 | 0.03 | n/a | n/a | n/a |
| 3-7/8 | (98) | 0.58 | 0.55 | 0.54 | 0.27 | 0.15 | 0.13 | 0.53 | 0.52 | 0.52 | 0.09 | 0.05 | 0.04 | 0.18 | 0.10 | 0.09 | n/a | n/a | n/a |
| 4 | (102) | 0.58 | 0.55 | 0.54 | 0.27 | 0.15 | 0.13 | 0.53 | 0.52 | 0.52 | 0.10 | 0.05 | 0.05 | 0.19 | 0.10 | 0.09 | n/a | n/a | n/a |
| 5 | (127) | 0.61 | 0.56 | 0.55 | 0.30 | 0.17 | 0.15 | 0.54 | 0.53 | 0.53 | 0.13 | 0.07 | 0.07 | 0.27 | 0.14 | 0.13 | n/a | n/a | n/a |
| 6 | (152) | 0.63 | 0.57 | 0.57 | 0.34 | 0.18 | 0.17 | 0.55 | 0.53 | 0.53 | 0.17 | 0.09 | 0.09 | 0.35 | 0.19 | 0.17 | n/a | n/a | n/a |
| 7 | (178) | 0.65 | 0.58 | 0.58 | 0.37 | 0.20 | 0.18 | 0.56 | 0.54 | 0.54 | 0.22 | 0.12 | 0.11 | 0.41 | 0.24 | 0.22 | n/a | n/a | n/a |
| 8 | (203) | 0.67 | 0.60 | 0.59 | 0.41 | 0.22 | 0.20 | 0.57 | 0.55 | 0.54 | 0.27 | 0.15 | 0.13 | 0.44 | 0.29 | 0.26 | n/a | n/a | n/a |
| 9 | (229) | 0.69 | 0.61 | 0.60 | 0.45 | 0.24 | 0.22 | 0.58 | 0.55 | 0.55 | 0.32 | 0.17 | 0.16 | 0.47 | 0.33 | 0.32 | n/a | n/a | n/a |
| 10 | (254) | 0.71 | 0.62 | 0.61 | 0.49 | 0.27 | 0.24 | 0.59 | 0.56 | 0.55 | 0.38 | 0.20 | 0.18 | 0.51 | 0.35 | 0.33 | 0.59 | n/a | n/a |
| 11 | (279) | 0.73 | 0.63 | 0.62 | 0.54 | 0.29 | 0.27 | 0.60 | 0.56 | 0.56 | 0.43 | 0.23 | 0.21 | 0.55 | 0.37 | 0.35 | 0.62 | n/a | n/a |
| 12 | (305) | 0.75 | 0.64 | 0.63 | 0.59 | 0.32 | 0.29 | 0.60 | 0.57 | 0.56 | 0.49 | 0.27 | 0.24 | 0.59 | 0.38 | 0.36 | 0.65 | n/a | n/a |
| 14 | (356) | 0.80 | 0.67 | 0.65 | 0.69 | 0.37 | 0.34 | 0.62 | 0.58 | 0.58 | 0.62 | 0.34 | 0.31 | 0.69 | 0.42 | 0.40 | 0.70 | n/a | n/a |
| 16 | (406) | 0.84 | 0.69 | 0.67 | 0.78 | 0.43 | 0.39 | 0.64 | 0.59 | 0.59 | 0.76 | 0.41 | 0.37 | 0.78 | 0.46 | 0.43 | 0.74 | 0.61 | n/a |
| 18 | (457) | 0.88 | 0.71 | 0.70 | 0.88 | 0.48 | 0.44 | 0.66 | 0.60 | 0.60 | 0.91 | 0.49 | 0.45 | 0.88 | 0.50 | 0.46 | 0.79 | 0.64 | 0.62 |
| 20 | (508) | 0.92 | 0.74 | 0.72 | 0.98 | 0.53 | 0.48 | 0.67 | 0.62 | 0.61 | 1.00 | 0.57 | 0.52 | 0.98 | 0.54 | 0.50 | 0.83 | 0.68 | 0.66 |
| 22 | (559) | 0.97 | 0.76 | 0.74 | 1.00 | 0.59 | 0.53 | 0.69 | 0.63 | 0.62 | | 0.66 | 0.60 | 1.00 | 0.59 | 0.54 | 0.87 | 0.71 | 0.69 |
| 24 | (610) | 1.00 | 0.79 | 0.76 | | 0.64 | 0.58 | 0.71 | 0.64 | 0.63 | | 0.76 | 0.69 | | 0.64 | 0.58 | 0.91 | 0.74 | 0.72 |
| 26 | (660) | | 0.81 | 0.78 | | 0.69 | 0.63 | 0.73 | 0.65 | 0.64 | | 0.85 | 0.78 | | 0.69 | 0.63 | 0.95 | 0.77 | 0.75 |
| 28 | (711) | | 0.83 | 0.80 | | 0.75 | 0.68 | 0.74 | 0.66 | 0.65 | | 0.95 | 0.87 | | 0.75 | 0.68 | 0.99 | 0.80 | 0.78 |
| 30 | (762) | | 0.86 | 0.83 | | 0.80 | 0.73 | 0.76 | 0.67 | 0.66 | | 1.00 | 0.96 | | 0.80 | 0.73 | 1.00 | 0.83 | 0.81 |
| 36 | (914) | | 0.93 | 0.89 | | 0.96 | 0.87 | 0.81 | 0.71 | 0.69 | | | 1.00 | | 0.96 | 0.87 | | 0.91 | 0.88 |
| > 48 | (1219) | | 1.00 | 1.00 | | 1.00 | 1.00 | 0.92 | 0.78 | 0.76 | | | | | 1.00 | 1.00 | | 1.00 | 1.00 |

Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm)

## Table 76 — Load adjustment factors for 20M rebar in cracked concrete[1,2,3]

| 20M Rebar cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 |
| in. | (mm) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) |
| 1-3/4 | (44) | n/a | n/a | n/a | 0.43 | 0.39 | 0.39 | n/a | n/a | n/a | 0.03 | 0.02 | 0.01 | 0.06 | 0.03 | 0.03 | n/a | n/a | n/a |
| 3-7/8 | (98) | 0.58 | 0.55 | 0.54 | 0.53 | 0.45 | 0.44 | 0.53 | 0.52 | 0.52 | 0.09 | 0.05 | 0.05 | 0.18 | 0.10 | 0.09 | n/a | n/a | n/a |
| 4 | (102) | 0.58 | 0.55 | 0.54 | 0.54 | 0.45 | 0.44 | 0.54 | 0.52 | 0.52 | 0.10 | 0.05 | 0.05 | 0.19 | 0.10 | 0.10 | n/a | n/a | n/a |
| 5 | (127) | 0.61 | 0.56 | 0.55 | 0.59 | 0.48 | 0.47 | 0.54 | 0.53 | 0.53 | 0.14 | 0.07 | 0.07 | 0.27 | 0.15 | 0.13 | n/a | n/a | n/a |
| 6 | (152) | 0.63 | 0.57 | 0.57 | 0.64 | 0.51 | 0.49 | 0.55 | 0.53 | 0.53 | 0.18 | 0.10 | 0.09 | 0.36 | 0.19 | 0.17 | n/a | n/a | n/a |
| 7 | (178) | 0.65 | 0.58 | 0.58 | 0.70 | 0.53 | 0.52 | 0.56 | 0.54 | 0.54 | 0.22 | 0.12 | 0.11 | 0.45 | 0.24 | 0.22 | n/a | n/a | n/a |
| 8 | (203) | 0.67 | 0.60 | 0.59 | 0.76 | 0.56 | 0.54 | 0.57 | 0.55 | 0.54 | 0.27 | 0.15 | 0.13 | 0.55 | 0.30 | 0.27 | n/a | n/a | n/a |
| 9 | (229) | 0.69 | 0.61 | 0.60 | 0.82 | 0.59 | 0.57 | 0.58 | 0.55 | 0.55 | 0.33 | 0.18 | 0.16 | 0.65 | 0.35 | 0.32 | n/a | n/a | n/a |
| 10 | (254) | 0.71 | 0.62 | 0.61 | 0.88 | 0.62 | 0.60 | 0.59 | 0.56 | 0.55 | 0.38 | 0.21 | 0.19 | 0.77 | 0.41 | 0.38 | 0.59 | n/a | n/a |
| 11 | (279) | 0.73 | 0.63 | 0.62 | 0.95 | 0.65 | 0.62 | 0.60 | 0.56 | 0.56 | 0.44 | 0.24 | 0.22 | 0.88 | 0.48 | 0.43 | 0.62 | n/a | n/a |
| 12 | (305) | 0.75 | 0.64 | 0.63 | 1.00 | 0.69 | 0.65 | 0.61 | 0.57 | 0.57 | 0.50 | 0.27 | 0.25 | 1.00 | 0.54 | 0.49 | 0.65 | n/a | n/a |
| 14 | (356) | 0.80 | 0.67 | 0.65 | | 0.75 | 0.71 | 0.62 | 0.58 | 0.58 | 0.64 | 0.34 | 0.31 | | 0.68 | 0.62 | 0.70 | n/a | n/a |
| 16 | (406) | 0.84 | 0.69 | 0.67 | | 0.82 | 0.77 | 0.64 | 0.59 | 0.59 | 0.77 | 0.42 | 0.38 | | 0.82 | 0.76 | 0.75 | 0.61 | n/a |
| 18 | (457) | 0.88 | 0.71 | 0.70 | | 0.89 | 0.83 | 0.66 | 0.60 | 0.60 | 0.93 | 0.50 | 0.45 | | 0.89 | 0.83 | 0.80 | 0.65 | 0.63 |
| 20 | (508) | 0.92 | 0.74 | 0.72 | | 0.96 | 0.90 | 0.68 | 0.62 | 0.61 | 1.00 | 0.58 | 0.53 | | 0.96 | 0.90 | 0.84 | 0.68 | 0.66 |
| 22 | (559) | 0.97 | 0.76 | 0.74 | | 1.00 | 0.96 | 0.69 | 0.63 | 0.62 | | 0.67 | 0.61 | | 1.00 | 0.96 | 0.88 | 0.72 | 0.69 |
| 24 | (610) | 1.00 | 0.79 | 0.76 | | | 1.00 | 0.71 | 0.64 | 0.63 | | 0.77 | 0.70 | | | 1.00 | 0.92 | 0.75 | 0.72 |
| 26 | (660) | | 0.81 | 0.78 | | | | 0.73 | 0.65 | 0.64 | | 0.87 | 0.79 | | | | 0.96 | 0.78 | 0.75 |
| 28 | (711) | | 0.83 | 0.80 | | | | 0.75 | 0.66 | 0.65 | | 0.97 | 0.88 | | | | 0.99 | 0.81 | 0.78 |
| 30 | (762) | | 0.86 | 0.83 | | | | 0.76 | 0.67 | 0.66 | | 1.00 | 0.98 | | | | 1.00 | 0.84 | 0.81 |
| 36 | (914) | | 0.93 | 0.89 | | | | 0.82 | 0.71 | 0.70 | | | 1.00 | | | | | 0.92 | 0.89 |
| > 48 | (1219) | | 1.00 | 1.00 | | | | 0.92 | 0.78 | 0.76 | | | | | | | | 1.00 | 1.00 |

Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm)

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 77 — Load adjustment factors for 25M rebar in uncracked concrete[1,2,3]

| 25M Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.22 | 0.12 | 0.10 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.02 | 0.02 | n/a | n/a | n/a |
| | 5 | (127) | 0.59 | 0.55 | 0.54 | 0.30 | 0.17 | 0.13 | 0.54 | 0.52 | 0.52 | 0.11 | 0.05 | 0.04 | 0.22 | 0.10 | 0.08 | n/a | n/a | n/a |
| | 6 | (152) | 0.61 | 0.56 | 0.55 | 0.33 | 0.18 | 0.14 | 0.55 | 0.53 | 0.52 | 0.14 | 0.06 | 0.05 | 0.28 | 0.13 | 0.10 | n/a | n/a | n/a |
| | 7 | (178) | 0.63 | 0.57 | 0.56 | 0.36 | 0.20 | 0.16 | 0.55 | 0.53 | 0.53 | 0.18 | 0.08 | 0.06 | 0.36 | 0.16 | 0.13 | n/a | n/a | n/a |
| | 8 | (203) | 0.65 | 0.58 | 0.57 | 0.39 | 0.21 | 0.17 | 0.56 | 0.54 | 0.53 | 0.22 | 0.10 | 0.08 | 0.41 | 0.20 | 0.16 | n/a | n/a | n/a |
| | 9 | (229) | 0.67 | 0.59 | 0.58 | 0.42 | 0.23 | 0.18 | 0.57 | 0.54 | 0.53 | 0.26 | 0.12 | 0.09 | 0.44 | 0.24 | 0.19 | n/a | n/a | n/a |
| | 10 | (254) | 0.68 | 0.60 | 0.58 | 0.45 | 0.25 | 0.20 | 0.58 | 0.54 | 0.54 | 0.30 | 0.14 | 0.11 | 0.47 | 0.28 | 0.22 | n/a | n/a | n/a |
| | 11-9/16 | (294) | 0.71 | 0.62 | 0.60 | 0.50 | 0.28 | 0.22 | 0.59 | 0.55 | 0.54 | 0.38 | 0.17 | 0.14 | 0.52 | 0.34 | 0.28 | 0.59 | n/a | n/a |
| | 12 | (305) | 0.72 | 0.63 | 0.60 | 0.52 | 0.28 | 0.23 | 0.59 | 0.55 | 0.55 | 0.40 | 0.18 | 0.15 | 0.53 | 0.36 | 0.29 | 0.60 | n/a | n/a |
| | 14 | (356) | 0.76 | 0.65 | 0.62 | 0.60 | 0.33 | 0.26 | 0.61 | 0.56 | 0.55 | 0.50 | 0.23 | 0.18 | 0.60 | 0.39 | 0.34 | 0.65 | n/a | n/a |
| | 16 | (406) | 0.79 | 0.67 | 0.63 | 0.69 | 0.38 | 0.30 | 0.62 | 0.57 | 0.56 | 0.62 | 0.28 | 0.22 | 0.69 | 0.42 | 0.37 | 0.69 | n/a | n/a |
| | 18 | (457) | 0.83 | 0.69 | 0.65 | 0.77 | 0.42 | 0.34 | 0.64 | 0.58 | 0.57 | 0.74 | 0.33 | 0.27 | 0.77 | 0.46 | 0.39 | 0.74 | n/a | n/a |
| | 18-7/16 | (469) | 0.84 | 0.69 | 0.66 | 0.79 | 0.43 | 0.35 | 0.64 | 0.58 | 0.57 | 0.76 | 0.35 | 0.28 | 0.79 | 0.46 | 0.40 | 0.75 | 0.57 | n/a |
| | 20 | (508) | 0.87 | 0.71 | 0.67 | 0.86 | 0.47 | 0.37 | 0.65 | 0.59 | 0.58 | 0.86 | 0.39 | 0.31 | 0.86 | 0.49 | 0.42 | 0.78 | 0.60 | n/a |
| | 22-3/8 | (568) | 0.91 | 0.73 | 0.69 | 0.96 | 0.53 | 0.42 | 0.67 | 0.60 | 0.59 | 1.00 | 0.46 | 0.37 | 0.96 | 0.53 | 0.45 | 0.82 | 0.63 | 0.59 |
| | 24 | (610) | 0.94 | 0.75 | 0.70 | 1.00 | 0.56 | 0.45 | 0.68 | 0.61 | 0.59 | | 0.51 | 0.41 | 1.00 | 0.56 | 0.47 | 0.85 | 0.65 | 0.61 |
| | 26 | (660) | 0.98 | 0.77 | 0.72 | | 0.61 | 0.49 | 0.70 | 0.62 | 0.60 | | 0.58 | 0.46 | | 0.61 | 0.50 | 0.89 | 0.68 | 0.63 |
| | 28 | (711) | 1.00 | 0.79 | 0.74 | | 0.66 | 0.52 | 0.71 | 0.62 | 0.61 | | 0.65 | 0.52 | | 0.66 | 0.53 | 0.92 | 0.71 | 0.66 |
| | 30 | (762) | | 0.81 | 0.75 | | 0.71 | 0.56 | 0.73 | 0.63 | 0.62 | | 0.72 | 0.58 | | 0.71 | 0.56 | 0.95 | 0.73 | 0.68 |
| | 36 | (914) | | 0.88 | 0.80 | | 0.85 | 0.67 | 0.77 | 0.66 | 0.64 | | 0.94 | 0.76 | | 0.85 | 0.67 | 1.00 | 0.80 | 0.74 |
| | > 48 | (1219) | | 1.00 | 0.90 | | 1.00 | 0.90 | 0.86 | 0.71 | 0.68 | | 1.00 | 1.00 | | 1.00 | 0.90 | | 0.92 | 0.86 |

## Table 78 — Load adjustment factors for 25M rebar in cracked concrete[1,2,3]

| 25M Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.42 | 0.39 | 0.38 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.05 | 0.03 | 0.02 | n/a | n/a | n/a |
| | 5 | (127) | 0.59 | 0.55 | 0.54 | 0.55 | 0.46 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.06 | 0.05 | 0.23 | 0.13 | 0.10 | n/a | n/a | n/a |
| | 6 | (152) | 0.61 | 0.56 | 0.55 | 0.60 | 0.48 | 0.46 | 0.55 | 0.53 | 0.53 | 0.15 | 0.08 | 0.07 | 0.30 | 0.17 | 0.14 | n/a | n/a | n/a |
| | 7 | (178) | 0.63 | 0.57 | 0.56 | 0.65 | 0.51 | 0.48 | 0.55 | 0.54 | 0.53 | 0.19 | 0.11 | 0.09 | 0.38 | 0.21 | 0.17 | n/a | n/a | n/a |
| | 8 | (203) | 0.65 | 0.58 | 0.57 | 0.70 | 0.53 | 0.50 | 0.56 | 0.54 | 0.54 | 0.23 | 0.13 | 0.11 | 0.46 | 0.26 | 0.21 | n/a | n/a | n/a |
| | 9 | (229) | 0.67 | 0.59 | 0.58 | 0.75 | 0.56 | 0.51 | 0.57 | 0.55 | 0.54 | 0.27 | 0.16 | 0.13 | 0.55 | 0.31 | 0.25 | n/a | n/a | n/a |
| | 10 | (254) | 0.68 | 0.60 | 0.58 | 0.80 | 0.59 | 0.53 | 0.58 | 0.55 | 0.55 | 0.32 | 0.18 | 0.15 | 0.64 | 0.37 | 0.29 | n/a | n/a | n/a |
| | 11-9/16 | (294) | 0.71 | 0.62 | 0.60 | 0.89 | 0.63 | 0.57 | 0.59 | 0.56 | 0.55 | 0.40 | 0.23 | 0.18 | 0.80 | 0.46 | 0.37 | 0.60 | n/a | n/a |
| | 12 | (305) | 0.72 | 0.63 | 0.60 | 0.91 | 0.64 | 0.58 | 0.59 | 0.56 | 0.56 | 0.42 | 0.24 | 0.19 | 0.85 | 0.48 | 0.39 | 0.61 | n/a | n/a |
| | 14 | (356) | 0.76 | 0.65 | 0.62 | 1.00 | 0.69 | 0.62 | 0.61 | 0.58 | 0.56 | 0.53 | 0.30 | 0.24 | 1.00 | 0.61 | 0.49 | 0.66 | n/a | n/a |
| | 16 | (406) | 0.79 | 0.67 | 0.63 | | 0.75 | 0.66 | 0.63 | 0.59 | 0.57 | 0.65 | 0.37 | 0.30 | | 0.74 | 0.59 | 0.71 | n/a | n/a |
| | 18 | (457) | 0.83 | 0.69 | 0.65 | | 0.81 | 0.71 | 0.64 | 0.60 | 0.58 | 0.78 | 0.44 | 0.35 | | 0.81 | 0.71 | 0.75 | n/a | n/a |
| | 18-7/16 | (469) | 0.84 | 0.69 | 0.66 | | 0.83 | 0.72 | 0.64 | 0.60 | 0.59 | 0.81 | 0.46 | 0.37 | | 0.83 | 0.72 | 0.76 | 0.63 | n/a |
| | 20 | (508) | 0.87 | 0.71 | 0.67 | | 0.87 | 0.75 | 0.66 | 0.61 | 0.59 | 0.91 | 0.52 | 0.42 | | 0.87 | 0.75 | 0.79 | 0.66 | n/a |
| | 22-3/8 | (568) | 0.91 | 0.73 | 0.69 | | 0.95 | 0.81 | 0.68 | 0.62 | 0.60 | 1.00 | 0.61 | 0.49 | | 0.95 | 0.81 | 0.84 | 0.69 | 0.64 |
| | 24 | (610) | 0.94 | 0.75 | 0.70 | | 1.00 | 0.85 | 0.69 | 0.63 | 0.61 | | 0.68 | 0.55 | | 1.00 | 0.85 | 0.87 | 0.72 | 0.67 |
| | 26 | (660) | 0.98 | 0.77 | 0.72 | | | 0.90 | 0.70 | 0.64 | 0.62 | | 0.77 | 0.62 | | | 0.90 | 0.90 | 0.75 | 0.69 |
| | 28 | (711) | 1.00 | 0.79 | 0.74 | | | 0.95 | 0.72 | 0.65 | 0.63 | | 0.86 | 0.69 | | | 0.95 | 0.94 | 0.78 | 0.72 |
| | 30 | (762) | | 0.81 | 0.75 | | | 1.00 | 0.73 | 0.66 | 0.64 | | 0.95 | 0.76 | | | 1.00 | 0.97 | 0.80 | 0.75 |
| | 36 | (914) | | 0.88 | 0.80 | | | | 0.78 | 0.69 | 0.67 | | 1.00 | 1.00 | | | | 1.00 | 0.88 | 0.82 |
| | > 48 | (1219) | | 1.00 | 0.90 | | | | 0.88 | 0.76 | 0.72 | | | | | | | | 1.00 | 0.94 |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 79 — Load adjustment factors for 30M rebar in uncracked concrete[1,2,3]

| 30M Rebar uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 |
| in. | (mm) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) |
| 1-3/4 | (44) | n/a | n/a | n/a | 0.23 | 0.13 | 0.09 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.02 | 0.01 | n/a | n/a | n/a |
| 5-7/8 | (150) | 0.60 | 0.55 | 0.54 | 0.33 | 0.18 | 0.13 | 0.54 | 0.52 | 0.52 | 0.12 | 0.05 | 0.04 | 0.23 | 0.10 | 0.07 | n/a | n/a | n/a |
| 6 | (152) | 0.60 | 0.56 | 0.54 | 0.33 | 0.18 | 0.13 | 0.54 | 0.52 | 0.52 | 0.12 | 0.05 | 0.04 | 0.24 | 0.10 | 0.07 | n/a | n/a | n/a |
| 7 | (178) | 0.61 | 0.57 | 0.55 | 0.36 | 0.19 | 0.14 | 0.55 | 0.53 | 0.52 | 0.15 | 0.06 | 0.05 | 0.30 | 0.13 | 0.09 | n/a | n/a | n/a |
| 8 | (203) | 0.63 | 0.57 | 0.56 | 0.38 | 0.20 | 0.15 | 0.55 | 0.53 | 0.52 | 0.18 | 0.08 | 0.06 | 0.36 | 0.16 | 0.11 | n/a | n/a | n/a |
| 9 | (229) | 0.65 | 0.58 | 0.56 | 0.41 | 0.22 | 0.16 | 0.56 | 0.53 | 0.53 | 0.22 | 0.09 | 0.07 | 0.42 | 0.19 | 0.13 | n/a | n/a | n/a |
| 10 | (254) | 0.66 | 0.59 | 0.57 | 0.44 | 0.23 | 0.18 | 0.57 | 0.54 | 0.53 | 0.25 | 0.11 | 0.08 | 0.45 | 0.22 | 0.16 | n/a | n/a | n/a |
| 11 | (279) | 0.68 | 0.60 | 0.58 | 0.46 | 0.25 | 0.19 | 0.57 | 0.54 | 0.53 | 0.29 | 0.13 | 0.09 | 0.47 | 0.25 | 0.18 | n/a | n/a | n/a |
| 12 | (305) | 0.70 | 0.61 | 0.58 | 0.49 | 0.26 | 0.20 | 0.58 | 0.55 | 0.54 | 0.33 | 0.14 | 0.10 | 0.50 | 0.29 | 0.21 | n/a | n/a | n/a |
| 13-1/4 | (337) | 0.72 | 0.62 | 0.59 | 0.53 | 0.28 | 0.21 | 0.59 | 0.55 | 0.54 | 0.39 | 0.17 | 0.12 | 0.54 | 0.33 | 0.24 | 0.60 | n/a | n/a |
| 14 | (356) | 0.73 | 0.63 | 0.60 | 0.55 | 0.30 | 0.22 | 0.59 | 0.55 | 0.54 | 0.42 | 0.18 | 0.13 | 0.56 | 0.36 | 0.26 | 0.61 | n/a | n/a |
| 16 | (406) | 0.76 | 0.65 | 0.61 | 0.63 | 0.34 | 0.25 | 0.61 | 0.56 | 0.55 | 0.51 | 0.22 | 0.16 | 0.63 | 0.40 | 0.32 | 0.65 | n/a | n/a |
| 18 | (457) | 0.79 | 0.67 | 0.63 | 0.71 | 0.38 | 0.28 | 0.62 | 0.57 | 0.56 | 0.61 | 0.26 | 0.19 | 0.71 | 0.42 | 0.36 | 0.69 | n/a | n/a |
| 20 | (508) | 0.83 | 0.69 | 0.64 | 0.79 | 0.42 | 0.32 | 0.63 | 0.58 | 0.56 | 0.72 | 0.31 | 0.22 | 0.79 | 0.45 | 0.38 | 0.73 | n/a | n/a |
| 20-7/8 | (531) | 0.84 | 0.69 | 0.65 | 0.82 | 0.44 | 0.33 | 0.64 | 0.58 | 0.56 | 0.77 | 0.33 | 0.24 | 0.82 | 0.47 | 0.39 | 0.75 | n/a | n/a |
| 22 | (559) | 0.86 | 0.70 | 0.66 | 0.87 | 0.46 | 0.35 | 0.65 | 0.58 | 0.57 | 0.83 | 0.36 | 0.26 | 0.87 | 0.49 | 0.40 | 0.77 | 0.58 | n/a |
| 24 | (610) | 0.89 | 0.72 | 0.67 | 0.94 | 0.50 | 0.38 | 0.66 | 0.59 | 0.57 | 0.94 | 0.41 | 0.29 | 0.94 | 0.52 | 0.42 | 0.80 | 0.61 | n/a |
| 26-9/16 | (675) | 0.93 | 0.75 | 0.69 | 1.00 | 0.56 | 0.42 | 0.68 | 0.60 | 0.58 | 1.00 | 0.47 | 0.34 | 1.00 | 0.56 | 0.45 | 0.84 | 0.64 | 0.57 |
| 28 | (711) | 0.96 | 0.76 | 0.70 | | 0.59 | 0.44 | 0.69 | 0.61 | 0.59 | | 0.51 | 0.37 | | 0.59 | 0.47 | 0.86 | 0.65 | 0.59 |
| 30 | (762) | 0.99 | 0.78 | 0.71 | | 0.63 | 0.47 | 0.70 | 0.61 | 0.59 | | 0.57 | 0.41 | | 0.63 | 0.49 | 0.89 | 0.68 | 0.61 |
| 36 | (914) | 1.00 | 0.83 | 0.75 | | 0.76 | 0.57 | 0.74 | 0.64 | 0.61 | | 0.75 | 0.54 | | 0.76 | 0.57 | 0.98 | 0.74 | 0.66 |
| > 48 | (1219) | | 0.95 | 0.84 | | 1.00 | 0.76 | 0.82 | 0.68 | 0.65 | | 1.00 | 0.83 | | 1.00 | 0.76 | 1.00 | 0.86 | 0.77 |

Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm)

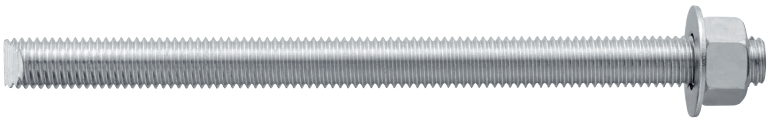
## Table 80 — Load adjustment factors for 30M rebar in cracked concrete[1,2,3]

| 30M Rebar cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 |
| in. | (mm) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) |
| 1-3/4 | (44) | n/a | n/a | n/a | 0.41 | 0.38 | 0.38 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.02 | 0.02 | n/a | n/a | n/a |
| 5-7/8 | (150) | 0.60 | 0.55 | 0.54 | 0.56 | 0.47 | 0.44 | 0.54 | 0.53 | 0.52 | 0.12 | 0.06 | 0.05 | 0.23 | 0.12 | 0.09 | n/a | n/a | n/a |
| 6 | (152) | 0.60 | 0.56 | 0.54 | 0.57 | 0.47 | 0.44 | 0.54 | 0.53 | 0.52 | 0.12 | 0.06 | 0.05 | 0.24 | 0.13 | 0.10 | n/a | n/a | n/a |
| 7 | (178) | 0.61 | 0.57 | 0.55 | 0.61 | 0.49 | 0.46 | 0.55 | 0.53 | 0.53 | 0.15 | 0.08 | 0.06 | 0.30 | 0.16 | 0.12 | n/a | n/a | n/a |
| 8 | (203) | 0.63 | 0.57 | 0.56 | 0.65 | 0.51 | 0.47 | 0.55 | 0.54 | 0.53 | 0.19 | 0.10 | 0.07 | 0.37 | 0.19 | 0.15 | n/a | n/a | n/a |
| 9 | (229) | 0.65 | 0.58 | 0.56 | 0.69 | 0.53 | 0.49 | 0.56 | 0.54 | 0.53 | 0.22 | 0.12 | 0.09 | 0.44 | 0.23 | 0.18 | n/a | n/a | n/a |
| 10 | (254) | 0.66 | 0.59 | 0.57 | 0.74 | 0.56 | 0.50 | 0.57 | 0.54 | 0.54 | 0.26 | 0.14 | 0.10 | 0.52 | 0.27 | 0.21 | n/a | n/a | n/a |
| 11 | (279) | 0.68 | 0.60 | 0.58 | 0.79 | 0.58 | 0.52 | 0.57 | 0.55 | 0.54 | 0.30 | 0.16 | 0.12 | 0.60 | 0.31 | 0.24 | n/a | n/a | n/a |
| 12 | (305) | 0.70 | 0.61 | 0.58 | 0.83 | 0.60 | 0.54 | 0.58 | 0.55 | 0.54 | 0.34 | 0.18 | 0.14 | 0.68 | 0.36 | 0.27 | n/a | n/a | n/a |
| 13-1/4 | (337) | 0.72 | 0.62 | 0.59 | 0.89 | 0.63 | 0.56 | 0.59 | 0.56 | 0.55 | 0.40 | 0.21 | 0.16 | 0.79 | 0.41 | 0.32 | 0.60 | n/a | n/a |
| 14 | (356) | 0.73 | 0.63 | 0.60 | 0.93 | 0.65 | 0.57 | 0.59 | 0.56 | 0.55 | 0.43 | 0.22 | 0.17 | 0.86 | 0.45 | 0.34 | 0.62 | n/a | n/a |
| 16 | (406) | 0.76 | 0.65 | 0.61 | 1.00 | 0.70 | 0.61 | 0.61 | 0.57 | 0.56 | 0.52 | 0.27 | 0.21 | 1.00 | 0.55 | 0.42 | 0.66 | n/a | n/a |
| 18 | (457) | 0.79 | 0.67 | 0.63 | | 0.75 | 0.64 | 0.62 | 0.58 | 0.57 | 0.62 | 0.33 | 0.25 | | 0.65 | 0.50 | 0.70 | n/a | n/a |
| 20 | (508) | 0.83 | 0.69 | 0.64 | | 0.81 | 0.68 | 0.64 | 0.59 | 0.57 | 0.73 | 0.38 | 0.29 | | 0.77 | 0.58 | 0.74 | n/a | n/a |
| 20-7/8 | (531) | 0.84 | 0.69 | 0.65 | | 0.83 | 0.70 | 0.64 | 0.59 | 0.58 | 0.78 | 0.41 | 0.31 | | 0.82 | 0.62 | 0.75 | n/a | n/a |
| 22 | (559) | 0.86 | 0.70 | 0.66 | | 0.86 | 0.72 | 0.65 | 0.60 | 0.58 | 0.84 | 0.44 | 0.34 | | 0.86 | 0.67 | 0.77 | 0.62 | n/a |
| 24 | (610) | 0.89 | 0.72 | 0.67 | | 0.92 | 0.76 | 0.66 | 0.61 | 0.59 | 0.96 | 0.50 | 0.38 | | 0.92 | 0.76 | 0.81 | 0.65 | n/a |
| 26-9/16 | (675) | 0.93 | 0.75 | 0.69 | | 0.99 | 0.81 | 0.68 | 0.62 | 0.60 | 1.00 | 0.59 | 0.45 | | 0.99 | 0.81 | 0.85 | 0.68 | 0.62 |
| 28 | (711) | 0.96 | 0.76 | 0.70 | | 1.00 | 0.84 | 0.69 | 0.62 | 0.60 | | 0.63 | 0.48 | | 1.00 | 0.84 | 0.87 | 0.70 | 0.64 |
| 30 | (762) | 0.99 | 0.78 | 0.71 | | | 0.88 | 0.70 | 0.63 | 0.61 | | 0.70 | 0.54 | | | 0.88 | 0.90 | 0.73 | 0.66 |
| 36 | (914) | 1.00 | 0.83 | 0.75 | | | 1.00 | 0.74 | 0.66 | 0.63 | | 0.93 | 0.70 | | | 1.00 | 0.99 | 0.80 | 0.73 |
| > 48 | (1219) | | 0.95 | 0.84 | | | | 0.82 | 0.71 | 0.68 | | 1.00 | 1.00 | | | | 1.00 | 0.92 | 0.84 |

Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm)

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## HIT-HY 200 A/R V3 Adhesive with Hilti HAS Threaded Rod



### Table 81 — Steel factored resistance for Hilti HAS threaded rods for use with CSA A23.3 Annex D

| Nominal anchor diameter in. | HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr.36[4,6] | | | HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6] | | | HAS-B-105 / HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6] | | | HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tensile[1] $\Phi N_{sar}$ lb (kN) | Shear[2] $\Phi V_{sar}$ lb (kN) | Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN) | Tensile[1] $\Phi N_{sar}$ lb (kN) | Shear[2] $\Phi V_{sar}$ lb (kN) | Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN) | Tensile[1] $\Phi N_{sar}$ lb (kN) | Shear[2] $\Phi V_{sar}$ lb (kN) | Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN) | Tensile[1] $\Phi N_{sar}$ lb (kN) | Shear[2] $\Phi V_{sar}$ lb (kN) | Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN) |
| 3/8 | 3,055 (13.6) | 1,720 (7.7) | 1,030 (4.6) | 3,955 (17.6) | 2,225 (9.9) | 1,560 (6.9) | 6,570 (29.2) | 3,695 (16.4) | 2,585 (11.5) | 4,610 (20.5) | 2,570 (11.4) | 1,800 (8.0) |
| 1/2 | 5,595 (24.9) | 3,150 (14.0) | 1,890 (8.4) | 7,240 (32.2) | 4,070 (18.1) | 2,850 (12.7) | 12,035 (53.5) | 6,765 (30.1) | 4,735 (21.1) | 8,445 (37.6) | 4,705 (20.9) | 3,295 (14.7) |
| 5/8 | 8,915 (39.7) | 5,015 (22.3) | 3,010 (13.4) | 11,525 (51.3) | 6,485 (28.8) | 4,540 (20.2) | 19,160 (85.2) | 10,780 (48.0) | 7,545 (33.6) | 13,445 (59.8) | 7,490 (33.3) | 5,245 (23.3) |
| 3/4 | 13,190 (58.7) | 7,420 (33.0) | 4,450 (19.8) | 17,060 (75.9) | 9,600 (42.7) | 6,720 (29.9) | 28,365 (126.2) | 15,955 (71.0) | 11,170 (49.7) | 16,920 (75.3) | 9,425 (41.9) | 6,600 (29.4) |
| 7/8 | 18,210 (81.0) | 10,245 (45.6) | 6,145 (27.3) | 23,550 (104.8) | 13,245 (58.9) | 9,270 (41.2) | 39,150 (174.1) | 22,020 (97.9) | 15,415 (68.6) | 23,350 (103.9) | 13,010 (57.9) | 9,105 (40.5) |
| 1 | 23,890 (106.3) | 13,440 (59.8) | 8,065 (35.9) | 30,890 (137.4) | 17,380 (77.3) | 12,165 (54.1) | 51,360 (228.5) | 28,890 (128.5) | 20,225 (90.0) | 30,635 (136.3) | 17,065 (75.9) | 11,945 (53.1) |
| 1-1/4 | 38,225 (170.0) | 21,500 (95.6) | 12,900 (57.4) | 49,425 (219.9) | 27,800 (123.7) | 19,460 (86.6) | 82,175 (365.5) | 46,220 (205.6) | 32,355 (143.9) | 37,565 (167.1) | 21,130 (94.0) | 12,680 (56.4) |

1 Tensile = $A_{se,N}$ ϕ $f_{uta}$ R as noted in CSA A23.3 Eq. D.2.
2 Shear = $A_{se,V}$ ϕ 0.60 $f_{uta}$ R as noted in CSA A23.3 Eq. D.31.
3 Seismic Shear = $\alpha_{V,seis} V_{sar}$ : Reduction factor for seismic shear only. See CSA A23.3 Annex D for additional information on seismic applications.
4 HAS-V, HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).
5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.
6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

## Table 82 — Hilti HIT-HY 200 V3 design information with Hilti HAS threaded rods in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Nominal rod diameter (in.) | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 | A23.3-14 |
| Nominal anchor Diameter | | $d_a$ | mm | 9.5 | 12.7 | 15.9 | 19.1 | 22.2 | 25.4 | 31.8 | |
| Effective minimum embedment[2] | | $h_{ef,min}$ | mm | 60 | 70 | 79 | 89 | 89 | 102 | 127 | |
| Effective maximum embedment[2] | | $h_{ef,max}$ | mm | 191 | 254 | 318 | 381 | 445 | 508 | 635 | |
| Minimum concrete thickness[2] | | $h_{min}$ | mm | $h_{ef}$ + 30 | | $h_{ef}$ + $2d_0$ | | | | | |
| Critical edge distance | | $c_{ac}$ | | $2h_{ef}$ | | | | | | | |
| Minimum edge distance | | $c_{min}$ | mm | 45 | 45 | 50[3] | 55[3] | 60[3] | 70[3] | 80[3] | |
| Minimum anchor spacing | | $s_{min}$ | mm | 48 | 64 | 79 | 95 | 111 | 127 | 159 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete[4] | | $k_{c,uncr}$ | – | 10 | | | | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete[4] | | $k_{c,cr}$ | – | 7 | | | | | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_c$ | – | 0.65 | | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | | | | | | |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 1,045 (7.2) | 1,135 (7.7) | 1,170 (8.2) | 1,260 (8.4) | 1,290 (8.6) | 1,325 (8.7) | 1,380 (9.1) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 2,220 (15.3) | 2,220 (15.3) | 2,220 (15.3) | 2,220 (15.3) | 2,220 (15.3) | 2,220 (15.3) | 2,220 (15.3) | D.6.5.2 |
| Temp. range B[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 1,045 (7.2) | 1,135 (7.7) | 1,170 (8.2) | 1,260 (8.4) | 1,290 (8.6) | 1,325 (8.7) | 1,380 (9.1) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 2,220 (15.3) | 2,220 (15.3) | 2,220 (15.3) | 2,220 (15.3) | 2,220 (15.3) | 2,220 (15.3) | 2,220 (15.3) | D.6.5.2 |
| Temp. range C[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 885 (6.1) | 930 (6.3) | 960 (6.7) | 1,035 (6.9) | 1,055 (7.3) | 1,085 (7.1) | 1,130 (7.4) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 1,820 (12.6) | 1,820 (12.6) | 1,820 (12.6) | 1,820 (12.6) | 1,820 (12.6) | 1,820 (12.6) | 1,820 (12.6) | D.6.5.2 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | – | 0.88 | 0.99 | | 1.0 | | 0.95 | 0.99 | |
| Permissible installation conditions | Resistance modification factor tension & shear, bond failure dry and water saturated concrete | Anchor category | – | 1 | | | | | | | D.5.3 (c ) |
| | | $R_{dry}$, $R_{ws}$ | – | 1.00 | | | | | | | |
| | Resistance modification factor tension & shear, bond failure water-filled concrete | Anchor category | – | 3 | | | | | | | D.5.3 (c ) |
| | | $R_{wf}$ | – | 0.75 | | | | | | | |

1 Design information in this table is taken from ELC-4868, tables 8 and 10 for use with CSA A23.3 Annex D.
2 See figure 10 of this section.
3 Minimum edge distance may be reduced to 45mm ≤ $c_{ai}$ < 5d provided $T_{inst}$ is reduced. See ELC-4868 Installation Torque Subject to Edge Distance section.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
7 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].
8 For water-filled holes, multiply characteristic bond stress by 0.61.

## Table 83 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8,9]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 2-3/8 (60) | 3,060 (13.6) | 3,425 (15.2) | 3,750 (16.7) | 4,330 (19.3) | 3,060 (13.6) | 3,425 (15.2) | 3,750 (16.7) | 4,330 (19.3) |
| | 3-3/8 (86) | 5,185 (23.1) | 5,800 (25.8) | 6,065 (27.0) | 6,245 (27.8) | 10,375 (46.1) | 11,600 (51.6) | 12,135 (54.0) | 12,490 (55.6) |
| | 4-1/2 (114) | 7,770 (34.6) | 7,945 (35.3) | 8,090 (36.0) | 8,325 (37.0) | 15,535 (69.1) | 15,885 (70.7) | 16,180 (72.0) | 16,650 (74.1) |
| | 7-1/2 (191) | 12,945 (57.6) | 13,240 (58.9) | 13,485 (60.0) | 13,875 (61.7) | 25,895 (115.2) | 26,480 (117.8) | 26,965 (119.9) | 27,755 (123.5) |
| 1/2 | 2-3/4 (70) | 3,815 (17.0) | 4,265 (19.0) | 4,670 (20.8) | 5,395 (24.0) | 7,630 (33.9) | 8,530 (37.9) | 9,345 (41.6) | 10,790 (48.0) |
| | 4-1/2 (114) | 7,985 (35.5) | 8,930 (39.7) | 9,780 (43.5) | 11,100 (49.4) | 15,970 (71.0) | 17,855 (79.4) | 19,560 (87.0) | 22,200 (98.8) |
| | 6 (152) | 12,295 (54.7) | 13,745 (61.1) | 14,380 (64.0) | 14,800 (65.8) | 24,590 (109.4) | 27,490 (122.3) | 28,765 (127.9) | 29,605 (131.7) |
| | 10 (254) | 23,015 (102.4) | 23,535 (104.7) | 23,970 (106.6) | 24,670 (109.7) | 46,035 (204.8) | 47,075 (209.4) | 47,940 (213.2) | 49,340 (219.5) |
| 5/8 | 3-1/8 (79) | 4,620 (20.6) | 5,165 (23.0) | 5,660 (25.2) | 6,535 (29.1) | 9,245 (41.1) | 10,335 (46.0) | 11,320 (50.4) | 13,070 (58.1) |
| | 5-5/8 (143) | 11,160 (49.6) | 12,480 (55.5) | 13,670 (60.8) | 15,785 (70.2) | 22,320 (99.3) | 24,955 (111.0) | 27,335 (121.6) | 31,565 (140.4) |
| | 7-1/2 (191) | 17,185 (76.4) | 19,210 (85.5) | 21,045 (93.6) | 23,125 (102.9) | 34,365 (152.9) | 38,420 (170.9) | 42,090 (187.2) | 46,255 (205.8) |
| | 12-1/2 (318) | 35,965 (160.0) | 36,775 (163.6) | 37,450 (166.6) | 38,545 (171.5) | 71,930 (320.0) | 73,550 (327.2) | 74,905 (333.2) | 77,090 (342.9) |
| 3/4 | 3-1/2 (89) | 5,480 (24.4) | 6,125 (27.2) | 6,710 (29.8) | 7,745 (34.5) | 10,955 (48.7) | 12,250 (54.5) | 13,420 (59.7) | 15,495 (68.9) |
| | 6-3/4 (171) | 14,670 (65.3) | 16,400 (73.0) | 17,970 (79.9) | 20,745 (92.3) | 29,340 (130.5) | 32,805 (145.9) | 35,935 (159.8) | 41,495 (184.6) |
| | 9 (229) | 22,585 (100.5) | 25,255 (112.3) | 27,665 (123.1) | 31,945 (142.1) | 45,175 (200.9) | 50,505 (224.7) | 55,325 (246.1) | 63,885 (284.2) |
| | 15 (381) | 48,600 (216.2) | 52,955 (235.6) | 53,930 (239.9) | 55,505 (246.9) | 97,200 (432.4) | 105,915 (471.1) | 107,865 (479.8) | 111,010 (493.8) |
| 7/8 | 3-1/2 (89) | 5,480 (24.4) | 6,125 (27.2) | 6,710 (29.8) | 7,745 (34.5) | 10,955 (48.7) | 12,250 (54.5) | 13,420 (59.7) | 15,495 (68.9) |
| | 7-7/8 (200) | 18,485 (82.2) | 20,670 (91.9) | 22,640 (100.7) | 26,145 (116.3) | 36,975 (164.5) | 41,340 (183.9) | 45,285 (201.4) | 52,290 (232.6) |
| | 10-1/2 (267) | 28,465 (126.6) | 31,820 (141.6) | 34,860 (155.1) | 40,255 (179.1) | 56,925 (253.2) | 63,645 (283.1) | 69,720 (310.1) | 80,505 (358.1) |
| | 17-1/2 (445) | 61,240 (272.4) | 68,470 (304.6) | 73,405 (326.5) | 75,550 (336.1) | 122,485 (544.8) | 136,940 (609.1) | 146,815 (653.1) | 151,100 (672.1) |
| 1 | 4 (102) | 6,690 (29.8) | 7,480 (33.3) | 8,195 (36.5) | 9,465 (42.1) | 13,385 (59.5) | 14,965 (66.6) | 16,395 (72.9) | 18,930 (84.2) |
| | 9 (229) | 22,585 (100.5) | 25,255 (112.3) | 27,665 (123.1) | 31,945 (142.1) | 45,175 (200.9) | 50,505 (224.7) | 55,325 (246.1) | 63,885 (284.2) |
| | 12 (305) | 34,775 (154.7) | 38,880 (172.9) | 42,590 (189.5) | 49,180 (218.8) | 69,550 (309.4) | 77,760 (345.9) | 85,180 (378.9) | 98,360 (437.5) |
| | 20 (508) | 74,825 (332.8) | 83,655 (372.1) | 91,640 (407.6) | 98,675 (438.9) | 149,650 (665.7) | 167,310 (744.2) | 183,280 (815.3) | 197,355 (877.9) |
| 1-1/4 | 5 (127) | 9,355 (41.6) | 10,455 (46.5) | 11,455 (51.0) | 13,225 (58.8) | 18,705 (83.2) | 20,915 (93.0) | 22,910 (101.9) | 26,455 (117.7) |
| | 11-1/4 (286) | 31,565 (140.4) | 35,290 (157.0) | 38,660 (172.0) | 44,640 (198.6) | 63,135 (280.8) | 70,585 (314.0) | 77,320 (343.9) | 89,285 (397.1) |
| | 15 (381) | 48,600 (216.2) | 54,335 (241.7) | 59,520 (264.8) | 68,730 (305.7) | 97,200 (432.4) | 108,670 (483.4) | 119,045 (529.5) | 137,460 (611.4) |
| | 25 (635) | 104,570 (465.1) | 116,910 (520.0) | 128,070 (569.7) | 147,885 (657.8) | 209,140 (930.3) | 233,825 (1040.1) | 256,140 (1139.4) | 295,765 (1315.6) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 42 - 55 as necessary to the above values. Compare to the steel values in table 81. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength (factored resistance) by 0.46.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51.
For all-lightweight, $\lambda_a$ = 0.45
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 84 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete / bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8,9]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (5,800 psi) lb (kN) |
| 3/8 | 2-3/8 (60) | 1,930 (8.6) | 1,975 (8.8) | 2,010 (8.9) | 2,070 (9.2) | 1,930 (8.6) | 1,975 (8.8) | 2,010 (8.9) | 2,070 (9.2) |
| | 3-3/8 (86) | 2,745 (12.2) | 2,805 (12.5) | 2,855 (12.7) | 2,940 (13.1) | 5,485 (24.4) | 5,610 (24.9) | 5,710 (25.4) | 5,880 (26.1) |
| | 4-1/2 (114) | 3,655 (16.3) | 3,740 (16.6) | 3,810 (16.9) | 3,920 (17.4) | 7,315 (32.5) | 7,480 (33.3) | 7,615 (33.9) | 7,840 (34.9) |
| | 7-1/2 (191) | 6,095 (27.1) | 6,230 (27.7) | 6,345 (28.2) | 6,530 (29.1) | 12,190 (54.2) | 12,465 (55.4) | 12,695 (56.5) | 13,065 (58.1) |
| 1/2 | 2-3/4 (70) | 2,670 (11.9) | 2,985 (13.3) | 3,270 (14.5) | 3,470 (15.4) | 5,340 (23.8) | 5,970 (26.6) | 6,540 (29.1) | 6,935 (30.9) |
| | 4-1/2 (114) | 5,295 (23.6) | 5,415 (24.1) | 5,515 (24.5) | 5,675 (25.2) | 10,590 (47.1) | 10,830 (48.2) | 11,030 (49.1) | 11,350 (50.5) |
| | 6 (152) | 7,060 (31.4) | 7,220 (32.1) | 7,355 (32.7) | 7,565 (33.7) | 14,120 (62.8) | 14,440 (64.2) | 14,705 (65.4) | 15,135 (67.3) |
| | 10 (254) | 11,770 (52.3) | 12,035 (53.5) | 12,255 (54.5) | 12,610 (56.1) | 23,535 (104.7) | 24,065 (107.1) | 24,510 (109.0) | 25,225 (112.2) |
| 5/8 | 3-1/8 (79) | 3,235 (14.4) | 3,615 (16.1) | 3,960 (17.6) | 4,575 (20.4) | 6,470 (28.8) | 7,235 (32.2) | 7,925 (35.2) | 9,150 (40.7) |
| | 5-5/8 (143) | 7,810 (34.8) | 8,720 (38.8) | 8,880 (39.5) | 9,140 (40.7) | 15,625 (69.5) | 17,445 (77.6) | 17,765 (79.0) | 18,285 (81.3) |
| | 7-1/2 (191) | 11,370 (50.6) | 11,630 (51.7) | 11,845 (52.7) | 12,190 (54.2) | 22,745 (101.2) | 23,260 (103.5) | 23,685 (105.4) | 24,375 (108.4) |
| | 12-1/2 (318) | 18,955 (84.3) | 19,380 (86.2) | 19,740 (87.8) | 20,315 (90.4) | 37,910 (168.6) | 38,765 (172.4) | 39,475 (175.6) | 40,630 (180.7) |
| 3/4 | 3-1/2 (89) | 3,835 (17.1) | 4,285 (19.1) | 4,695 (20.9) | 5,425 (24.1) | 7,670 (34.1) | 8,575 (38.1) | 9,390 (41.8) | 10,845 (48.2) |
| | 6-3/4 (171) | 10,270 (45.7) | 11,480 (51.1) | 12,575 (55.9) | 14,175 (63.1) | 20,540 (91.4) | 22,965 (102.1) | 25,155 (111.9) | 28,355 (126.1) |
| | 9 (229) | 15,810 (70.3) | 17,675 (78.6) | 18,365 (81.7) | 18,900 (84.1) | 31,620 (140.7) | 35,355 (157.3) | 36,730 (163.4) | 37,805 (168.2) |
| | 15 (381) | 29,395 (130.7) | 30,055 (133.7) | 30,610 (136.2) | 31,505 (140.1) | 58,785 (261.5) | 60,115 (267.4) | 61,220 (272.3) | 63,005 (280.3) |
| 7/8 | 3-1/2 (89) | 3,835 (17.1) | 4,285 (19.1) | 4,695 (20.9) | 5,425 (24.1) | 7,670 (34.1) | 8,575 (38.1) | 9,390 (41.8) | 10,845 (48.2) |
| | 7-7/8 (200) | 12,940 (57.6) | 14,470 (64.4) | 15,850 (70.5) | 18,300 (81.4) | 25,880 (115.1) | 28,935 (128.7) | 31,700 (141.0) | 36,605 (162.8) |
| | 10-1/2 (267) | 19,925 (88.6) | 22,275 (99.1) | 24,400 (108.5) | 26,340 (117.2) | 39,850 (177.3) | 44,550 (198.2) | 48,805 (217.1) | 52,680 (234.3) |
| | 17-1/2 (445) | 40,960 (182.2) | 41,885 (186.3) | 42,655 (189.7) | 43,900 (195.3) | 81,920 (364.4) | 83,770 (372.6) | 85,310 (379.5) | 87,800 (390.6) |
| 1 | 4 (102) | 4,685 (20.8) | 5,240 (23.3) | 5,740 (25.5) | 6,625 (29.5) | 9,370 (41.7) | 10,475 (46.6) | 11,475 (51.0) | 13,250 (58.9) |
| | 9 (229) | 15,810 (70.3) | 17,675 (78.6) | 19,365 (86.1) | 22,360 (99.5) | 31,620 (140.7) | 35,355 (157.3) | 38,730 (172.3) | 44,720 (198.9) |
| | 12 (305) | 24,340 (108.3) | 27,215 (121.1) | 29,815 (132.6) | 34,425 (153.1) | 48,685 (216.6) | 54,430 (242.1) | 59,625 (265.2) | 68,850 (306.3) |
| | 20 (508) | 52,375 (233.0) | 56,190 (249.9) | 57,225 (254.5) | 58,895 (262.0) | 104,755 (466.0) | 112,380 (499.9) | 114,450 (509.1) | 117,790 (524.0) |
| 1-1/4 | 5 (127) | 6,545 (29.1) | 7,320 (32.6) | 8,020 (35.7) | 9,260 (41.2) | 13,095 (58.2) | 14,640 (65.1) | 16,035 (71.3) | 18,520 (82.4) |
| | 11-1/4 (286) | 22,095 (98.3) | 24,705 (109.9) | 27,060 (120.4) | 31,250 (139.0) | 44,195 (196.6) | 49,410 (219.8) | 54,125 (240.8) | 62,500 (278.0) |
| | 15 (381) | 34,020 (151.3) | 38,035 (169.2) | 41,665 (185.3) | 48,110 (214.0) | 68,040 (302.7) | 76,070 (338.4) | 83,330 (370.7) | 96,220 (428.0) |
| | 25 (635) | 73,200 (325.6) | 81,840 (364.0) | 89,650 (398.8) | 95,845 (426.3) | 146,395 (651.2) | 163,675 (728.1) | 179,300 (797.6) | 191,685 (852.7) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 42 - 55 as necessary to the above values. Compare to the steel values in table 81. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.82.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry and water saturated concrete conditions. For water-filled concrete multiply design strength (factored resistance) by 0.46.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by la as follows: For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors:
3/8-in diameter - $\alpha_{seis}$ = 0.66, 1/2-in, 5/8-in, and 1-1/4-in diameter - $\alpha_{seis}$ = 0.74, 3/4-in and 7/8-in diameter - $\alpha_{seis}$ = 0.75
See section 3.1.8 for additional information on seismic applications.

## HIT-HY 200 A/R V3 Adhesive with Hilti HIS-N and HIS-RN internally threaded inserts



### Table 85 — Steel factored resistance for steel bolt/cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

| Thread size | ASTM A193 B7 | | | ASTM A193 Grade B8M Stainless Steel | | |
|---|---|---|---|---|---|---|
| | Tensile[4] $N_{sar}$ lb (kN) | Shear[5] $V_{sar}$ lb (kN) | Seismic Shear[6] $V_{sar,eq}$ lb (kN) | Tensile[4] $N_{sar}$ lb (kN) | Shear[5] $V_{sar}$ lb (kN) | Seismic Shear[6] $V_{sar,eq}$ lb (kN) |
| 3/8-16 UNC | 5,765 (25.6) | 3,215 (14.3) | 2,250 (10.0) | 5,070 (22.6) | 2,825 (12.6) | 1,975 (8.8) |
| 1/2-13 UNC | 9,635 (42.9) | 5,880 (26.2) | 4,115 (18.3) | 9,290 (41.3) | 5,175 (23.0) | 3,620 (16.1) |
| 5/8-11 UNC | 16,020 (71.3) | 9,365 (41.7) | 6,555 (29.2) | 14,790 (65.8) | 8,240 (36.7) | 5,770 (25.7) |
| 3/4-10 UNC | 16,280 (72.4) | 13,860 (61.7) | 9,700 (43.1) | 21,895 (97.4) | 12,195 (54.2) | 8,535 (38.0) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Hilti HIS-N and HIS-RN inserts with steel bolts are considered brittle steel elements.
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.
4 Tensile = $A_{se,N}$ $\phi_s$ $f_{uta}$ R as noted in CSA A23.3 Annex D.
5 Shear = $A_{se,V}$ $\phi_s$ 0.60 $f_{uta}$ R as noted in CSA A23.3 Annex D. For 3/8-in diameter insert, shear = $A_{se,V}$ $\phi_s$ 0.50 $f_{uta}$ R.
6 Seismic Shear = $\alpha_{V,seis}$ $V_{sar}$ : Reduction factor for seismic shear only. See section 3.1.8 for additional information on seismic applications.

### Table 86 — Hilti HIT-HY 200 A/R V3 design information with Hilti HIS-N and HIS-RN internally threaded inserts in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Nominal bolt/cap screw diameter (in.) | | | | Ref |
|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | A23.3-14 |
| HIS insert outside diameter | | D | mm | 16.5 | 20.5 | 25.4 | 27.6 | |
| Effective embedment[2] | | $h_{ef}$ | mm | 110 | 125 | 170 | 205 | |
| Minimum concrete thickness[2] | | $h_{min}$ | mm | 150 | 170 | 230 | 270 | |
| Critical edge distance | | $c_{ac}$ | – | $2h_{ef}$ | | | | |
| Minimum edge distance | | $c_{min}$ | mm | 83 | 102 | 127 | 140 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 83 | 102 | 127 | 140 | |
| Coeff. for factored concrete breakout resistance, uncracked concrete[3] | | $k_{c,uncr}$ | – | 10 | | | | D.6.2.2 |
| Coeff. for factored concrete breakout resistance, cracked concrete[3] | | $k_{c,cr}$ | – | 7 | | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_c$ | – | 0.65 | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[4] | | $R_{conc}$ | – | 1.00 | | | | D.5.3 (c ) |
| Temp range A[5] | Characteristic pullout resistance in cracked concrete[6] | $\tau_{cr}$ | psi (MPa) | 870 (6.0) | 890 (6.1) | 910 (6.3) | 920 (6.3) | D.6.5.2 |
| | Characteristic pullout resistance in uncracked concrete[6] | $\tau_{uncr}$ | psi (MPa) | 1,950 (13.4) | 1,950 (13.4) | 1,950 (13.4) | 1,950 (13.4) | D.6.5.2 |
| Temp range B[5] | Characteristic pullout resistance in cracked concrete[6] | $\tau_{cr}$ | psi (MPa) | 870 (6.0) | 890 (6.1) | 910 (6.3) | 92 (0.6) | D.6.5.2 |
| | Characteristic pullout resistance in uncracked concrete[6] | $\tau_{uncr}$ | psi (MPa) | 1,950 (13.4) | 1,950 (13.4) | 1,950 (13.4) | 1,950 (13.4) | D.6.5.2 |
| Temp range C[5] | Characteristic pullout resistance in cracked concrete[6] | $\tau_{cr}$ | psi (MPa) | 715 (4.9) | 730 (5.0) | 750 (5.2) | 755 (5.2) | D.6.5.2 |
| | Characteristic pullout resistance in uncracked concrete[6] | $\tau_{uncr}$ | psi (MPa) | 1,600 (11.0) | 1,600 (11.0) | 1,600 (11.0) | 1,600 (11.0) | D.6.5.2 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | – | 0.92 | | | | |
| Permissible installation conditions | Resistance modification factor tension and shear, pullout failure dry concrete | Anch cat | – | 1 | | | | D.5.3 (c ) |
| | | $R_{dry}$ | – | 1.00 | | | | |
| | Resistance modification factor tension and shear, pullout failure water-saturated concrete | Anch cat | – | 1 | | | | D.5.3 (c ) |
| | | $R_{ws}$ | – | 1.0 | | | | |

1 Design information in this table is taken from ELC-4868, tables 19 and 20, for use with CSA A23.3 Annex D.
2 See figure 13 of this section.
3 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

## Table 87 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8,9]

| Thread size | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8-16 UNC | 4-3/8 (110) | 7,540 (33.5) | 8,430 (37.5) | 9,235 (41.1) | 10,660 (47.4) | 15,080 (67.1) | 16,860 (75.0) | 18,470 (82.1) | 21,325 (94.9) |
| 1/2-13 UNC | 5 (125) | 9,135 (40.6) | 10,210 (45.4) | 11,185 (49.8) | 12,915 (57.5) | 18,265 (81.3) | 20,420 (90.8) | 22,370 (99.5) | 25,830 (114.9) |
| 5/8-11 UNC | 6-3/4 (170) | 14,485 (64.4) | 16,195 (72.0) | 17,740 (78.9) | 20,485 (91.1) | 28,970 (128.9) | 32,390 (144.1) | 35,480 (157.8) | 40,970 (182.2) |
| 3/4-10 UNC | 8-1/8 (205) | 19,180 (85.3) | 21,445 (95.4) | 23,490 (104.5) | 27,125 (120.7) | 38,360 (170.6) | 42,890 (190.8) | 46,985 (209.0) | 54,255 (241.3) |

## Table 88 — Hilti HIT-HY 200 A/R V3 adhesive factored resistance with concrete/bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9]

| Thread size | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8-16 UNC | 4-3/8 (110) | 5,235 (23.3) | 5,595 (24.9) | 5,910 (26.3) | 6,445 (28.7) | 10,470 (46.6) | 11,190 (49.8) | 11,820 (52.6) | 12,885 (57.3) |
| 1/2-13 UNC | 5 (125) | 6,395 (28.4) | 7,150 (31.8) | 7,830 (34.8) | 9,040 (40.2) | 12,785 (56.9) | 14,295 (63.6) | 15,660 (69.7) | 18,080 (80.4) |
| 5/8-11 UNC | 6-3/4 (170) | 10,140 (45.1) | 11,335 (50.4) | 12,420 (55.2) | 14,340 (63.8) | 20,280 (90.2) | 22,675 (100.9) | 24,835 (110.5) | 28,680 (127.6) |
| 3/4-10 UNC | 8-1/8 (205) | 13,425 (59.7) | 15,010 (66.8) | 16,445 (73.1) | 18,990 (84.5) | 26,855 (119.5) | 30,025 (133.5) | 32,890 (146.3) | 37,975 (168.9) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 60 - 61 as necessary to the above values. Compare to the steel values in table 85. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.92.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above values by 0.78.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength value by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors:
For all insert diameters - $\alpha_{seis}$ = 0.69
See section 3.1.8 for additional information on seismic applications.

# POST-INSTALLED REBAR DESIGN IN CONCRETE PER ACI 318





## Development and splicing of post-installed reinforcement

Calculations for post-installed rebar for typical development lengths may be done according to ACI 318 Chapter 25 (formerly ACI 318-11 Chapter 12) and CSA A23.3 Chapter 12 for adhesive anchors tested and approved in accordance with AC 308. This section contains tables for the data provided in ICC Evaluation Services ESR-4868. Refer to section 3.1.14 and the Hilti North America Post-Installed Reinforcing Bar Guide for the design method.

**Table 89 — Calculated tension development and Class B splice lengths for Grade 60 bars in walls, slabs, columns, and footings per ACI 318 Chapter 25 for Hilti HIT-HY 200 A/R V3 — SDC A and B only[3,4,5,6,7,8]**

| Rebar size | System | | $\frac{c_b + K_{tr}}{d_b}$ | Minimum edge dist. in.[1] | Minimum spacing in.[2] | $f'_c$ = 2,500 psi | | $f'_c$ = 3,000 psi | | $f'_c$ = 4,000 psi | | $f'_c$ = 6,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HIT-HY 200-A V3 | HIT-HY 200-R V3 | | | | $\ell_d$ in. | Class B splice in. | $\ell_d$ in. | Class B splice in. | $\ell_d$ in. | Class B splice in. | $\ell_d$ in. | Class B splice in. |
| #3 | ◐ | ◐ | 2.5 | 2-1/4 | 2 | 12 | 14 | 12 | 13 | 12 | 12 | 12 | 12 |
| #4 | ◐ | ◐ | | 2-3/4 | 2-1/2 | 14 | 19 | 13 | 17 | 12 | 15 | 12 | 12 |
| #5 | ◐ | ◐ | | 3 | 3-1/4 | 18 | 23 | 16 | 21 | 14 | 18 | 12 | 15 |
| #6 | ■ | ◐ | | 3-3/4 | 3-3/4 | 22 | 28 | 20 | 26 | 17 | 22 | 14 | 18 |
| #7 | ■ | ◐ | | 4-1/2 | 4-1/2 | 32 | 41 | 29 | 37 | 25 | 32 | 20 | 26 |
| #8 | ■ | ◐ | | 5 | 5 | 36 | 47 | 33 | 43 | 28 | 37 | 23 | 30 |
| #9 | ■ | ◐ | | 5-1/4 | 5-3/4 | 41 | 53 | 37 | 48 | 32 | 42 | 26 | 34 |
| #10 | ■ | ◐ | | 5-3/4 | 6-1/2 | 46 | 59 | 42 | 54 | 36 | 47 | 30 | 38 |

◐ Applicable for use with special installation provisions and installation temperature restrictions to account for short gel time with deep embedment depth. See the Instruction For Use (IFU), packaged with the product for special installation parameters.

■ Not recommended due to limited gel time of adhesive.

1 Edge distances are determined using the minimum cover specified by ESR-4868 with an additional 6% of the development length per suggestions for drilling without an aid per Hilti Post-Installed Reinforcing Bar Guide Section 3.3. Smaller edge distances may be possible, for which development and splice lengths may need to be recalculated. For further information on required cover see ACI 318, Sec. 20.6.1.3; see Sec. 2.2 for determination of $c_b$.

2 Spacing values represent those producing $c_b$ =5 $d_b$ rounded up to the nearest 1/4 in. Smaller spacing values may be possible, for which development and splice lengths may need to be recalculated. For further information on required spacing see ACI 318 Sec. 25.2; see Sec. 2.2 for determination of $c_b$.

3 $\psi_t$ = 1.0 See ACI 318, Sec. 25.4.2.4.

4 $\psi_e$ = 1.0 for non-epoxy coated bars. See ACI 318, Sec. 25.4.2.4.

5 $\psi_s$ = 0.8 for #6 bars and smaller bars, 1.0 for #7 and larger bars. See ACI 318, Sec. 25.4.2.4.

6 Values are for normal weight concrete. For sand-lightweight concrete, multiply development and splice lengths by 1.18, for all-lightweight concrete multiply development and splice lengths by 1.33. See ACI 318 Sec. 19.2.4.

7 Development and splice length values are for static design. Seismic design development and splice lengths can be found in ACI 318 18.8.5 for special moment frames and ACI 318 18.10.2.3 for special structural walls. For further information about reinforcement in seismic design, see ACI 318 Ch. 18.

8 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples.

## Table 90 — Suggested embedment, edge distance, and spacing (see figure below) to develop 125% of $f_y$ in Grade 60 bars based on ACI 318 Chapter 17 - SDC A and B only[1,2,3,4,5,6,7]

| Rebar size | $f'_c$ = 2,500 psi | | | | $f'_c$ = 3,000 psi | | | | $f'_c$ = 4,000 psi | | | | $f'_c$ = 6,000 psi | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing $s_{min}$ in. | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing $s_{min}$ in. | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing $s_{min}$ in. | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing $s_{min}$ in. |
| | | Cond. I | Cond. II | | | Cond. I | Cond. II | | | Cond. I | Cond. II | | | Cond. I | Cond. II | |
| #3 | 7 | 18 | 8 | 15 | 7 | 18 | 7 | 14 | 7 | 18 | 7 | 13 | 7 | 17 | 6 | 11 |
| #4 | 10 | 25 | 11 | 22 | 10 | 25 | 11 | 21 | 9 | 24 | 10 | 19 | 9 | 24 | 9 | 17 |
| #5 | 12 | 31 | 15 | 29 | 12 | 31 | 14 | 28 | 12 | 30 | 13 | 25 | 11 | 29 | 11 | 22 |
| #6 | 14 | 37 | 19 | 37 | 14 | 36 | 18 | 35 | 14 | 36 | 16 | 32 | 13 | 35 | 14 | 28 |
| #7 | 17 | 43 | 23 | 45 | 16 | 42 | 22 | 43 | 16 | 41 | 20 | 39 | 15 | 40 | 17 | 34 |
| #8 | 19 | 49 | 27 | 54 | 19 | 49 | 26 | 51 | 18 | 48 | 23 | 47 | 18 | 47 | 21 | 41 |
| #9 | 21 | 55 | 32 | 63 | 21 | 54 | 30 | 60 | 20 | 54 | 27 | 54 | 20 | 52 | 24 | 48 |
| #10 | 25 | 65 | 37 | 74 | 24 | 62 | 35 | 70 | 23 | 60 | 32 | 64 | 22 | 59 | 28 | 56 |

1 For additional information see May-June 2013 issue of the ACI Structural Journal, “Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures” by Charney, Pal and Silva.
2 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Additional reductions per ACI 318, 17.3.1.2 for sustained loading conditions are not included and as such these suggested embedments are not intended for sustained tension load applications. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the unbolded and bolded tabulated hef values by 0.80 and 0.86, respectively. Reduction factors for non-sustained loading and no bar overstrength may be combined.
3 $c_a$ and s are the minimum edge distance and bar spacing (from bar centerline) associated with the tabulated embedments. Refer to sec. 3.1.14 for applicability of edge distance “Condition I” and “Condition II.”
4 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.
5 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868 Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.
6 Values are for normal weight concrete. For lightweight concrete contact Hilti.
7 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

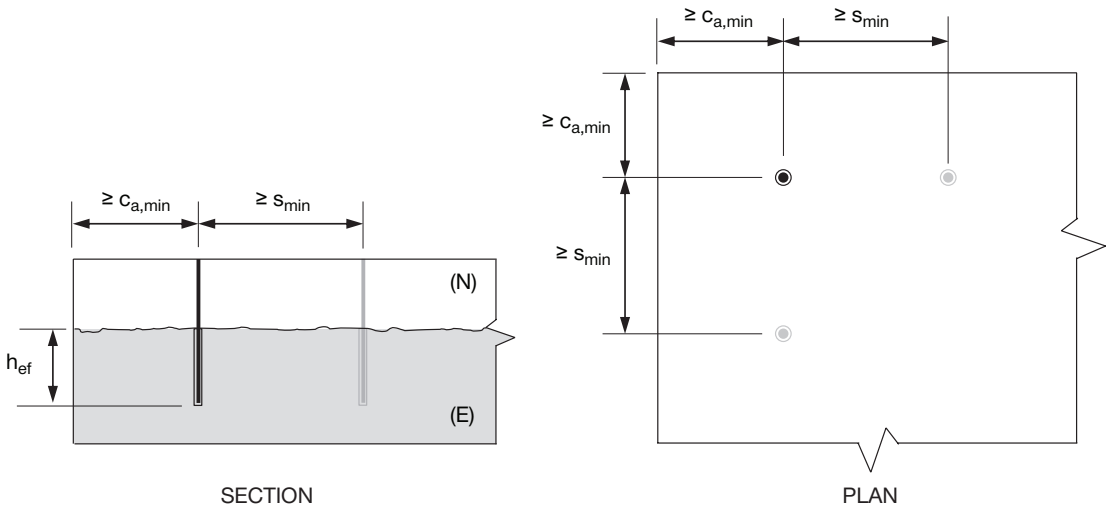



Illustration of Table 90 dimensions

**Table 91 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of $f_y$ in Grade 60 wall/column starter bars in a linear array with bar spacing = 24 inches - SDC A and B only[1,2,3,4,5,6]**

| Rebar size | Linear spacing s in. | $f'_c$ = 2,500 psi | | | $f'_c$ = 3,000 psi | | | $f'_c$ = 4,000 psi | | | $f'_c$ = 6,000 psi | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | |
| | | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II |
| #3 | 24 | 7 | 18 | 8 | 7 | 18 | 7 | 7 | 18 | 7 | 7 | 17 | 6 |
| #4 | | 10 | 25 | 12 | 10 | 25 | 11 | 9 | 24 | 10 | 9 | 24 | 9 |
| #5 | | 13 | 33 | 19 | 12 | 31 | 17 | 12 | 30 | 15 | 11 | 29 | 12 |
| #6 | | 21 | 55 | 32 | 19 | 49 | 28 | 15 | 40 | 23 | 13 | 35 | 18 |
| #7 | | 32 | 83 | 47 | 28 | 75 | 42 | 23 | 62 | 35 | 18 | 48 | 26 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated $h_{ef}$ values by 0.86.

2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 24 in. Refer to sec. 3.1.14 for applicability of edge distance "Condition I" and "Condition II."

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-] Tables 12 and 13 assuming dry concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for detailed explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

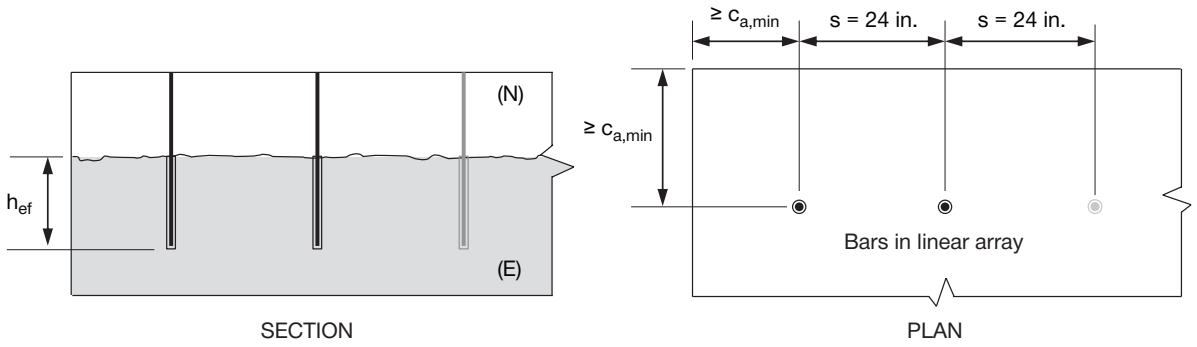



Illustration of Table 91 dimensions

**Table 92 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of $f_y$ in Grade 60 wall/column starter bars in a linear array with bar spacing = 18 inches - SDC A and B only[1,2,3,4,5,6]**

| Rebar size | Linear spacing s in. | $f'_c$ = 2,500 psi | | | $f'_c$ = 3,000 psi | | | $f'_c$ = 4,000 psi | | | $f'_c$ = 6,000 psi | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | |
| | | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II |
| #3 | 18 | 7 | 18 | 8 | 7 | 18 | 7 | 7 | 18 | 7 | 7 | 17 | 6 |
| #4 | | 10 | 25 | 14 | 10 | 25 | 13 | 9 | 24 | 12 | 9 | 24 | 10 |
| #5 | | 18 | 47 | 27 | 16 | 41 | 24 | 13 | 34 | 19 | 11 | 29 | 15 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated $h_{ef}$ values by 0.86.
2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 18 in. Refer to sec. 3.1.14 for applicability of edge distance “Condition I” and “Condition II.”
3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.
4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.
5 Values are for normal weight concrete. For lightweight concrete contact Hilti.
6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for detailed explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

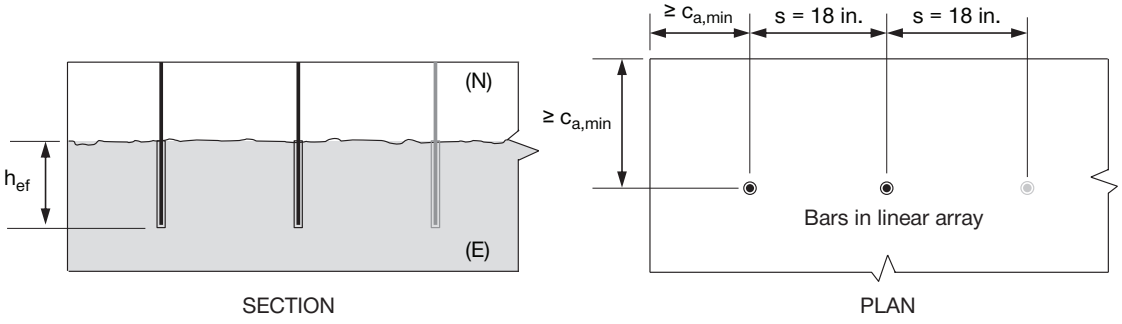



Illustration of Table 92 dimensions

**Table 93 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of $f_y$ in Grade 60 wall/column starter bars in a linear array with bar spacing = 12 inches - SDC A and B only[1,2,3,4,5,6]**

| Rebar size | Linear spacing s in. | $f'_c$ = 2,500 psi | | | $f'_c$ = 3,000 psi | | | $f'_c$ = 4,000 psi | | | $f'_c$ = 6,000 psi | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | |
| | | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II |
| #3 | 12 | 7 | 18 | 10 | 7 | 18 | 9 | 7 | 18 | 8 | 7 | 17 | 7 |
| #4 | | – | – | – | 13 | 35 | 20 | 11 | 29 | 16 | 9 | 24 | 13 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated $h_{ef}$ values by 0.86.
2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 12 in. Refer to sec. 3.1.14 for applicability of edge distance "Condition I" and "Condition II."
3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.
4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.
5 Values are for normal weight concrete. For lightweight concrete contact Hilti.
6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

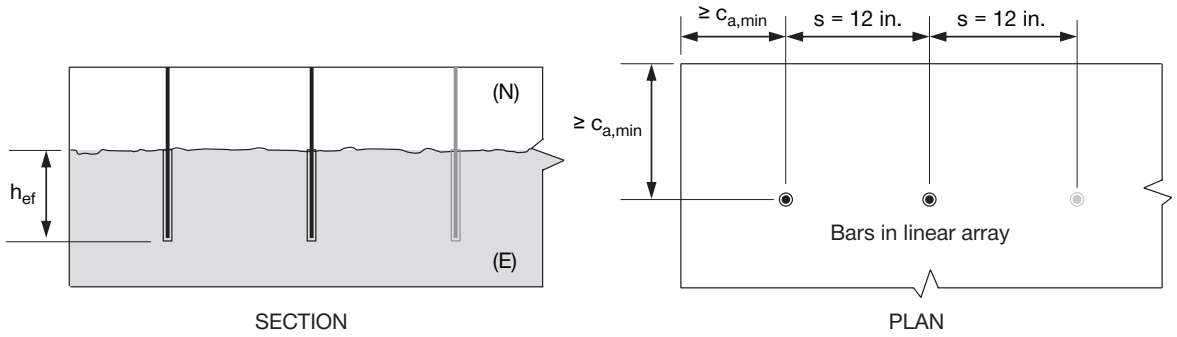



Illustration of Table 93 dimensions

## Table 94 — Calculated tension development and splice lengths for Canadian 400 MPa bars in walls, slabs, columns, and footings per CSA A23.3 for Hilti HIT-HY 200 A/R V3 — non-seismic design only[3,4,5,6,7,8]

| Rebar size | System | | $d_{cs} + K_{tr}$ | Minimum edge dist. mm[1] | Minimum spacing mm[2] | $f'_c$ = 20 MPa | | $f'_c$ = 25 MPa | | $f'_c$ = 30 MPa | | $f'_c$ = 40 MPa | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HIT-HY 200-A V3 | HIT-HY 200-R V3 | | | | $\ell_d$ mm | Class B splice mm | $\ell_d$ mm | Class B splice mm | $\ell_d$ mm | Class B splice mm | $\ell_d$ mm | Class B splice mm |
| 10M | ◐ | ◐ | $2.5d_b$ | 60 | 50 | 300 | 380 | 300 | 340 | 300 | 310 | 300 | 300 |
| 15M | ◐ | ◐ | | 70 | 75 | 410 | 540 | 370 | 480 | 340 | 440 | 300 | 380 |
| 20M | ◐ | ◐ | | 80 | 100 | 510 | 660 | 450 | 590 | 410 | 540 | 360 | 460 |
| 25M | ■ | ◐ | | 120 | 125 | 820 | 1,060 | 730 | 950 | 670 | 870 | 580 | 750 |
| 30M | ■ | ◐ | | 130 | 150 | 960 | 1,250 | 860 | 1,120 | 790 | 1,020 | 680 | 890 |

◐ Applicable for use with special installation provisions and installation temperature restrictions to account for short gel time with deep embedment depth. See Instructions for Use (IFU) for special installation parameters.

■ Not recommended due to limited gel time of adhesive.

1 Edge distances are determined using the minimum cover specified by ESR-4868 with an additional 6% of the development length per suggestions for drilling without an aid per Hilti Post-Installed Reinforcing Bar Guide Section 3.3. Smaller edge distances may be possible, for which development and splice lengths may need to be recalculated. For further information on required cover see CSA A23.1-14 Table 17; see Sec. 3.2 for determination of $d_{cs}$.

2 Spacing values represent those producing $c_b$ $5d_b$. Smaller spacing values may be possible, for which development and splice lengths may need to be recalculated. For further information on required spacing see CSA A23.1 Sec. 6.6.5.2; see Sec. 3.2 for determination of $d_{cs}$.

3 $k_1$ and $k_2$ as defined by CSA A23.3 12.2.4 (a) and (b), are taken as 1.0 for post-installed reinforcing bars. For additional information see May-June 2013 issue of the ACI Structural Journal, "Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures" by Charney, Pal and Silva.

4 $k_3$ = 0.8 for 20M bars and smaller bars, 1.0 for 25M and larger bars. See CSA A23.3 12.2.4 (d).

5 $K_{tr}$ is assumed to equal zero.

6 Values are for normal weight concrete. For lightweight concrete, multiply development and splice lengths by 1.3.

7 Development and splice length values are for static design. For tension development and splice lengths of bars in joints, see CSA A23.3 21.3.3.5. For further information about reinforcement in seismic design, see CSA A23.3 Ch. 21.

8 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples.

## Table 95 — Suggested embedment, edge distance, and spacing (see figure below) to develop 125% of $f_y$ in Canadian 400 MPa bars based on CSA A23.3 Annex D — non-seismic design only[1,2,3,4,5,6,7]

| Rebar size | $f'_c$ = 20 MPa | | | | $f'_c$ = 25 MPa | | | | $f'_c$ = 30 MPa | | | | $f'_c$ = 40 MPa | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Min. spacing $s_{min}$ mm | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Min. spacing $s_{min}$ mm | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Min. spacing $s_{min}$ mm | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Min. spacing $s_{min}$ mm |
| | | Cond. I | Cond. II | | | Cond. I | Cond. II | | | Cond. I | Cond. II | | | Cond. I | Cond. II | |
| 10M | 200 | 520 | 220 | 440 | 200 | 510 | 200 | 400 | 200 | 510 | 190 | 380 | 190 | 500 | 180 | 350 |
| 15M | 280 | 740 | 350 | 690 | 280 | 730 | 320 | 640 | 270 | 720 | 300 | 600 | 270 | 710 | 280 | 550 |
| 20M | 350 | 910 | 450 | 900 | 340 | 890 | 420 | 840 | 330 | 880 | 400 | 790 | 320 | 870 | 360 | 720 |
| 25M | 450 | 1,170 | 630 | 1,260 | 440 | 1,150 | 590 | 1,170 | 430 | 1,140 | 560 | 1,110 | 420 | 1,120 | 500 | 1,000 |
| 30M | 530 | 1,390 | 790 | 1,580 | 520 | 1,360 | 740 | 1,470 | 510 | 1,350 | 690 | 1,380 | 490 | 1,320 | 630 | 1,260 |

1 For additional information see May-June 2013 issue of the ACI Structural Journal, “Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures” by Charney, Pal and Silva.

2 $h_{ef}$ is the calculated bar embedment uncracked based on bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Additional reductions per ACI 318 17.3.1.2 for sustained loading conditions are not included and as such these suggested embedments are not intended for sustained tension load applications. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the unbolded and bolded tabulated $h_{ef}$ values by 0.80 and 0.86, respectively.

3 $c_a$ and s are the minimum edge distance and bar spacing (from bar centerline) associated with the tabulated embedments. Refer to sec. 3.1.14 for applicability of edge distance “Condition I” and “Condition II.”

4 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

5 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868 Tables 20 and 21 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

6 Values are for normal weight concrete. For lightweight concrete contact Hilti.

7 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

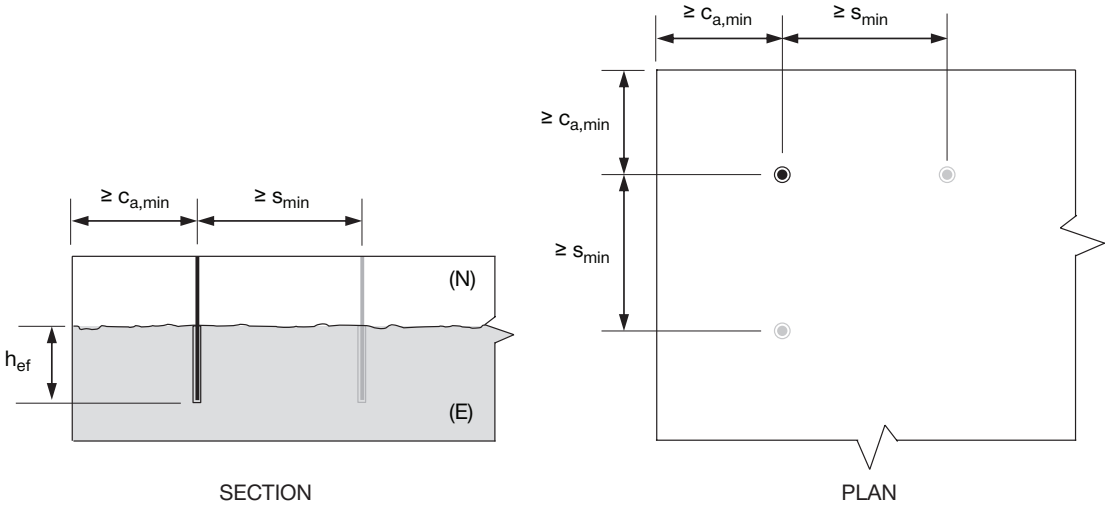



Illustration of Table 95 dimensions

## Table 96 — Suggested embedment and edge distance (see figure below) based on CSA A23.3 Annex D to develop 125% of $f_y$ in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 600 millimeters - non-seismic design only[1,2,3,4,5,6]

| Rebar size | Linear spacing s mm | $f'_c$ = 20 MPa | | | $f'_c$ = 25 MPa | | | $f'_c$ = 30 MPa | | | $f'_c$ = 40 MPa | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | |
| | | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II |
| 10M | 600 | 200 | 520 | 220 | 200 | 510 | 200 | 200 | 510 | 190 | 190 | 500 | 180 |
| 15M | | 280 | 740 | 420 | 280 | 730 | 350 | 270 | 720 | 300 | 270 | 710 | 280 |
| 20M | | 510 | 1,340 | 760 | 430 | 1,150 | 650 | 380 | 1,010 | 570 | 320 | 870 | 460 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated $h_{ef}$ values by 0.86.

2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 600 mm. Refer to sec. 3.1.14 for applicability of edge distance "Condition I" and "Condition II."

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

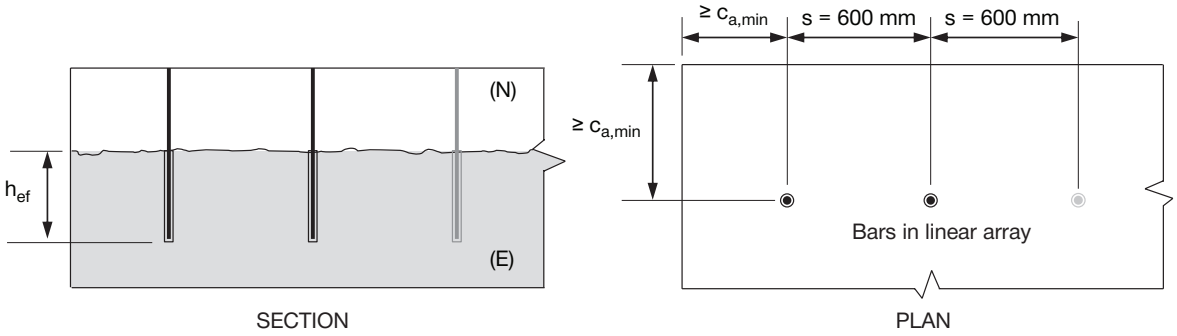



Illustration of Table 96 dimensions

**Table 97 — Suggested embedment and edge distance (see figure below) based on CSA A23.3 Annex D to develop 125% of $f_y$ in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 450 millimeters - non-seismic design only[1,2,3,4,5,6]**

| Rebar size | Linear spacing s mm | $f'_c$ = 20 MPa | | | $f'_c$ = 25 MPa | | | $f'_c$ = 30 MPa | | | $f'_c$ = 40 MPa | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | |
| | | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II |
| 10M | 450 | 200 | 520 | 220 | 200 | 510 | 200 | 200 | 510 | 190 | 190 | 500 | 180 |
| 15M | | 390 | 1,040 | 590 | 340 | 890 | 500 | 300 | 790 | 440 | 270 | 710 | 360 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated $h_{ef}$ values by 0.86.

2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 450 mm. Refer to sec. 3.1.14 for applicability of edge distance "Condition I" and "Condition II."

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868 Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

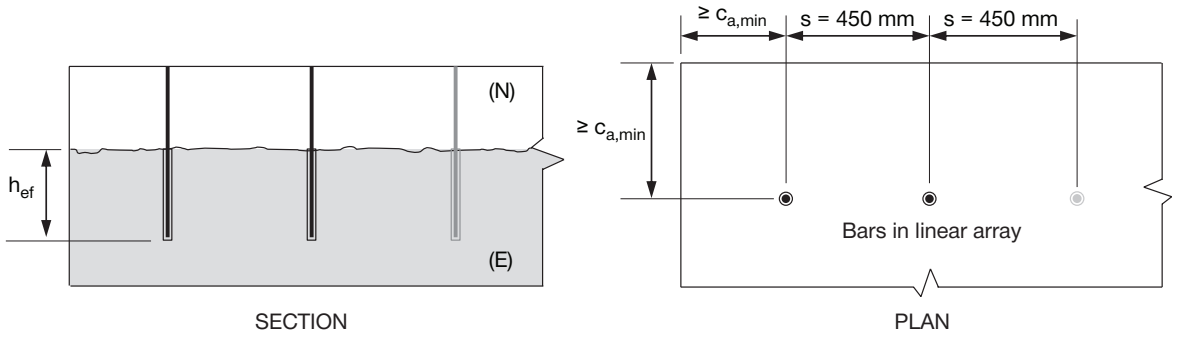



Illustration of Table 97 dimensions

## Table 98 — Suggested embedment and edge distance (see figure below) based on CSA A23.3 Annex D to develop 125% of $f_y$ in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 300 millimeters - non-seismic design only[1,2,3,4,5,6]

| Rebar size | Linear spacing s mm | $f'_c$ = 20 MPa | | | $f'_c$ = 25 MPa | | | $f'_c$ = 30 MPa | | | $f'_c$ = 40 MPa | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | |
| | | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II |
| 10M | 300 | 240 | 610 | 350 | 200 | 520 | 300 | 200 | 510 | 260 | 190 | 500 | 210 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 300 mm. Refer to sec. 3.1.14 for applicability of edge distance "Condition I" and "Condition II."

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-4868 Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

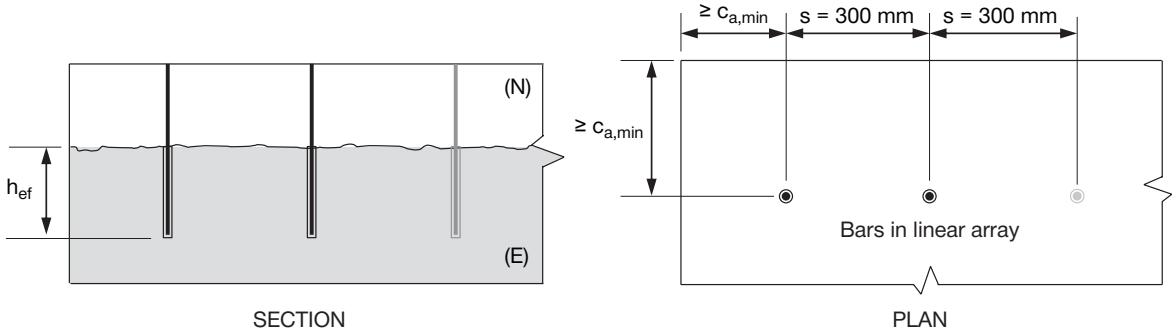



Illustration of Table 98 dimensions

# DESIGN DATA IN MASONRY

**Hilti HIT-HY 200 A/R V3 adhesive in grout-filled CMU with Hilti HAS threaded rod , Deformed Reinforcing Bar (Rebar), and Hilti HIT-Z(-R) anchor rods**

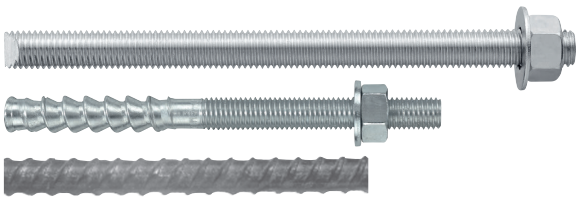


**Figure 9 — Hilti HAS threaded rod installation conditions**

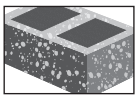
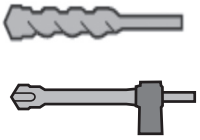
| | | | |
|---|---|---|---|
| Permissible Base Materials |  Grout-filled concrete masonry | Permissible drilling method |  Hammer drilling with carbide tipped drill bit<br>Hilti TE-CD or TE-YD Hollow Drill Bit |

**Table 99 — Hilti HIT-HY 200 A/R V3 allowable adhesive bond tension loads for threaded rods, HIT-Z(-R) anchor rods, and reinforcing bars in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]**

| Nominal anchor diameter in. | Rebar Size | Effective embedment in. (mm)[11] | Tension lb (kN) | Spacing[9] | | | Edge distance[10] | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load Reduction Factor @ $s_{min}$[12] | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load Reduction Factor @ $c_{min}$[12] |
| 3/8 | No. 3 | 3 3/8 (86) | 960 (4.3) | 13.5 (343) | 4 (102) | 0.60 | 12 (305) | 4 (102) | 0.58 |
| 1/2 | No. 4 | 4 1/2 (114) | 1,520 (6.8) | 18 (457) | | 0.60 | 20 (508) | | 0.70 |
| 5/8 | No. 5 | 5 5/8 (143) | 1,810 (8.1) | 22.5 (572) | | 0.50 | 20 (508) | | 0.82 |
| 3/4 | No. 6 | 6 3/4 (171) | 2,215 (9.9) | 27 (686) | | 0.50 | 20 (508) | | 0.68 |

**Table 100 — Hilti HIT-HY 200 A/R V3 allowable adhesive bond shear loads for threaded rods, HIT-Z(-R) anchor rods, and reinforcing bars in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]**

| Nominal anchor diameter in. | Rebar Size | Effective embedment in. (mm)[11] | Shear lb (kN) | Spacing[9] | | | Edge distance[10] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load Reduction Factor @ $s_{min}$[12] | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load Reduction Factor @ $c_{min}$[12] | |
| | | | | | | | | | Load ⊥ to edge | Load ∥ edge |
| 3/8 | No. 3 | 3 3/8 (86) | 825 (3.7) | 13.5 (343) | 4 (102) | 0.56 | 12 (305) | 4 (102) | 0.60 | 0.72 |
| 1/2 | No. 4 | 4 1/2 (114) | 1,240 (5.5) | 18 (457) | | 0.50 | 12 (305) | | 0.44 | 0.85 |
| 5/8 | No. 5 | 5 5/8 (143) | 2,120 (9.4) | 22.5 (572) | | 0.50 | 20 (508) | | 0.22 | 0.71 |
| 3/4 | No. 6 | 6 3/4 (171) | 2,480 (11.0) | 27 (686) | | 0.50 | 20 (508) | | 0.19 | 0.71 |

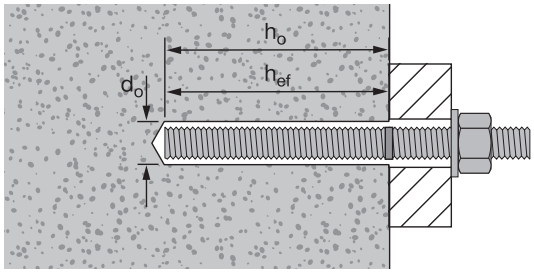
1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.
2 Anchors may be installed in any location in the face of the masonry wall including cell, web, and mortar joints. Anchors are limited to one per masonry cell.
3 Linear interpolation of load values between minimum spacing ($s_{min}$) and critical spacing ($s_{cr}$) and between minimum edge distance ($c_{min}$) and critical edge distance ($c_{cr}$) is permitted.
4 Concrete masonry thickness must be equal to or greater than 1.5 times the anchor embedment depth. EXCEPTION: the 5/8-inch- and the 3/4-inch diameter anchors (No. 5 and No. 6 bars) may be installed in minimum nominally 8-inch thick concrete masonry.
5 When using the basic load combinations in accordance with IBC Section 1605.3.1, tabulated allowable loads must not be increased for seismic or wind loading When using the alternative basic load combinations in IBC Section 1605.3.2 that include seismic or wind loads, tabulated allowable loads may be increased by 33-1/3 percent, or the alternative basic load combinations may be reduced by a factor of 0.75.
6 Allowable loads must be the lesser of the adjusted masonry or bond tabulated values and the steel values given in tables 102 and 103.
7 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 14.
8 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$
9 The critical spacing, $s_{cr}$, is the anchor spacing where full load values may be used. The minimum spacing, $s_{min}$, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.
10 The critical edge distance, $c_{cr}$, is the edge distance where full load values may be used. The minimum edge distance, $c_{min}$, is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to the closest edge.
11 Embedment depth is measured from the outside face of the concrete masonry unit.
12 Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than $s_{cr}$ and $c_{cr}$ must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

**Table 101 — Hilti HIT-HY 200 A/R V3 allowable adhesive bond loads for threaded rods and reinforcing bars in the top of grout-filled concrete masonry walls[1,2,3,4,5,6,7]**

| Nominal anchor diameter or rebar size | Effective embedment in. (mm) | Edge distance in. (mm)[8] | Minimum end distance in. (mm) | Tension lb (kN) | Shear load lb (kN)[9] | |
|---|---|---|---|---|---|---|
| | | | | | Load parallel to edge of masonry wall | Load perpendicular to edge of masonry wall |
| 1/2" | 4 -1/2 (114) | 1 3/4 (44) | 8 (203) | 685 (3.0) | 775 (3.4) | 285 (1.3) |
| | | 4 (102) | | 880 (3.9) | 1,156 (5.1) | 480 (2.1) |
| 5/8" | 5 -5/8 (143) | 1 3/4 (44) | | 830 (3.7) | 890 (4.0) | 315 (1.4) |
| | | 4 (102) | | 980 (4.4) | 1,315 (5.8) | 625 (2.8) |
| #4 | 4 -1/2 (114) | 1 3/4 (44) | | 770 (3.4) | 605 (2.7) | 235 (1.0) |
| #5 | 5 -5/8 (143) | | | 795 (3.5) | 720 (3.2) | 295 (1.3) |

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.
2 When using the basic load combinations in accordance with IBC Section 1605.3.1 or the alternative basic load combinations in IBC Section 1605.3.2. Tabulated allowable loads must not be increased for seismic or wind loading.
3 One anchor shall be permitted to be installed in each concrete block.
4 Anchors are not permitted to be installed in a head joint, flange or web of the concrete masonry unit.
5 Allowable loads must be the lesser of the adjusted masonry or bond tabulated values and the steel values given in tables 102 and 103.
6 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 14.
7 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$
8 The tabulated edge distance is measured from the anchor centerline to the edge of the concrete block. See figure below.
9 Linear interpolation of load values between the two tabulated edge distances is permitted.

**Hilti HIT-HY 200 A/R V3 specifications for HAS threaded rod in grout-filled masonry walls**




**Edge and end distances for threaded rods and reinforcing bars installed in the top of grout-filled CMU**

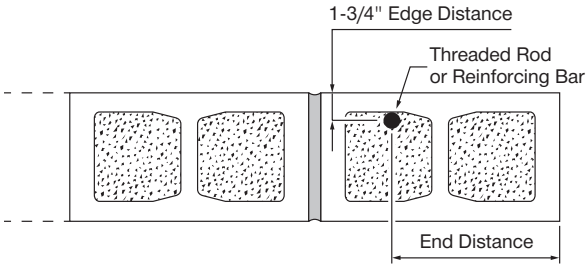


**Table 102 — Hilti HIT-HY 200 A/R V3 allowable tension and shear values for threaded rods based on steel strength[1,2,3]**

| Anchor diameter in. | Tension lb (kN) | | | | | | Shear lb (kN) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ISO 898 class 5.8 | ASTM A36 | ASTM A307 | ASTM A193 B7 | ASTM F593 CW (316/304) | HIT-(Z(-R) | ISO 898 class 5.8 | ASTM A36 | ASTM A307 | ASTM A193 B7 | ASTM F593 CW (316/304) | HIT-(Z(-R) |
| 3/8 | 2,640 (11.7) | 2,115 (9.4) | 2,185 (9.7) | 4,555 (20.3) | 3,645 (16.2) | 3,430 (15.3) | 1,360 (6.0) | 1,090 (4.8) | 1,125 (5.0) | 2,345 (10.4) | 1,875 (8.3) | 1,770 (7.9) |
| 1/2 | 4,700 (20.9) | 3,755 (16.7) | 3,885 (17.3) | 8,100 (36.0) | 6,480 (28.8) | 6,100 (27.1) | 2,420 (10.8) | 1,935 (8.6) | 2,000 (8.9) | 4,170 (18.5) | 3,335 (14.8) | 3,145 (14.0) |
| 5/8 | 7,340 (32.6) | 5,870 (26.1) | 6,075 (27.0) | 12,655 (56.3) | 10,125 (45.0) | 9,535 (42.4) | 3,780 (16.8) | 3,025 (13.5) | 3,130 (13.9) | 6,520 (29.0) | 5,215 (23.2) | 4,915 (21.9) |
| 3/4 | 10,570 (47.0) | 8,455 (37.6) | 8,750 (38.9) | 18,225 (81.1) | 12,390 (55.1) | 13,735 (61.1) | 5,445 (24.2) | 4,355 (19.4) | 4,505 (20.0) | 9,390 (41.8) | 6,385 (28.4) | 7,075 (31.5) |

**Table 103 — Hilti HIT-HIT-HY 200 A/R V3 allowable tension and shear values for reinforcing bars based on steel strength[1,2,3]**

| Rebar size | Tension lb (kN) | Shear lb (kN) |
|---|---|---|
| | ASTM A615, GRADE 60 | ASTM A615, GRADE 60 |
| #3 | 3,270 (14.5) | 1,685 (7.5) |
| #4 | 5,940 (26.4) | 3,060 (13.6) |
| #5 | 9,205 (40.9) | 4,745 (21.1) |
| #6 | 13,070 (58.1) | 6,730 (29.9) |

1 Allowable load used in the design must be the lesser of bond values and tabulated steel values.
2 The allowable tension and shear values for threaded rods to resist short term loads, such as wind or seismic, must be calculated in accordance with the appropriate IBC Sections.
3 Allowable steel loads are based on tension and shear stresses equal to 0.33 x Fu and 0.17 x Fu , respectively.

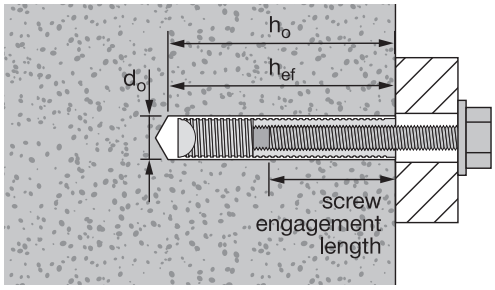


**Table 104 — Hilti HIT-HY 200 A/R V3 allowable adhesive bond tension loads for HIS-N inserts in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]**

| Thread size in. | Effective embedment in. (mm)[11] | Tension lb (kN) | Spacing[9] | | | Edge Distance[10] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load Reduction Factor @ $s_{min}$[12] | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load Reduction Factor @ $c_{min}$[12] |
| 3/8-16 UNC | 4 3/8 (111) | 1,355 (6.0) | 17 (432) | 4 (102) | 0.68 | 12 (305) | 4 (102) | 0.81 |
| 1/2-13 UNC | 5 (127) | 1,640 (7.3) | 20 (508) | | 0.68 | 20 (508) | | 0.74 |

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.
2 Anchors may be installed in any location in the face of the masonry wall including cell, web, and mortar joints. Anchors are limited to one per masonry cell.
3 Linear interpolation of load values between minimum spacing ($s_{min}$) and critical spacing ($s_{cr}$) and between minimum edge distance ($c_{min}$) and critical edge distance ($c_{cr}$) is permitted.
4 Concrete masonry thickness must be equal to or greater than 1.5 times the anchor embedment depth.
5 When using the basic load combinations in accordance with IBC Section 1605.3.1, tabulated allowable loads must not be increased for seismic or wind loading When using the alternative basic load combinations in IBC Section 1605.3.2 that include seismic or wind loads, tabulated allowable loads may be increased by 33-1/3 percent, or the alternative basic load combinations may be reduced by a factor of 0.75.
6 Allowable loads must be the lesser of the adjusted masonry or bond tabulated values and the steel values given in tables 102 and 103.
7 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 14.
8 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$
9 The critical spacing, $s_{cr}$, is the anchor spacing where full load values may be used. The minimum spacing, $s_{min}$, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.
10 The critical edge distance, $c_{cr}$, is the edge distance where full load values may be used. The minimum edge distance, $c_{min}$, is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to the closest edge.
11 Embedment depth is measured from the outside face of the concrete masonry unit.
12 Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than $s_{cr}$ and $c_{cr}$ must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

## Hilti HIT-HY 200 A/R V3 specifications for HIS-N inserts in grout-filled masonry walls




## Allowable anchor installation locations in the face of grout-filled concrete block

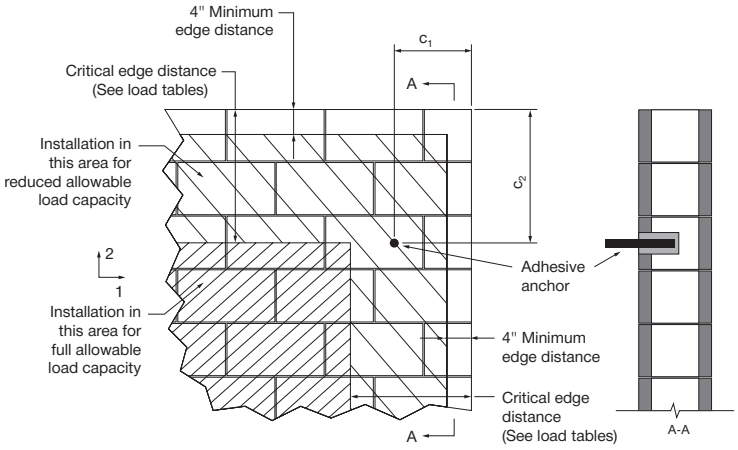
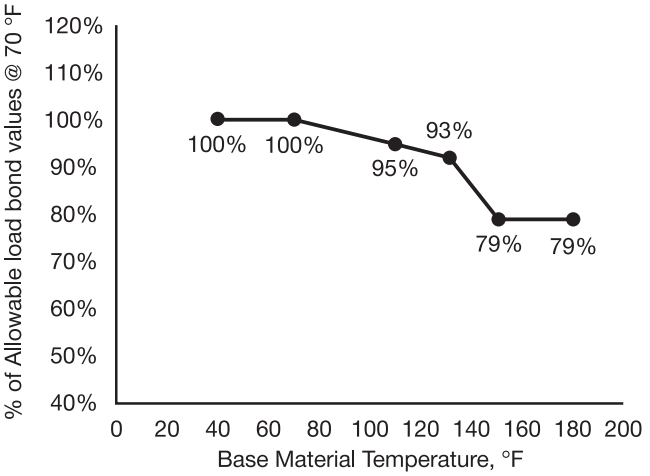


**Table 105 — Hilti HIT-HY 200 A/R V3 allowable adhesive bond shear loads for HIS-N inserts in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]**

| Thread size in. | Effective embedment in. (mm)[11] | Shear lb (kN) | Spacing[9] | | | Edge Distance[10] | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load Reduction Factor @ $s_{min}$[12] | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load Reduction Factor @ $c_{min}$[12] | |
| | | | | | | | | Load perpendicular to edge | Load parallel to edge |
| 3/8-16 UNC | 4 3/8 (111) | 1,045 (4.6) | 17.0 (432) | 4 (102) | 0.56 | 12 (305) | 4 (102) | 0.65 | 1.00 |
| 1/2-13 UNC | 5 (127) | 1,730 (7.7) | 20 (508) | | 0.50 | 20 (508) | | 0.36 | 0.91 |

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.
2 Anchors may be installed in any location in the face of the masonry wall including cell, web, and mortar joints. Anchors are limited to one per masonry cell.
3 Linear interpolation of load values between minimum spacing ($s_{min}$) and critical spacing ($s_{cr}$) and between minimum edge distance ($c_{min}$) and critical edge distance ($c_{cr}$) is permitted.
4 Concrete masonry thickness must be equal to or greater than 1.5 times the anchor embedment depth.
5 When using the basic load combinations in accordance with IBC Section 1605.3.1, tabulated allowable loads must not be increased for seismic or wind loading When using the alternative basic load combinations in IBC Section 1605.3.2 that include seismic or wind loads, tabulated allowable loads may be increased by 33-1/3 percent, or the alternative basic load combinations may be reduced by a factor of 0.75.
6 Allowable loads must be the lesser of the adjusted masonry or bond tabulated values and the steel values given in tables 102 and 103.
7 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 14.
8 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$
9 The critical spacing, $s_{cr}$, is the anchor spacing where full load values may be used. The minimum spacing, $s_{min}$, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.
10 The critical edge distance, $c_{cr}$, is the edge distance where full load values may be used. The minimum edge distance, $c_{min}$, is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to the closest edge.
11 Embedment depth is measured from the outside face of the concrete masonry unit.
12 Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than $s_{cr}$ and $c_{cr}$ must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

**Figure 14 — Influence of in-service temperature on bond strength[1]**




1 Test procedure involves the concrete being held at the elevated temperature for 24 hours then removing it from the controlled environment and testing to failure.

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## MATERIAL SPECIFICATIONS

**Figure 15 — Hilti HIT-HY 200 A/R V3 adhesive cure time and working time (approx.)**

| HIT-HY 200-A | | | | | |
|---|---|---|---|---|---|
| | | HAS / HIS-N / Rebar | | HIT-Z[1] | |
| [°C] | [°F] | $t_{work}$ | $t_{cure}$ | $t_{work}$ | $t_{cure}$ |
| -10...-5 | 14...23 | 1.5 h | 7 h | – | – |
| -4...0 | 24...32 | 50 min | 4 h | – | – |
| 1...5 | 33...41 | 25 min | 2 h | – | – |
| 6...10 | 42...50 | 15 min | 1.25 h | 15 min | 1.25 h |
| 11...20 | 51...68 | 7 min | 45 min | 7 min | 45 min |
| 21...30 | 69...86 | 4 min | 30 min | 4 min | 30 min |
| 31...40 | 87...104 | 3 min | 30 min | 3 min | 30 min |

| HIT-HY 200-R | | | | | |
|---|---|---|---|---|---|
| | | HAS / HIS-N / Rebar | | HIT-Z[1] | |
| [°C] | [°F] | $t_{work}$ | $t_{cure}$ | $t_{work}$ | $t_{cure}$ |
| -10...-5 | 14...23 | 3 h | 20 h | – | – |
| -4...0 | 24...32 | 2 h | 8 h | – | – |
| 1...5 | 33...41 | 1 h | 4 h | – | – |
| 6...10 | 42...50 | 40 min | 2.5 h | 40 min | 2.5 h |
| 11...20 | 51...68 | 15 min | 1.5 h | 15 min | 1.5 h |
| 21...30 | 69...86 | 9 min | 1 h | 9 min | 1 h |
| 31...40 | 87...104 | 6 min | 1 h | 6 min | 1 h |

1 It is permitted to install Hilti HIT-HY 200 V3 with HIT-Z anchor rod down to 14° F (-10° C) provided the drilled hole has the drilling dust fully removed. This can be done with Hilti TE-CD or TE-YD hollow drill bit or with cleaning procedures used with standard threaded rod.

**Resistance of cured Hilti HIT-HY 200 A/R V3 to chemicals**

| Chemical | | Behavior |
|---|---|---|
| Acetic acid | 10% | + |
| Acetone | | ● |
| Ammonia | 5% | + |
| Benzyl alcohol | | – |
| Hydrochloric acid | 10% | ● |
| Chlorinated lime | 10% | + |
| Citric acid | 10% | + |
| Concrete plasticizer | | + |
| De-icing salt (Calcium chloride) | | + |
| Demineralized water | | + |
| Diesel fuel | | + |
| Drilling dust suspension pH 13.2 | | + |
| Ethanol | 96% | – |
| Ethylacetate | | – |
| Formic acid | 10% | + |
| Formwork oil | | + |
| Gasoline | | + |
| Glycole | | ● |
| Hydrogen peroxide | 10% | ● |
| Lactic acid | 10% | + |
| Maschinery oil | | + |
| Methylethylketon | | ● |
| Nitric acid | 10% | ● |
| Phosphoric acid | 10% | + |
| Potassium Hydroxide pH 13.2 | | + |
| Sea water | | + |
| Sewage sludge | | + |
| Sodium carbonate 10% | 10% | + |
| Sodium hypochlorite 2% | 2% | + |
| Sulphuric acid | 10% | + |
| | 30% | + |
| Toluene | | ● |
| Xylene | | ● |

Key: – non-resistant
+ resistant
● limited resistance

Samples of the HIT-HY 200 A/R V3 adhesive were immersed in the various chemical compounds for up to one year. At the end of the test period, the samples were analyzed. Any samples showing no visible damage and having less than a 25% reduction in bending (flexural) strength were classified as “Resistant.” Samples that had slight damage, such as small cracks, chips, etc. or reduction in bending strength of 25% or more were classified as “Limited Resistance” (i.e. exposed for 48 hours or less until chemical is cleaned up). Samples that were heavily damaged or destroyed were classified as “Non-Resistant.”

Note: In actual use, the majority of the adhesive is encased in the base material, leaving very little surface area exposed.

# ORDERING INFORMATION

## HIT-Z anchor rod

| Description | Bit dia. (in.) | Min. embed. (in.) | Qty |
|---|---|---|---|
| **HIT-Z 3/8 x 3-3/8** | 7/16 | 2-3/8 | 40 |
| **HIT-Z 3/8 x 4 3/8** | 7/16 | 2-3/8 | 40 |
| **HIT-Z 3/8 x 5 1/8** | 7/16 | 2-3/8 | 40 |
| **HIT-Z 3/8 x 6 3/8** | 7/16 | 2-3/8 | 40 |
| **HIT-Z 1/2 x 4 1/2** | 9/16 | 2-3/4 | 20 |
| **HIT-Z 1/2 x 6 ½** | 9/16 | 2-3/4 | 20 |
| **HIT-Z 1/2 x 8** | 9/16 | 2-3/4 | 20 |
| **HIT-Z 5/8 x 6** | 3/4 | 3-3/4 | 12 |
| **HIT-Z 5/8 x 8** | 3/4 | 3-3/4 | 12 |
| **HIT-Z 5/8 x 9 1/2** | 3/4 | 3-3/4 | 12 |
| **HIT-Z 3/4 x 6-1/2** | 7/8 | 4 | 6 |
| **HIT-Z 3/4 x 8 1/2** | 7/8 | 4 | 6 |
| **HIT-Z 3/4 x 9 ¾** | 7/8 | 4 | 6 |




HIT-HY 200-A V3




HIT-HY 200-R V3

## HIT-HY 200-A V3 (accelerated working time)

| Description | Package contents | Qty |
|---|---|---|
| **HIT-HY 200-A V3 (11.1 fl oz/330 ml)** | Includes (1) foil pack with (1) mixer and 3/8 filler tube per pack | 1 |
| **HIT-HY 200-A V3 Master Carton (11.1 fl oz/330 ml)** | Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack | 25 |
| **HIT-HY 200-A V3 Combo (11.1 fl oz/330 ml)** | Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 Manual Dispenser | 25 |
| **HIT-HY 200-A V3 Master Carton (16.9 fl oz/500 ml)** | Includes (1) master carton containing (20) foil packs with (1) mixer and 3/8 filler tube per pack | 20 |
| **HIT-HY 200-A V3 Combo (16.9 fl oz/500 ml)** | Includes (2) master cartons containing (20) foil packs each with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 Manual Dispenser | 40 |
| **HIT-RE-M Static Mixer** | For use with HIT-HY 200-A V3 cartridges | 1 |

## HIT-HY 200-R V3 (regular working time)

| Description | Package contents | Qty |
|---|---|---|
| **HIT-HY 200-R V3 (11.1 fl oz/330 ml)** | Includes (1) foil pack with (1) mixer and 3/8 filler tube per pack | 1 |
| **HIT-HY 200-R V3 Master Carton (11.1 fl oz/330 ml)** | Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack | 25 |
| **HIT-HY 200-R V3 Combo (11.1 fl oz/330 ml)** | Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 manual dispenser | 25 |
| **HIT-HY 200-R V3 Master Carton (16.9 fl oz/500 ml)** | Includes (1) master carton containing (20) foil packs with (1) mixer and 3/8 filler tube per pack | 20 |
| **HIT-HY 200-R V3 Combo (16.9 fl oz/500 ml)** | Includes (2) master cartons containing (20) foil packs each with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 manual dispenser | 40 |
| **HIT-RE-M Static Mixer** | For use with HIT-HY 200-R V3 cartridges | 1 |

## TE-CD Hollow Drill Bits

| Order Description | Working length (in.) |
|---|---|
| **Hollow Drill Bit TE-CD 1/2-13** | 8 |
| **Hollow Drill Bit TE-CD 9/16-14** | 9-1/2 |
| **Hollow Drill Bit TE-CD 5/8-14** | 9-1/2 |
| **Hollow Drill Bit TE-CD 3/4-14** | 9-1/2 |
| **Hollow Drill Bit TE-CD 16-A (Replacement collar)** | |

## TE-YD Hollow Drill Bits

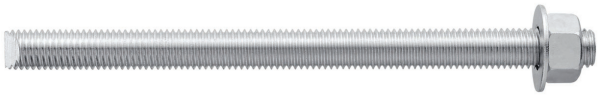
| Order Description | Working Length (in.) |
|---|---|
| **Hollow Drill Bit TE-YD 3/4-24** | 15-1/2 |
| **Hollow Drill Bit TE-YD 7/8-24** | 15-1/2 |
| **Hollow Drill Bit TE-YD 1-24** | 15-1/2 |
| **Hollow Drill Bit TE-YD 1 1/8-24** | 15-1/2 |
| **Hollow Drill Bit TE-YD 25-A (Replacement collar)** | |

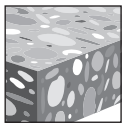
For ordering information on anchor rods and inserts, dispensers, hole cleaning equipment and other accessories, see section 3.2.9.

# 3.2.3 HIT-RE 500 V3 EPOXY ADHESIVE ANCHORING SYSTEM

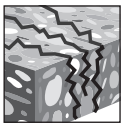
## PRODUCT DESCRIPTION

**HIT-RE 500 V3 with Threaded Rod, Rebar, and HIS-N/RN Inserts**

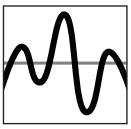
| Anchor System | | Features and Benefits |
|---|---|---|
|  | Hilti HIT-RE 500 V3 Cartridge | • Superior bond performance in both cracked and uncracked concrete<br>• Seismic qualified in accordance with ICC-ES Acceptance Criteria AC308 and ACI 355.4<br>• No hole cleaning requirement when installed with SafeSet™ hollow drill bit and Hilti vacuum technology<br>• ICC-ES approved for cracked concrete and seismic service<br>• May be installed in diamond cored holes in cracked and uncracked concrete including all seismic zones concrete using the Safe-Set™ system using the TE-YRT Roughening tool<br>• Use underwater up to 165 ft (50 m)<br>• Meets requirements of ASTM C881-14, Type I, II, IV, and V, Grade 3, Class A, B, and C.<br>• Meets requirements of AASHTO specification M235, Type I, II, IV, and V, Grade 3, Class A, B, and C<br>• Technical data available for larger diameters, oversized holes, deeper embedments. Contact Hilti Technical Services for additional information |
|  | Hilti HAS Threaded Rods | |
|  | Rebar | |
|  | Hilti HIS-N | |



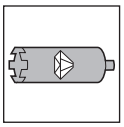
Uncracked concrete



Cracked concrete



Seismic design categories A-F



Diamond cored holes for cracked and uncracked concrete




Hollow drill bit Roughening tool




Profis anchor design software

| Approvals/Listings | |
|---|---|
| **ICC-ES (International Code Council)** | ESR-3814 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC308<br>ELC-3814 in concrete per CSA A23.3 / ACI 355.2 |
| **NSF/ANSI Std 61** | Certification for use in potable water |
| **European Technical Approval** | ETA-16/0142, ETA-16/0143, ETA-16/0180 |
| **City of Los Angeles** | City of Los Angeles 2017 LABC Supplement (within ESR-3814) |
| **Florida Building Code** | 2017 FBC Supplement (within ESR-1814) |
| **U.S. Green Building Council** | LEED® Credit 4.1-Low Emitting Materials |
| **Department of Transportation** | Contact Hilti for various states |

## MATERIAL SPECIFICATIONS

**Table 1 — Material properties of fully cured Hilti HIT-RE 500 V3**

| | | |
|---|---|---|
| Bond Strength ASTM C882-13A[1]<br>2 day cure<br>14 day cure | <br>10.8 MPa<br>11.7 MPa | <br>1,560 psi<br>1,690 psi |
| Compressive Strength ASTM D695-10[1] | 82.7 MPa | 12,000 psi |
| Compressive Modulus ASTM D695-10[1] | 2,600 MPa | 0.38 x $10^6$ psi |
| Tensile Strength 7 day ASTM D638-14 | 49.3 MPa | 7,150 psi |
| Elongation at break ASTM D638-14 | 1.1% | 1.1% |
| Heat Deflection Temperature ASTM D648-07 | 50°C | 122°F |
| Absorption ASTM D570-98 | 0.18% | 0.18% |
| Linear Coefficient of Shrinkage on Cure ASTM D2566-86 | 0.008 | 0.008 |

1 Minimum values obtained as the result of tests at 35°F, 50°F, 75°F and 110°F.

## DESIGN DATA IN CONCRETE FOR ACI 318

### ACI 318 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the strength design parameters and variables of ESR-3814 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to Section 3.1.8. Data tables from ESR-3814 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

## HIT-RE 500 V3 adhesive with deformed reinforcing bars (rebar)



**Figure 1 — Rebar installed with Hilti HIT-RE 500 V3 adhesive**

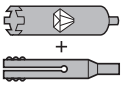
| Cracked or uncracked concrete | Permissible drilling methods | Permissible concrete conditions |
|---|---|---|
|   Cracked and uncracked concrete |  Hammer drilling with carbide-tipped drill bit |  Dry concrete<br>  Water-saturated concrete<br>  Water-filled holes<br>  Submerged (underwater) |
| |  Hilti TE-CD or TE-YD hollow drill bit and VC 20/40 vacuum<br>  Diamond core drill bit with Hilti TE-YRT roughening tool |  Dry concrete<br>  Water-saturated concrete |
|  Uncracked concrete |  Diamond core drill bit |  Dry concrete<br>  Water-saturated concrete |

**Figure 2 — Rebar installed with Hilti HIT-RE 500 V3 adhesive**

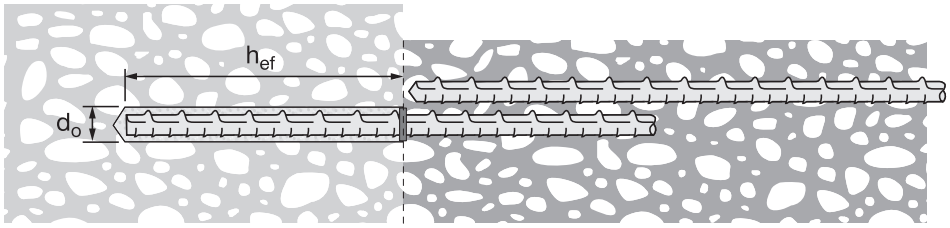



**Table 2 — Specifications for rebar installed with Hilti HIT-RE 500 V3 adhesive**

| Setting information | | Symbol | Units | Rebar size | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 |
| Nominal bit diameter | | $d_o$ | in. | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/8 | 1-3/8 | 1-1/2 |
| Effective embedment | minimum | $h_{ef,min}$ | in. (mm) | 2-3/8 (60) | 2-3/8 (60) | 3 (76) | 3 (76) | 3-3/8 (85) | 4 (102) | 4-1/2 (114) | 5 (127) |
| | maximum | $h_{ef,max}$ | in. (mm) | 7-1/2 (191) | 10 (254) | 12-1/2 (318) | 15 (381) | 17-1/2 (445) | 20 (508) | 22-1/2 (572) | 25 (635) |
| Minimum concrete member thickness | | $h_{min}$ | in. (mm) | $h_{ef}$ + 1-1/4 ($h_{ef}$ + 30) | | ($h_{ef}$ + 2$d_o$) | | | | | |
| Minimum edge distance[1] | | $c_{min}$ | in. (mm) | 1-7/8 (48) | 2-1/2 (64) | 3-1/8 (79) | 3-3/4 (95) | 4-3/8 (111) | 5 (127) | 5-5/8 (143) | 6-1/4 (159) |
| Minimum anchor spacing | | $s_{min}$ | in. (mm) | 1-7/8 (48) | 2-1/2 (64) | 3-1/8 (79) | 3-3/4 (95) | 4-3/8 (111) | 5 (127) | 5-5/8 (143) | 6-1/4 (159) |

1 Edge distance of 1-3/4-inch (44mm) is permitted provided the rebar remains un-torqued.

**Note:** The installation specifications in table 2 above and the data in tables 3 through 23 pertain to the use of Hilti HIT-RE 500 V3 with rebar designed as a post-installed anchor using the provisions of ACI 318 Chapter 17. For the use of Hilti HIT-RE 500 V3 with rebar for typical development calculations according to ACI 318 Chapter 25 (formerly ACI 318-11 Chapter 12), refer to section 3.1.14 for the design method and tables 83 through 87 in section 3.2.4.3.8.

## Table 3 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for US rebar in uncracked concrete [1,2,3,4,5,6,7,8,9,11]

| Rebar size | Effective embedment in. (mm) | Tension — $\phi N_n$ | | | | Shear — $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| #3 | 3-3/8 (86) | 4,575 (20.4) | 4,790 (21.3) | 5,145 (22.9) | 5,695 (25.3) | 9,855 (43.8) | 10,310 (45.9) | 11,080 (49.3) | 12,265 (54.6) |
| | 4-1/2 (114) | 6,100 (27.1) | 6,385 (28.4) | 6,860 (30.5) | 7,590 (33.8) | 13,135 (58.4) | 13,750 (61.2) | 14,775 (65.7) | 16,350 (72.7) |
| | 7-1/2 (191) | 10,165 (45.2) | 10,640 (47.3) | 11,435 (50.9) | 12,655 (56.3) | 21,895 (97.4) | 22,915 (101.9) | 24,625 (109.5) | 27,250 (121.2) |
| #4 | 4-1/2 (114) | 7,445 (33.1) | 8,155 (36.3) | 8,990 (40.0) | 9,950 (44.3) | 16,035 (71.3) | 17,570 (78.2) | 19,365 (86.1) | 21,430 (95.3) |
| | 6 (152) | 10,660 (47.4) | 11,155 (49.6) | 11,990 (53.3) | 13,265 (59.0) | 22,960 (102.1) | 24,030 (106.9) | 25,820 (114.9) | 28,575 (127.1) |
| | 10 (254) | 17,765 (79.0) | 18,595 (82.7) | 19,980 (88.9) | 22,110 (98.3) | 38,265 (170.2) | 40,050 (178.2) | 43,035 (191.4) | 47,625 (211.8) |
| #5[10] | 5-5/8 (143) | 10,405 (46.3) | 11,400 (50.7) | 13,165 (58.6) | 15,370 (68.4) | 22,415 (99.7) | 24,550 (109.2) | 28,350 (126.1) | 33,105 (147.3) |
| | 7-1/2 (191) | 16,020 (71.3) | 17,230 (76.6) | 18,515 (82.4) | 20,490 (91.1) | 34,505 (153.5) | 37,115 (165.1) | 39,880 (177.4) | 44,135 (196.3) |
| | 12-1/2 (318) | 27,440 (122.1) | 28,720 (127.8) | 30,860 (137.3) | 34,155 (151.9) | 59,100 (262.9) | 61,855 (275.1) | 66,470 (295.7) | 73,560 (327.2) |
| #6[10] | 6-3/4 (171) | 13,680 (60.9) | 14,985 (66.7) | 17,305 (77.0) | 21,190 (94.3) | 29,460 (131.0) | 32,275 (143.6) | 37,265 (165.8) | 45,645 (203.0) |
| | 9 (229) | 21,060 (93.7) | 23,070 (102.6) | 26,200 (116.5) | 28,995 (129.0) | 45,360 (201.8) | 49,690 (221.0) | 56,430 (251.0) | 62,450 (277.8) |
| | 15 (381) | 38,825 (172.7) | 40,635 (180.8) | 43,665 (194.2) | 48,325 (215.0) | 83,620 (372.0) | 87,520 (389.3) | 94,045 (418.3) | 104,080 (463.0) |
| #7[10] | 7-7/8 (200) | 17,235 (76.7) | 18,885 (84.0) | 21,805 (97.0) | 26,705 (118.8) | 37,125 (165.1) | 40,670 (180.9) | 46,960 (208.9) | 57,515 (255.8) |
| | 10-1/2 (267) | 26,540 (118.1) | 29,070 (129.3) | 33,570 (149.3) | 38,995 (173.5) | 57,160 (254.3) | 62,615 (278.5) | 72,300 (321.6) | 83,995 (373.6) |
| | 17-1/2 (445) | 52,220 (232.3) | 54,655 (243.1) | 58,730 (261.2) | 64,995 (289.1) | 112,470 (500.3) | 117,715 (523.6) | 126,495 (562.7) | 139,990 (622.7) |
| #8[10] | 9 (229) | 21,060 (93.7) | 23,070 (102.6) | 26,640 (118.5) | 32,625 (145.1) | 45,360 (201.8) | 49,690 (221.0) | 57,375 (255.2) | 70,270 (312.6) |
| | 12 (305) | 32,425 (144.2) | 35,520 (158.0) | 41,015 (182.4) | 50,020 (222.5) | 69,835 (310.6) | 76,500 (340.3) | 88,335 (392.9) | 107,735 (479.2) |
| | 20 (508) | 66,980 (297.9) | 70,100 (311.8) | 75,330 (335.1) | 83,365 (370.8) | 144,260 (641.7) | 150,990 (671.6) | 162,250 (721.7) | 179,560 (798.7) |
| #9[10] | 10-1/8 (257) | 25,130 (111.8) | 27,530 (122.5) | 31,785 (141.4) | 38,930 (173.2) | 54,125 (240.8) | 59,290 (263.7) | 68,465 (304.5) | 83,850 (373.0) |
| | 13-1/2 (343) | 38,690 (172.1) | 42,380 (188.5) | 48,940 (217.7) | 59,940 (266.6) | 83,330 (370.7) | 91,285 (406.1) | 105,405 (468.9) | 129,095 (574.2) |
| | 22-1/2 (572) | 83,245 (370.3) | 87,640 (389.8) | 94,175 (418.9) | 104,225 (463.6) | 179,300 (797.6) | 188,765 (839.7) | 202,840 (902.3) | 224,480 (998.5) |
| #10 | 11-1/4 (286) | 29,430 (130.9) | 32,240 (143.4) | 37,230 (165.6) | 45,595 (202.8) | 63,395 (282.0) | 69,445 (308.9) | 80,185 (356.7) | 98,205 (436.8) |
| | 15 (381) | 45,315 (201.6) | 49,640 (220.8) | 57,320 (255.0) | 70,200 (312.3) | 97,600 (434.1) | 106,915 (475.6) | 123,455 (549.2) | 151,200 (672.6) |
| | 25 (635) | 97,500 (433.7) | 106,195 (472.4) | 114,115 (507.6) | 126,290 (561.8) | 210,000 (934.1) | 228,730 (1017.4) | 245,785 (1093.3) | 272,005 (1209.9) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 8-23 as necessary to the above values. Compare to the steel values in table 7. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete and water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.45.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. For diamond core drilling, except as indicated in note 10, multiply above values by 0.55.
Diamond core drilling is not permitted for the water-filled or under-water (submerged) applications.
10 Diamond core drilling with the Hilti TE-YRT roughening tool is permitted for #5, #6, #7, #8, and #9 rebar in dry and water-saturated concrete. See Table 5
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 4 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for US rebar in cracked concrete[1,2,3,4,5,6,7,8,9,11]

| Rebar size | Effective embedment in. (mm) | Tension — $\phi N_n$ | | | | Shear — $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| #3 | 3-3/8 (86) | 3,425 (15.2) | 3,585 (15.9) | 3,745 (16.7) | 3,980 (17.7) | 7,380 (32.8) | 7,725 (34.4) | 8,065 (35.9) | 8,570 (38.1) |
| | 4-1/2 (114) | 4,650 (20.7) | 4,780 (21.3) | 4,990 (22.2) | 5,305 (23.6) | 10,020 (44.6) | 10,300 (45.8) | 10,750 (47.8) | 11,425 (50.8) |
| | 7-1/2 (191) | 7,755 (34.5) | 7,970 (35.5) | 8,320 (37.0) | 8,840 (39.3) | 16,700 (74.3) | 17,165 (76.4) | 17,920 (79.7) | 19,045 (84.7) |
| #4 | 4-1/2 (114) | 5,275 (23.5) | 5,780 (25.7) | 6,670 (29.7) | 7,125 (31.7) | 11,360 (50.5) | 12,445 (55.4) | 14,370 (63.9) | 15,345 (68.3) |
| | 6 (152) | 8,120 (36.1) | 8,560 (38.1) | 8,940 (39.8) | 9,500 (42.3) | 17,490 (77.8) | 18,440 (82.0) | 19,255 (85.7) | 20,465 (91.0) |
| | 10 (254) | 13,885 (61.8) | 14,270 (63.5) | 14,900 (66.3) | 15,835 (70.4) | 29,910 (133.0) | 30,735 (136.7) | 32,095 (142.8) | 34,105 (151.7) |
| #5[10] | 5-5/8 (143) | 7,370 (32.8) | 8,075 (35.9) | 9,325 (41.5) | 11,380 (50.6) | 15,875 (70.6) | 17,390 (77.4) | 20,080 (89.3) | 24,510 (109.0) |
| | 7-1/2 (191) | 11,350 (50.5) | 12,430 (55.3) | 14,275 (63.5) | 15,170 (67.5) | 24,440 (108.7) | 26,775 (119.1) | 30,750 (136.8) | 32,680 (145.4) |
| | 12-1/2 (318) | 22,175 (98.6) | 22,790 (101.4) | 23,795 (105.8) | 25,285 (112.5) | 47,760 (212.4) | 49,085 (218.3) | 51,250 (228.0) | 54,465 (242.3) |
| #6[10] | 6-3/4 (171) | 9,690 (43.1) | 10,615 (47.2) | 12,255 (54.5) | 15,010 (66.8) | 20,870 (92.8) | 22,860 (101.7) | 26,395 (117.4) | 32,330 (143.8) |
| | 9 (229) | 14,920 (66.4) | 16,340 (72.7) | 18,870 (83.9) | 22,160 (98.6) | 32,130 (142.9) | 35,195 (156.6) | 40,640 (180.8) | 47,735 (212.3) |
| | 15 (381) | 32,095 (142.8) | 33,290 (148.1) | 34,760 (154.6) | 36,935 (164.3) | 69,135 (307.5) | 71,700 (318.9) | 74,865 (333.0) | 79,560 (353.9) |
| #7[10] | 7-7/8 (200) | 12,210 (54.3) | 13,375 (59.5) | 15,445 (68.7) | 18,915 (84.1) | 26,300 (117.0) | 28,810 (128.2) | 33,265 (148.0) | 40,740 (181.2) |
| | 10-1/2 (267) | 18,800 (83.6) | 20,590 (91.6) | 23,780 (105.8) | 29,120 (129.5) | 40,490 (180.1) | 44,355 (197.3) | 51,215 (227.8) | 62,725 (279.0) |
| | 17-1/2 (445) | 40,445 (179.9) | 44,310 (197.1) | 47,310 (210.4) | 50,275 (223.6) | 87,115 (387.5) | 95,430 (424.5) | 101,895 (453.2) | 108,285 (481.7) |
| #8[10] | 9 (229) | 14,920 (66.4) | 16,340 (72.7) | 18,870 (83.9) | 23,110 (102.8) | 32,130 (142.9) | 35,195 (156.6) | 40,640 (180.8) | 49,775 (221.4) |
| | 12 (305) | 22,965 (102.2) | 25,160 (111.9) | 29,050 (129.2) | 35,580 (158.3) | 49,465 (220.0) | 54,190 (241.0) | 62,570 (278.3) | 76,635 (340.9) |
| | 20 (508) | 49,415 (219.8) | 54,135 (240.8) | 62,230 (276.8) | 66,130 (294.2) | 106,435 (473.4) | 116,595 (518.6) | 134,035 (596.2) | 142,440 (633.6) |
| #9[10] | 10-1/8 (257) | 17,800 (79.2) | 19,500 (86.7) | 22,515 (100.2) | 27,575 (122.7) | 38,340 (170.5) | 42,000 (186.8) | 48,495 (215.7) | 59,395 (264.2) |
| | 13-1/2 (343) | 27,405 (121.9) | 30,020 (133.5) | 34,665 (154.2) | 42,455 (188.8) | 59,025 (262.6) | 64,660 (287.6) | 74,665 (332.1) | 91,445 (406.8) |
| | 22-1/2 (572) | 58,965 (262.3) | 64,595 (287.3) | 74,585 (331.8) | 81,930 (364.4) | 127,005 (564.9) | 139,125 (618.9) | 160,650 (714.6) | 176,465 (785.0) |
| #10 | 11-1/4 (286) | 20,850 (92.7) | 22,840 (101.6) | 26,370 (117.3) | 32,295 (143.7) | 44,905 (199.7) | 49,190 (218.8) | 56,800 (252.7) | 69,565 (309.4) |
| | 15 (381) | 32,095 (142.8) | 35,160 (156.4) | 40,600 (180.6) | 49,725 (221.2) | 69,135 (307.5) | 75,730 (336.9) | 87,445 (389.0) | 107,100 (476.4) |
| | 25 (635) | 69,060 (307.2) | 75,655 (336.5) | 87,360 (388.6) | 97,510 (433.7) | 148,750 (661.7) | 162,945 (724.8) | 188,155 (837.0) | 210,020 (934.2) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 8-23 as necessary to the above values. Compare to the steel values in table 7. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete and water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.45.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete except as indicated in note 10.
10 Diamond core drilling with the Hilti TE-YRT roughening tool is permitted for #5, #6, #7, #8, and #9 rebar in dry and water-saturated concrete. See Table 6
11 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.68. See section 3.1.8 for additional information on seismic applications.

**Table 5 — Hilti HIT-RE 500 V3 for Core Drilled Holes with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for US rebar in uncracked concrete[1,2,3,4,5,6,7,8,9]**

| Rebar size | Effective embedment in. (mm) | Tension — $\phi N_n$ | | | | Shear — $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| #5 | 5-5/8 (143) | 10,405 (46.3) | 11,400 (50.7) | 12,350 (54.9) | 12,350 (54.9) | 22,415 (99.7) | 24,550 (109.2) | 26,595 (118.3) | 26,595 (118.3) |
| | 7-1/2 (191) | 16,020 (71.3) | 16,465 (73.2) | 16,465 (73.2) | 16,465 (73.2) | 34,505 (153.5) | 35,460 (157.7) | 35,460 (157.7) | 35,460 (157.7) |
| | 12-1/2 (318) | 27,440 (122.1) | 27,440 (122.1) | 27,440 (122.1) | 27,440 (122.1) | 59,100 (262.9) | 59,100 (262.9) | 59,100 (262.9) | 59,100 (262.9) |
| #6 | 6-3/4 (171) | 13,680 (60.9) | 14,985 (66.7) | 17,305 (77.0) | 17,470 (77.7) | 29,460 (131.0) | 32,275 (143.6) | 37,265 (165.8) | 37,630 (167.4) |
| | 9 (229) | 21,060 (93.7) | 23,070 (102.6) | 23,295 (103.6) | 23,295 (103.6) | 45,360 (201.8) | 49,690 (221.0) | 50,175 (223.2) | 50,175 (223.2) |
| | 11-1/4 (286) | 29,120 (129.5) | 29,120 (129.5) | 29,120 (129.5) | 29,120 (129.5) | 62,715 (279.0) | 62,715 (279.0) | 62,715 (279.0) | 62,715 (279.0) |
| #7 | 7-7/8 (200) | 17,235 (76.7) | 18,885 (84.0) | 21,805 (97.0) | 23,500 (104.5) | 37,125 (165.1) | 40,670 (180.9) | 46,960 (208.9) | 50,610 (225.1) |
| | 10-1/2 (267) | 26,540 (118.1) | 29,070 (129.3) | 31,330 (139.4) | 31,330 (139.4) | 57,160 (254.3) | 62,615 (278.5) | 67,485 (300.2) | 67,485 (300.2) |
| | 17-1/2 (445) | 52,220 (232.3) | 52,220 (232.3) | 52,220 (232.3) | 52,220 (232.3) | 112,470 (500.3) | 112,470 (500.3) | 112,470 (500.3) | 112,470 (500.3) |
| #8 | 9 (229) | 21,060 (93.7) | 23,070 (102.6) | 26,640 (118.5) | 30,140 (134.1) | 45,360 (201.8) | 49,690 (221.0) | 57,375 (255.2) | 64,920 (288.8) |
| | 12 (305) | 32,425 (144.2) | 35,520 (158.0) | 40,185 (178.8) | 40,185 (178.8) | 69,835 (310.6) | 76,500 (340.3) | 86,555 (385.0) | 86,555 (385.0) |
| | 20 (508) | 66,980 (297.9) | 66,980 (297.9) | 66,980 (297.9) | 66,980 (297.9) | 144,260 (641.7) | 144,260 (641.7) | 144,260 (641.7) | 144,260 (641.7) |
| #9 | 10-1/8 (257) | 25,130 (111.8) | 27,530 (122.5) | 31,785 (141.4) | 37,680 (167.6) | 54,125 (240.8) | 59,290 (263.7) | 68,465 (304.5) | 81,160 (361.0) |
| | 13-1/2 (343) | 38,690 (172.1) | 42,380 (188.5) | 48,940 (217.7) | 50,240 (223.5) | 83,330 (370.7) | 91,285 (406.1) | 105,405 (468.9) | 108,215 (481.4) |
| | 22-1/2 (572) | 83,245 (370.3) | 83,735 (372.5) | 83,735 (372.5) | 83,735 (372.5) | 179,300 (797.6) | 180,355 (802.3) | 180,355 (802.3) | 180,355 (802.3) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 8 - 23 as necessary to the above values. Compare to the steel values in table 7. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete and water-saturated concrete conditions.
Water-filled and submerged (under water) applications are not permitted for this hole preparation method.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 6 — Hilti HIT-RE 500 V3 for Core Drilled Holes with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for US rebar in cracked concrete[1,2,3,4,5,6,7,8,9]

| Rebar size | Effective embedment in. (mm) | Tension — $\phi N_n$ | | | | Shear — $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| #5 | 5-5/8 (143) | 6,965 (31.0) | 6,965 (31.0) | 6,965 (31.0) | 6,965 (31.0) | 15,000 (66.7) | 15,000 (66.7) | 15,000 (66.7) | 15,000 (66.7) |
| | 7-1/2 (191) | 9,285 (41.3) | 9,285 (41.3) | 9,285 (41.3) | 9,285 (41.3) | 20,000 (89.0) | 20,000 (89.0) | 20,000 (89.0) | 20,000 (89.0) |
| | 12-1/2 (318) | 15,475 (68.8) | 15,475 (68.8) | 15,475 (68.8) | 15,475 (68.8) | 33,330 (148.3) | 33,330 (148.3) | 33,330 (148.3) | 33,330 (148.3) |
| #6 | 6-3/4 (171) | 9,690 (43.1) | 10,235 (45.5) | 10,235 (45.5) | 10,235 (45.5) | 20,870 (92.8) | 22,045 (98.1) | 22,045 (98.1) | 22,045 (98.1) |
| | 9 (229) | 13,645 (60.7) | 13,645 (60.7) | 13,645 (60.7) | 13,645 (60.7) | 29,390 (130.7) | 29,390 (130.7) | 29,390 (130.7) | 29,390 (130.7) |
| | 11-1/4 (286) | 17,055 (75.9) | 17,055 (75.9) | 17,055 (75.9) | 17,055 (75.9) | 36,740 (163.4) | 36,740 (163.4) | 36,740 (163.4) | 36,740 (163.4) |
| #7 | 7-7/8 (200) | 12,210 (54.3) | 13,375 (59.5) | 13,930 (62.0) | 13,930 (62.0) | 26,300 (117.0) | 28,810 (128.2) | 30,005 (133.5) | 30,005 (133.5) |
| | 10-1/2 (267) | 18,575 (82.6) | 18,575 (82.6) | 18,575 (82.6) | 18,575 (82.6) | 40,005 (178.0) | 40,005 (178.0) | 40,005 (178.0) | 40,005 (178.0) |
| | 17-1/2 (445) | 30,955 (137.7) | 30,955 (137.7) | 30,955 (137.7) | 30,955 (137.7) | 66,675 (296.6) | 66,675 (296.6) | 66,675 (296.6) | 66,675 (296.6) |
| #8 | 9 (229) | 14,920 (66.4) | 16,340 (72.7) | 18,285 (81.3) | 18,285 (81.3) | 32,130 (142.9) | 35,195 (156.6) | 39,385 (175.2) | 39,385 (175.2) |
| | 12 (305) | 22,965 (102.2) | 24,380 (108.4) | 24,380 (108.4) | 24,380 (108.4) | 49,465 (220.0) | 52,515 (233.6) | 52,515 (233.6) | 52,515 (233.6) |
| | 20 (508) | 40,635 (180.8) | 40,635 (180.8) | 40,635 (180.8) | 40,635 (180.8) | 87,525 (389.3) | 87,525 (389.3) | 87,525 (389.3) | 87,525 (389.3) |
| #9 | 10-1/8 (257) | 17,800 (79.2) | 19,500 (86.7) | 22,515 (100.2) | 22,560 (100.4) | 38,340 (170.5) | 42,000 (186.8) | 48,495 (215.7) | 48,595 (216.2) |
| | 13-1/2 (343) | 27,405 (121.9) | 30,020 (133.5) | 30,085 (133.8) | 30,085 (133.8) | 59,025 (262.6) | 64,660 (287.6) | 64,795 (288.2) | 64,795 (288.2) |
| | 22-1/2 (572) | 50,140 (223.0) | 50,140 (223.0) | 50,140 (223.0) | 50,140 (223.0) | 107,990 (480.4) | 107,990 (480.4) | 107,990 (480.4) | 107,990 (480.4) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 8 - 23 as necessary to the above values. Compare to the steel values in table 7. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete and water-saturated concrete conditions.
Water-filled and submerged (under water) applications are not permitted for this hole preparation method.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.68. See section 3.1.8 for additional information on seismic applications.

**Table 7 — Steel design strength for US rebar[1]**

| Rebar size | ASTM A 615 Grade 40[2] | | | ASTM A 615 Grade 60[2] | | | ASTM A 706 Grade 60[2] | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic Shear[5] $\phi V_{sa,eq}$ lb (kN) | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic Shear[5] $\phi V_{sa,eq}$ lb (kN) | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic Shear[5] $\phi V_{sa,eq}$ lb (kN) |
| #3 | 4,290 (19.1) | 2,375 (10.6) | 1,665 (7.4) | 5,720 (25.4) | 3,170 (14.1) | 2,220 (9.9) | 6,600 (29.4) | 3,430 (15.3) | 2,400 (10.7) |
| #4 | 7,800 (34.7) | 4,320 (19.2) | 3,025 (13.5) | 10,400 (46.3) | 5,760 (25.6) | 4,030 (17.9) | 12,000 (53.4) | 6,240 (27.8) | 4,370 (19.4) |
| #5 | 12,090 (53.8) | 6,695 (29.8) | 4,685 (20.8) | 16,120 (71.7) | 8,930 (39.7) | 6,250 (27.8) | 18,600 (82.7) | 9,670 (43.0) | 6,770 (30.1) |
| #6 | 17,160 (76.3) | 9,505 (42.3) | 6,655 (29.6) | 22,880 (101.8) | 12,670 (56.4) | 8,870 (39.5) | 26,400 (117.4) | 13,730 (61.1) | 9,610 (42.7) |
| #7 | 23,400 (104.1) | 12,960 (57.6) | 9,070 (40.3) | 31,200 (138.8) | 17,280 (76.9) | 12,095 (53.8) | 36,000 (160.1) | 18,720 (83.3) | 13,105 (58.3) |
| #8 | 30,810 (137.0) | 17,065 (75.9) | 11,945 (53.1) | 41,080 (182.7) | 22,750 (101.2) | 15,925 (70.8) | 47,400 (210.8) | 24,650 (109.6) | 17,255 (76.8) |
| #9 | 39,000 (173.5) | 21,600 (96.1) | 15,120 (67.3) | 52,000 (231.3) | 28,800 (128.1) | 20,160 (89.7) | 60,000 (266.9) | 31,200 (138.8) | 21,840 (97.1) |
| #10 | 49,530 (220.3) | 27,430 (122.0) | 19,200 (85.4) | 66,040 (293.8) | 36,575 (162.7) | 25,605 (113.9) | 76,200 (339.0) | 39,625 (176.3) | 27,740 (123.4) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 ASTM A706 Grade 60 rebar are considered ductile steel elements. ASTM A 615 Grade 40 and 60 rebar are considered brittle steel elements.
3 Tensile = $\phi\ A_{se,N}\ f_{uta}$ as noted in ACI 318 Chapter 17
4 Shear = $\phi$ 0.60 $A_{se,N}\ f_{uta}$ as noted in ACI 318 Chapter 17
5 Seismic Shear = $\alpha_{V,seis}\ \phi V_{sa}$ : Reduction for seismic shear only. See section 3.1.8 for additional information on seismic applications.

## Table 8 — Load adjustment factors for #3 rebar in uncracked concrete[1,2,3]

| #3 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment | | in. | 3-3/8 | 4-1/2 | 7-1/2 | 3-3/8 | 4-1/2 | 7-1/2 | 3-3/8 | 4-1/2 | 7-1/2 | 3-3/8 | 4-1/2 | 7-1/2 | 3-3/8 | 4-1/2 | 7-1/2 | 3-3/8 | 4-1/2 | 7-1/2 |
| $h_{ef}$ | | (mm) | (86) | (114) | (191) | (86) | (114) | (191) | (86) | (114) | (191) | (86) | (114) | (191) | (86) | (114) | (191) | (86) | (114) | (191) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.29 | 0.22 | 0.13 | n/a | n/a | n/a | 0.07 | 0.06 | 0.03 | 0.15 | 0.11 | 0.07 | n/a | n/a | n/a |
| | 1-7/8 | (48) | 0.59 | 0.57 | 0.54 | 0.30 | 0.22 | 0.13 | 0.53 | 0.53 | 0.52 | 0.08 | 0.06 | 0.04 | 0.17 | 0.12 | 0.07 | n/a | n/a | n/a |
| | 2 | (51) | 0.59 | 0.57 | 0.54 | 0.31 | 0.23 | 0.13 | 0.53 | 0.53 | 0.52 | 0.09 | 0.07 | 0.04 | 0.18 | 0.14 | 0.08 | n/a | n/a | n/a |
| | 3 | (76) | 0.64 | 0.61 | 0.57 | 0.38 | 0.28 | 0.16 | 0.55 | 0.54 | 0.53 | 0.17 | 0.13 | 0.08 | 0.34 | 0.25 | 0.15 | n/a | n/a | n/a |
| | 4 | (102) | 0.69 | 0.65 | 0.59 | 0.45 | 0.33 | 0.19 | 0.57 | 0.56 | 0.54 | 0.26 | 0.19 | 0.12 | 0.45 | 0.33 | 0.19 | n/a | n/a | n/a |
| | 4-5/8 | (117) | 0.72 | 0.67 | 0.60 | 0.50 | 0.37 | 0.22 | 0.58 | 0.56 | 0.55 | 0.32 | 0.24 | 0.14 | 0.50 | 0.37 | 0.22 | 0.56 | n/a | n/a |
| | 5 | (127) | 0.74 | 0.69 | 0.61 | 0.54 | 0.39 | 0.23 | 0.58 | 0.57 | 0.55 | 0.36 | 0.27 | 0.16 | 0.54 | 0.39 | 0.23 | 0.58 | n/a | n/a |
| | 5-3/4 | (146) | 0.77 | 0.71 | 0.63 | 0.61 | 0.45 | 0.26 | 0.60 | 0.58 | 0.56 | 0.45 | 0.33 | 0.20 | 0.61 | 0.45 | 0.26 | 0.62 | 0.57 | n/a |
| | 6 | (152) | 0.78 | 0.72 | 0.63 | 0.64 | 0.47 | 0.27 | 0.60 | 0.58 | 0.56 | 0.47 | 0.36 | 0.21 | 0.64 | 0.47 | 0.27 | 0.64 | 0.58 | n/a |
| | 7 | (178) | 0.83 | 0.76 | 0.66 | 0.75 | 0.54 | 0.32 | 0.62 | 0.60 | 0.57 | 0.60 | 0.45 | 0.27 | 0.75 | 0.54 | 0.32 | 0.69 | 0.63 | n/a |
| | 8 | (203) | 0.88 | 0.80 | 0.68 | 0.85 | 0.62 | 0.36 | 0.64 | 0.61 | 0.58 | 0.73 | 0.55 | 0.33 | 0.85 | 0.62 | 0.36 | 0.74 | 0.67 | n/a |
| | 8-3/4 | (222) | 0.91 | 0.82 | 0.69 | 0.93 | 0.68 | 0.39 | 0.65 | 0.62 | 0.59 | 0.84 | 0.63 | 0.38 | 0.93 | 0.68 | 0.39 | 0.77 | 0.70 | 0.59 |
| | 9 | (229) | 0.92 | 0.83 | 0.70 | 0.96 | 0.70 | 0.41 | 0.65 | 0.63 | 0.59 | 0.87 | 0.65 | 0.39 | 0.96 | 0.70 | 0.41 | 0.78 | 0.71 | 0.60 |
| | 10 | (254) | 0.97 | 0.87 | 0.72 | 1.00 | 0.78 | 0.45 | 0.67 | 0.64 | 0.60 | 1.00 | 0.77 | 0.46 | 1.00 | 0.78 | 0.45 | 0.82 | 0.75 | 0.63 |
| | 11 | (279) | 1.00 | 0.91 | 0.74 | | 0.85 | 0.50 | 0.69 | 0.65 | 0.61 | | 0.88 | 0.53 | | 0.85 | 0.50 | 0.86 | 0.78 | 0.66 |
| | 12 | (305) | | 0.94 | 0.77 | | 0.93 | 0.54 | 0.70 | 0.67 | 0.62 | | 1.00 | 0.60 | | 0.93 | 0.54 | 0.90 | 0.82 | 0.69 |
| | 14 | (356) | | 1.00 | 0.81 | | 1.00 | 0.63 | 0.74 | 0.70 | 0.64 | | | 0.76 | | 1.00 | 0.63 | 0.97 | 0.88 | 0.75 |
| | 16 | (406) | | | 0.86 | | | 0.72 | 0.77 | 0.72 | 0.66 | | | 0.93 | | | 0.72 | 1.00 | 0.95 | 0.80 |
| | 18 | (457) | | | 0.90 | | | 0.81 | 0.80 | 0.75 | 0.68 | | | 1.00 | | | 0.81 | | 1.00 | 0.85 |
| | 24 | (610) | | | 1.00 | | | 1.00 | 0.91 | 0.83 | 0.74 | | | | | | 1.00 | | | 0.98 |
| | 30 | (762) | | | | | | | 1.00 | 0.92 | 0.80 | | | | | | | | | 1.00 |
| | 36 | (914) | | | | | | | | 1.00 | 0.86 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | | 0.98 | | | | | | | | | |

## Table 9 — Load adjustment factors for #3 rebar in cracked concrete[1,2,3]

| #3 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment | | in. | 3-3/8 | 4-1/2 | 7-1/2 | 3-3/8 | 4-1/2 | 7-1/2 | 3-3/8 | 4-1/2 | 7-1/2 | 3-3/8 | 4-1/2 | 7-1/2 | 3-3/8 | 4-1/2 | 7-1/2 | 3-3/8 | 4-1/2 | 7-1/2 |
| $h_{ef}$ | | (mm) | (86) | (114) | (191) | (86) | (114) | (191) | (86) | (114) | (191) | (86) | (114) | (191) | (86) | (114) | (191) | (86) | (114) | (191) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.53 | 0.49 | 0.43 | n/a | n/a | n/a | 0.07 | 0.05 | 0.03 | 0.14 | 0.11 | 0.06 | n/a | n/a | n/a |
| | 1-7/8 | (48) | 0.59 | 0.57 | 0.54 | 0.55 | 0.50 | 0.44 | 0.53 | 0.53 | 0.52 | 0.08 | 0.06 | 0.03 | 0.16 | 0.12 | 0.07 | n/a | n/a | n/a |
| | 2 | (51) | 0.59 | 0.57 | 0.54 | 0.56 | 0.51 | 0.44 | 0.53 | 0.53 | 0.52 | 0.09 | 0.06 | 0.04 | 0.17 | 0.13 | 0.08 | n/a | n/a | n/a |
| | 3 | (76) | 0.64 | 0.61 | 0.57 | 0.68 | 0.60 | 0.49 | 0.55 | 0.54 | 0.53 | 0.16 | 0.12 | 0.07 | 0.32 | 0.24 | 0.14 | n/a | n/a | n/a |
| | 4 | (102) | 0.69 | 0.65 | 0.59 | 0.81 | 0.70 | 0.55 | 0.57 | 0.55 | 0.54 | 0.25 | 0.18 | 0.11 | 0.49 | 0.36 | 0.22 | n/a | n/a | n/a |
| | 4-5/8 | (117) | 0.72 | 0.67 | 0.60 | 0.90 | 0.76 | 0.58 | 0.58 | 0.56 | 0.54 | 0.31 | 0.23 | 0.14 | 0.61 | 0.45 | 0.27 | 0.55 | n/a | n/a |
| | 5 | (127) | 0.74 | 0.69 | 0.61 | 0.95 | 0.80 | 0.60 | 0.58 | 0.57 | 0.55 | 0.34 | 0.25 | 0.15 | 0.69 | 0.51 | 0.30 | 0.57 | n/a | n/a |
| | 5-3/4 | (146) | 0.77 | 0.71 | 0.63 | 1.00 | 0.88 | 0.64 | 0.59 | 0.58 | 0.55 | 0.42 | 0.31 | 0.19 | 0.85 | 0.63 | 0.38 | 0.61 | 0.55 | n/a |
| | 6 | (152) | 0.78 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.60 | 0.58 | 0.56 | 0.45 | 0.33 | 0.20 | 0.91 | 0.67 | 0.40 | 0.63 | 0.57 | n/a |
| | 7 | (178) | 0.83 | 0.76 | 0.66 | | 1.00 | 0.72 | 0.61 | 0.59 | 0.57 | 0.57 | 0.42 | 0.25 | 1.00 | 0.84 | 0.50 | 0.68 | 0.61 | n/a |
| | 8 | (203) | 0.88 | 0.80 | 0.68 | | | 0.78 | 0.63 | 0.61 | 0.58 | 0.70 | 0.51 | 0.31 | | 1.00 | 0.62 | 0.72 | 0.65 | n/a |
| | 8-3/4 | (222) | 0.91 | 0.82 | 0.69 | | | 0.83 | 0.64 | 0.62 | 0.58 | 0.80 | 0.59 | 0.35 | | | 0.70 | 0.76 | 0.68 | 0.58 |
| | 9 | (229) | 0.92 | 0.83 | 0.70 | | | 0.85 | 0.65 | 0.62 | 0.59 | 0.83 | 0.61 | 0.37 | | | 0.74 | 0.77 | 0.69 | 0.58 |
| | 10 | (254) | 0.97 | 0.87 | 0.72 | | | 0.91 | 0.66 | 0.63 | 0.60 | 0.97 | 0.72 | 0.43 | | | 0.86 | 0.81 | 0.73 | 0.62 |
| | 11 | (279) | 1.00 | 0.91 | 0.74 | | | 0.98 | 0.68 | 0.65 | 0.60 | 1.00 | 0.83 | 0.50 | | | 0.98 | 0.85 | 0.77 | 0.65 |
| | 12 | (305) | | 0.94 | 0.77 | | | 1.00 | 0.70 | 0.66 | 0.61 | | 0.94 | 0.57 | | | 1.00 | 0.89 | 0.80 | 0.68 |
| | 14 | (356) | | 1.00 | 0.81 | | | | 0.73 | 0.69 | 0.63 | | 1.00 | 0.71 | | | | 0.96 | 0.86 | 0.73 |
| | 16 | (406) | | | 0.86 | | | | 0.76 | 0.71 | 0.65 | | | 0.87 | | | | 1.00 | 0.92 | 0.78 |
| | 18 | (457) | | | 0.90 | | | | 0.79 | 0.74 | 0.67 | | | 1.00 | | | | | 0.98 | 0.83 |
| | 24 | (610) | | | 1.00 | | | | 0.89 | 0.82 | 0.73 | | | 1.00 | | | | | 1.00 | 0.96 |
| | 30 | (762) | | | | | | | 0.99 | 0.90 | 0.79 | | | 1.00 | | | | | | 1.00 |
| | 36 | (914) | | | | | | | 1.00 | 0.98 | 0.84 | | | 1.00 | | | | | | |
| | > 48 | (1219) | | | | | | | | 1.00 | 0.96 | | | 1.00 | | | | | | |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

### Table 10 — Load adjustment factors for #4 rebar in uncracked concrete[1,2,3]

| #4 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment | | in. | 4-1/2 | 6 | 10 | 4-1/2 | 6 | 10 | 4-1/2 | 6 | 10 | 4-1/2 | 6 | 10 | 4-1/2 | 6 | 10 | 4-1/2 | 6 | 10 |
| $h_{ef}$ | | (mm) | (114) | (152) | (254) | (114) | (152) | (254) | (114) | (152) | (254) | (114) | (152) | (254) | (114) | (152) | (254) | (114) | (152) | (254) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.26 | 0.20 | 0.11 | n/a | n/a | n/a | 0.05 | 0.04 | 0.02 | 0.11 | 0.07 | 0.04 | n/a | n/a | n/a |
| | 2-1/2 | (64) | 0.59 | 0.57 | 0.54 | 0.29 | 0.22 | 0.13 | 0.53 | 0.53 | 0.52 | 0.09 | 0.06 | 0.04 | 0.18 | 0.13 | 0.08 | n/a | n/a | n/a |
| | 3 | (76) | 0.61 | 0.58 | 0.55 | 0.32 | 0.24 | 0.14 | 0.54 | 0.53 | 0.52 | 0.12 | 0.08 | 0.05 | 0.24 | 0.17 | 0.10 | n/a | n/a | n/a |
| | 4 | (102) | 0.64 | 0.61 | 0.57 | 0.37 | 0.28 | 0.16 | 0.55 | 0.54 | 0.53 | 0.18 | 0.13 | 0.08 | 0.37 | 0.26 | 0.15 | n/a | n/a | n/a |
| | 5 | (127) | 0.68 | 0.64 | 0.58 | 0.42 | 0.32 | 0.18 | 0.57 | 0.55 | 0.54 | 0.26 | 0.18 | 0.11 | 0.42 | 0.32 | 0.18 | n/a | n/a | n/a |
| | 5-3/4 | (146) | 0.70 | 0.66 | 0.60 | 0.47 | 0.35 | 0.20 | 0.58 | 0.56 | 0.54 | 0.32 | 0.22 | 0.13 | 0.47 | 0.35 | 0.20 | 0.56 | n/a | n/a |
| | 6 | (152) | 0.71 | 0.67 | 0.60 | 0.48 | 0.36 | 0.21 | 0.58 | 0.56 | 0.55 | 0.34 | 0.24 | 0.14 | 0.48 | 0.36 | 0.21 | 0.57 | n/a | n/a |
| | 7 | (178) | 0.75 | 0.69 | 0.62 | 0.55 | 0.40 | 0.24 | 0.59 | 0.57 | 0.55 | 0.42 | 0.30 | 0.18 | 0.55 | 0.40 | 0.24 | 0.61 | n/a | n/a |
| | 7-1/4 | (184) | 0.76 | 0.70 | 0.62 | 0.57 | 0.42 | 0.24 | 0.60 | 0.58 | 0.55 | 0.45 | 0.31 | 0.19 | 0.57 | 0.42 | 0.24 | 0.62 | 0.55 | n/a |
| | 8 | (203) | 0.79 | 0.72 | 0.63 | 0.63 | 0.46 | 0.27 | 0.61 | 0.58 | 0.56 | 0.52 | 0.36 | 0.22 | 0.63 | 0.46 | 0.27 | 0.66 | 0.58 | n/a |
| | 9 | (229) | 0.82 | 0.75 | 0.65 | 0.70 | 0.52 | 0.30 | 0.62 | 0.60 | 0.57 | 0.62 | 0.43 | 0.26 | 0.70 | 0.52 | 0.30 | 0.70 | 0.62 | n/a |
| | 10 | (254) | 0.86 | 0.78 | 0.67 | 0.78 | 0.57 | 0.34 | 0.63 | 0.61 | 0.58 | 0.72 | 0.51 | 0.30 | 0.78 | 0.57 | 0.34 | 0.73 | 0.65 | n/a |
| | 11-1/4 | (286) | 0.90 | 0.81 | 0.69 | 0.88 | 0.65 | 0.38 | 0.65 | 0.62 | 0.58 | 0.86 | 0.60 | 0.36 | 0.88 | 0.65 | 0.38 | 0.78 | 0.69 | 0.58 |
| | 12 | (305) | 0.93 | 0.83 | 0.70 | 0.94 | 0.69 | 0.40 | 0.66 | 0.63 | 0.59 | 0.95 | 0.67 | 0.40 | 0.94 | 0.69 | 0.40 | 0.80 | 0.71 | 0.60 |
| | 14 | (356) | 1.00 | 0.89 | 0.73 | 1.00 | 0.80 | 0.47 | 0.69 | 0.65 | 0.61 | 1.00 | 0.84 | 0.50 | 1.00 | 0.80 | 0.47 | 0.87 | 0.77 | 0.65 |
| | 16 | (406) | | 0.94 | 0.77 | | 0.92 | 0.54 | 0.72 | 0.67 | 0.62 | | 1.00 | 0.61 | | 0.92 | 0.54 | 0.93 | 0.82 | 0.69 |
| | 18 | (457) | | 1.00 | 0.80 | | 1.00 | 0.60 | 0.74 | 0.69 | 0.64 | | | 0.73 | | 1.00 | 0.60 | 0.98 | 0.87 | 0.74 |
| | 20 | (508) | | | 0.83 | | | 0.67 | 0.77 | 0.71 | 0.65 | | | 0.86 | | | 0.67 | 1.00 | 0.92 | 0.78 |
| | 22 | (559) | | | 0.87 | | | 0.74 | 0.80 | 0.73 | 0.67 | | | 0.99 | | | 0.74 | | 0.97 | 0.81 |
| | 24 | (610) | | | 0.90 | | | 0.81 | 0.82 | 0.75 | 0.68 | | | 1.00 | | | 0.81 | | 1.00 | 0.85 |
| | 30 | (762) | | | 1.00 | | | 1.00 | 0.90 | 0.82 | 0.73 | | | | | | 1.00 | | | 0.95 |
| | 36 | (914) | | | | | | | 0.98 | 0.88 | 0.77 | | | | | | | | | 1.00 |
| | > 48 | (1219) | | | | | | | 1.00 | 1.00 | 0.86 | | | | | | | | | |

### Table 11 — Load adjustment factors for #4 rebar in cracked concrete[1,2,3]

| #4 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment | | in. | 4-1/2 | 6 | 10 | 4-1/2 | 6 | 10 | 4-1/2 | 6 | 10 | 4-1/2 | 6 | 10 | 4-1/2 | 6 | 10 | 4-1/2 | 6 | 10 |
| $h_{ef}$ | | (mm) | (114) | (152) | (254) | (114) | (152) | (254) | (114) | (152) | (254) | (114) | (152) | (254) | (114) | (152) | (254) | (114) | (152) | (254) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.48 | 0.45 | 0.41 | n/a | n/a | n/a | 0.05 | 0.03 | 0.02 | 0.11 | 0.07 | 0.04 | n/a | n/a | n/a |
| | 2-1/2 | (64) | 0.59 | 0.57 | 0.54 | 0.55 | 0.50 | 0.44 | 0.53 | 0.53 | 0.52 | 0.09 | 0.06 | 0.03 | 0.18 | 0.12 | 0.07 | n/a | n/a | n/a |
| | 3 | (76) | 0.61 | 0.58 | 0.55 | 0.59 | 0.53 | 0.46 | 0.54 | 0.53 | 0.52 | 0.12 | 0.08 | 0.05 | 0.24 | 0.16 | 0.09 | n/a | n/a | n/a |
| | 4 | (102) | 0.64 | 0.61 | 0.57 | 0.68 | 0.60 | 0.49 | 0.55 | 0.54 | 0.53 | 0.18 | 0.12 | 0.07 | 0.37 | 0.24 | 0.14 | n/a | n/a | n/a |
| | 5 | (127) | 0.68 | 0.64 | 0.58 | 0.78 | 0.67 | 0.53 | 0.57 | 0.55 | 0.54 | 0.26 | 0.17 | 0.10 | 0.52 | 0.34 | 0.20 | n/a | n/a | n/a |
| | 5-3/4 | (146) | 0.70 | 0.66 | 0.60 | 0.86 | 0.73 | 0.56 | 0.58 | 0.56 | 0.54 | 0.32 | 0.21 | 0.12 | 0.64 | 0.41 | 0.24 | 0.56 | n/a | n/a |
| | 6 | (152) | 0.71 | 0.67 | 0.60 | 0.89 | 0.75 | 0.57 | 0.58 | 0.56 | 0.54 | 0.34 | 0.22 | 0.13 | 0.68 | 0.44 | 0.26 | 0.57 | n/a | n/a |
| | 7 | (178) | 0.75 | 0.69 | 0.62 | 1.00 | 0.83 | 0.62 | 0.59 | 0.57 | 0.55 | 0.43 | 0.28 | 0.16 | 0.86 | 0.56 | 0.33 | 0.62 | n/a | n/a |
| | 7-1/4 | (184) | 0.76 | 0.70 | 0.62 | | 0.85 | 0.63 | 0.60 | 0.57 | 0.55 | 0.45 | 0.29 | 0.17 | 0.90 | 0.59 | 0.34 | 0.63 | 0.54 | n/a |
| | 8 | (203) | 0.79 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.61 | 0.58 | 0.56 | 0.52 | 0.34 | 0.20 | 1.00 | 0.68 | 0.40 | 0.66 | 0.57 | n/a |
| | 9 | (229) | 0.82 | 0.75 | 0.65 | | 1.00 | 0.70 | 0.62 | 0.59 | 0.56 | 0.62 | 0.41 | 0.24 | | 0.81 | 0.47 | 0.70 | 0.60 | n/a |
| | 10 | (254) | 0.86 | 0.78 | 0.67 | | | 0.75 | 0.64 | 0.60 | 0.57 | 0.73 | 0.47 | 0.28 | | 0.95 | 0.56 | 0.74 | 0.64 | n/a |
| | 11-1/4 | (286) | 0.90 | 0.81 | 0.69 | | | 0.81 | 0.65 | 0.61 | 0.58 | 0.87 | 0.57 | 0.33 | | 1.00 | 0.66 | 0.78 | 0.68 | 0.56 |
| | 12 | (305) | 0.93 | 0.83 | 0.70 | | | 0.85 | 0.66 | 0.62 | 0.59 | 0.96 | 0.62 | 0.36 | | | 0.73 | 0.81 | 0.70 | 0.58 |
| | 14 | (356) | 1.00 | 0.89 | 0.73 | | | 0.95 | 0.69 | 0.64 | 0.60 | 1.00 | 0.79 | 0.46 | | | 0.92 | 0.87 | 0.75 | 0.63 |
| | 16 | (406) | | 0.94 | 0.77 | | | 1.00 | 0.72 | 0.66 | 0.61 | | 0.96 | 0.56 | | | 1.00 | 0.93 | 0.81 | 0.67 |
| | 18 | (457) | | 1.00 | 0.80 | | | | 0.74 | 0.68 | 0.63 | | 1.00 | 0.67 | | | | 0.99 | 0.85 | 0.71 |
| | 20 | (508) | | | 0.83 | | | | 0.77 | 0.70 | 0.64 | | | 0.79 | | | | 1.00 | 0.90 | 0.75 |
| | 22 | (559) | | | 0.87 | | | | 0.80 | 0.72 | 0.66 | | | 0.91 | | | | | 0.94 | 0.79 |
| | 24 | (610) | | | 0.90 | | | | 0.82 | 0.74 | 0.67 | | | 1.00 | | | | | 0.99 | 0.83 |
| | 30 | (762) | | | 1.00 | | | | 0.91 | 0.80 | 0.71 | | | | | | | | 1.00 | 0.92 |
| | 36 | (914) | | | | | | | 0.99 | 0.87 | 0.76 | | | | | | | | | 1.00 |
| | > 48 | (1219) | | | | | | | 1.00 | 0.99 | 0.84 | | | | | | | | | |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 12 — Load adjustment factors for #5 rebar in uncracked concrete[1,2,3]

| #5 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | ‖ To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.24 | 0.18 | 0.11 | n/a | n/a | n/a | 0.04 | 0.03 | 0.02 | 0.08 | 0.06 | 0.03 | n/a | n/a | n/a |
| | 3-1/8 | (79) | 0.59 | 0.57 | 0.54 | 0.29 | 0.22 | 0.13 | 0.54 | 0.53 | 0.52 | 0.10 | 0.07 | 0.04 | 0.20 | 0.13 | 0.08 | n/a | n/a | n/a |
| | 4 | (102) | 0.61 | 0.59 | 0.55 | 0.33 | 0.25 | 0.14 | 0.55 | 0.53 | 0.52 | 0.15 | 0.10 | 0.06 | 0.29 | 0.19 | 0.11 | n/a | n/a | n/a |
| | 5 | (127) | 0.64 | 0.61 | 0.57 | 0.37 | 0.28 | 0.16 | 0.56 | 0.54 | 0.53 | 0.21 | 0.13 | 0.08 | 0.37 | 0.27 | 0.16 | n/a | n/a | n/a |
| | 6 | (152) | 0.67 | 0.63 | 0.58 | 0.41 | 0.31 | 0.18 | 0.57 | 0.55 | 0.54 | 0.27 | 0.18 | 0.10 | 0.41 | 0.31 | 0.18 | n/a | n/a | n/a |
| | 7 | (178) | 0.70 | 0.66 | 0.59 | 0.46 | 0.34 | 0.20 | 0.58 | 0.56 | 0.54 | 0.34 | 0.22 | 0.13 | 0.46 | 0.34 | 0.20 | n/a | n/a | n/a |
| | 7-1/8 | (181) | 0.70 | 0.66 | 0.60 | 0.46 | 0.34 | 0.20 | 0.58 | 0.56 | 0.54 | 0.35 | 0.23 | 0.13 | 0.46 | 0.34 | 0.20 | 0.57 | n/a | n/a |
| | 8 | (203) | 0.73 | 0.68 | 0.61 | 0.51 | 0.38 | 0.22 | 0.59 | 0.57 | 0.55 | 0.41 | 0.27 | 0.16 | 0.51 | 0.38 | 0.22 | 0.61 | n/a | n/a |
| | 9 | (229) | 0.76 | 0.70 | 0.62 | 0.56 | 0.41 | 0.24 | 0.60 | 0.58 | 0.55 | 0.50 | 0.32 | 0.19 | 0.56 | 0.41 | 0.24 | 0.65 | 0.56 | n/a |
| | 10 | (254) | 0.79 | 0.72 | 0.63 | 0.63 | 0.46 | 0.27 | 0.62 | 0.59 | 0.56 | 0.58 | 0.38 | 0.22 | 0.63 | 0.46 | 0.27 | 0.68 | 0.59 | n/a |
| | 11 | (279) | 0.82 | 0.74 | 0.65 | 0.69 | 0.51 | 0.30 | 0.63 | 0.60 | 0.57 | 0.67 | 0.43 | 0.25 | 0.69 | 0.51 | 0.30 | 0.71 | 0.62 | n/a |
| | 12 | (305) | 0.84 | 0.77 | 0.66 | 0.75 | 0.55 | 0.32 | 0.64 | 0.60 | 0.57 | 0.76 | 0.50 | 0.29 | 0.75 | 0.55 | 0.32 | 0.75 | 0.65 | n/a |
| | 14 | (356) | 0.90 | 0.81 | 0.69 | 0.88 | 0.64 | 0.38 | 0.66 | 0.62 | 0.59 | 0.96 | 0.62 | 0.36 | 0.88 | 0.64 | 0.38 | 0.81 | 0.70 | 0.58 |
| | 16 | (406) | 0.96 | 0.86 | 0.71 | 1.00 | 0.74 | 0.43 | 0.69 | 0.64 | 0.60 | 1.00 | 0.76 | 0.45 | 1.00 | 0.74 | 0.43 | 0.86 | 0.75 | 0.62 |
| | 18 | (457) | 1.00 | 0.90 | 0.74 | | 0.83 | 0.49 | 0.71 | 0.66 | 0.61 | | 0.91 | 0.53 | | 0.83 | 0.49 | 0.91 | 0.79 | 0.66 |
| | 20 | (508) | | 0.94 | 0.77 | | 0.92 | 0.54 | 0.73 | 0.67 | 0.62 | | 1.00 | 0.62 | | 0.92 | 0.54 | 0.96 | 0.83 | 0.70 |
| | 22 | (559) | | 0.99 | 0.79 | | 1.00 | 0.59 | 0.75 | 0.69 | 0.63 | | | 0.72 | | 1.00 | 0.59 | 1.00 | 0.87 | 0.73 |
| | 24 | (610) | | 1.00 | 0.82 | | | 0.65 | 0.78 | 0.71 | 0.65 | | | 0.82 | | | 0.65 | | 0.91 | 0.76 |
| | 26 | (660) | | | 0.85 | | | 0.70 | 0.80 | 0.73 | 0.66 | | | 0.92 | | | 0.70 | | 0.95 | 0.79 |
| | 28 | (711) | | | 0.87 | | | 0.75 | 0.82 | 0.74 | 0.67 | | | 1.00 | | | 0.75 | | 0.99 | 0.82 |
| | 30 | (762) | | | 0.90 | | | 0.81 | 0.85 | 0.76 | 0.68 | | | | | | 0.81 | | 1.00 | 0.85 |
| | 36 | (914) | | | 0.98 | | | 0.97 | 0.92 | 0.81 | 0.72 | | | | | | 0.97 | | | 0.94 |
| | > 48 | (1219) | | | 1.00 | | | 1.00 | 1.00 | 0.92 | 0.79 | | | | | | 1.00 | | | 1.00 |

## Table 13 — Load adjustment factors for #5 rebar in cracked concrete[1,2,3]

| #5 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | ‖ To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.46 | 0.43 | 0.40 | n/a | n/a | n/a | 0.04 | 0.03 | 0.01 | 0.09 | 0.06 | 0.03 | n/a | n/a | n/a |
| | 3-1/8 | (79) | 0.59 | 0.57 | 0.54 | 0.55 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.10 | 0.07 | 0.03 | 0.20 | 0.13 | 0.07 | n/a | n/a | n/a |
| | 4 | (102) | 0.61 | 0.59 | 0.55 | 0.61 | 0.55 | 0.46 | 0.55 | 0.53 | 0.52 | 0.15 | 0.10 | 0.05 | 0.30 | 0.19 | 0.10 | n/a | n/a | n/a |
| | 5 | (127) | 0.64 | 0.61 | 0.57 | 0.69 | 0.60 | 0.49 | 0.56 | 0.54 | 0.53 | 0.21 | 0.13 | 0.07 | 0.41 | 0.27 | 0.14 | n/a | n/a | n/a |
| | 6 | (152) | 0.67 | 0.63 | 0.58 | 0.77 | 0.66 | 0.53 | 0.57 | 0.55 | 0.53 | 0.27 | 0.18 | 0.09 | 0.54 | 0.35 | 0.18 | n/a | n/a | n/a |
| | 7 | (178) | 0.70 | 0.66 | 0.59 | 0.85 | 0.72 | 0.56 | 0.58 | 0.56 | 0.54 | 0.34 | 0.22 | 0.11 | 0.68 | 0.44 | 0.23 | n/a | n/a | n/a |
| | 7-1/8 | (181) | 0.70 | 0.66 | 0.60 | 0.86 | 0.73 | 0.56 | 0.58 | 0.56 | 0.54 | 0.35 | 0.23 | 0.12 | 0.70 | 0.46 | 0.23 | 0.58 | n/a | n/a |
| | 8 | (203) | 0.73 | 0.68 | 0.61 | 0.93 | 0.78 | 0.59 | 0.59 | 0.57 | 0.54 | 0.42 | 0.27 | 0.14 | 0.84 | 0.54 | 0.28 | 0.61 | n/a | n/a |
| | 9 | (229) | 0.76 | 0.70 | 0.62 | 1.00 | 0.85 | 0.62 | 0.60 | 0.58 | 0.55 | 0.50 | 0.32 | 0.17 | 1.00 | 0.65 | 0.33 | 0.65 | 0.56 | n/a |
| | 10 | (254) | 0.79 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.62 | 0.59 | 0.56 | 0.58 | 0.38 | 0.19 | | 0.76 | 0.39 | 0.68 | 0.59 | n/a |
| | 11 | (279) | 0.82 | 0.74 | 0.65 | | 0.98 | 0.69 | 0.63 | 0.60 | 0.56 | 0.67 | 0.44 | 0.22 | | 0.88 | 0.45 | 0.72 | 0.62 | n/a |
| | 12 | (305) | 0.84 | 0.77 | 0.66 | | 1.00 | 0.73 | 0.64 | 0.60 | 0.57 | 0.77 | 0.50 | 0.26 | | 1.00 | 0.51 | 0.75 | 0.65 | n/a |
| | 14 | (356) | 0.90 | 0.81 | 0.69 | | | 0.81 | 0.66 | 0.62 | 0.58 | 0.97 | 0.63 | 0.32 | | | 0.64 | 0.81 | 0.70 | 0.56 |
| | 16 | (406) | 0.96 | 0.86 | 0.71 | | | 0.89 | 0.69 | 0.64 | 0.59 | 1.00 | 0.77 | 0.39 | | | 0.79 | 0.86 | 0.75 | 0.60 |
| | 18 | (457) | 1.00 | 0.90 | 0.74 | | | 0.97 | 0.71 | 0.66 | 0.60 | | 0.92 | 0.47 | | | 0.94 | 0.92 | 0.79 | 0.63 |
| | 20 | (508) | | 0.94 | 0.77 | | | 1.00 | 0.73 | 0.67 | 0.61 | | 1.00 | 0.55 | | | 1.00 | 0.97 | 0.84 | 0.67 |
| | 22 | (559) | | 0.99 | 0.79 | | | | 0.76 | 0.69 | 0.62 | | | 0.63 | | | | 1.00 | 0.88 | 0.70 |
| | 24 | (610) | | 1.00 | 0.82 | | | | 0.78 | 0.71 | 0.63 | | | 0.72 | | | | | 0.92 | 0.73 |
| | 26 | (660) | | | 0.85 | | | | 0.80 | 0.73 | 0.65 | | | 0.81 | | | | | 0.95 | 0.76 |
| | 28 | (711) | | | 0.87 | | | | 0.83 | 0.74 | 0.66 | | | 0.91 | | | | | 0.99 | 0.79 |
| | 30 | (762) | | | 0.90 | | | | 0.85 | 0.76 | 0.67 | | | 1.00 | | | | | 1.00 | 0.82 |
| | 36 | (914) | | | 0.98 | | | | 0.92 | 0.81 | 0.70 | | | | | | | | | 0.90 |
| | > 48 | (1219) | | | 1.00 | | | | 1.00 | 0.92 | 0.77 | | | | | | | | | 1.00 |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

### Table 14 — Load adjustment factors for #6 rebar in uncracked concrete[1,2,3]

| #6 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment | in. | | 6-3/4 | 9 | 15 | 6-3/4 | 9 | 15 | 6-3/4 | 9 | 15 | 6-3/4 | 9 | 15 | 6-3/4 | 9 | 15 | 6-3/4 | 9 | 15 |
| $h_{ef}$ | (mm) | | (171) | (229) | (381) | (171) | (229) | (381) | (171) | (229) | (381) | (171) | (229) | (381) | (171) | (229) | (381) | (171) | (229) | (381) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | 0.03 | 0.02 | 0.01 | 0.07 | 0.05 | 0.02 | n/a | n/a | n/a |
| | 3-3/4 | (95) | 0.59 | 0.57 | 0.54 | 0.30 | 0.22 | 0.13 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.04 | 0.22 | 0.14 | 0.08 | n/a | n/a | n/a |
| | 4 | (102) | 0.60 | 0.57 | 0.54 | 0.31 | 0.23 | 0.13 | 0.54 | 0.53 | 0.52 | 0.12 | 0.08 | 0.04 | 0.24 | 0.16 | 0.08 | n/a | n/a | n/a |
| | 5 | (127) | 0.62 | 0.59 | 0.56 | 0.34 | 0.25 | 0.15 | 0.55 | 0.54 | 0.53 | 0.17 | 0.11 | 0.06 | 0.33 | 0.22 | 0.12 | n/a | n/a | n/a |
| | 6 | (152) | 0.64 | 0.61 | 0.57 | 0.38 | 0.28 | 0.16 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.08 | 0.38 | 0.28 | 0.16 | n/a | n/a | n/a |
| | 7 | (178) | 0.67 | 0.63 | 0.58 | 0.41 | 0.30 | 0.18 | 0.57 | 0.55 | 0.54 | 0.28 | 0.18 | 0.10 | 0.41 | 0.30 | 0.18 | n/a | n/a | n/a |
| | 8 | (203) | 0.69 | 0.65 | 0.59 | 0.45 | 0.33 | 0.19 | 0.58 | 0.56 | 0.54 | 0.34 | 0.22 | 0.12 | 0.45 | 0.33 | 0.19 | n/a | n/a | n/a |
| | 8-1/2 | (216) | 0.70 | 0.66 | 0.59 | 0.47 | 0.34 | 0.20 | 0.59 | 0.56 | 0.54 | 0.37 | 0.24 | 0.13 | 0.47 | 0.34 | 0.20 | 0.59 | n/a | n/a |
| | 9 | (229) | 0.72 | 0.67 | 0.60 | 0.49 | 0.36 | 0.21 | 0.59 | 0.57 | 0.55 | 0.40 | 0.26 | 0.14 | 0.49 | 0.36 | 0.21 | 0.60 | n/a | n/a |
| | 10 | (254) | 0.74 | 0.69 | 0.61 | 0.53 | 0.39 | 0.23 | 0.60 | 0.58 | 0.55 | 0.47 | 0.31 | 0.17 | 0.53 | 0.39 | 0.23 | 0.64 | n/a | n/a |
| | 10-3/4 | (273) | 0.76 | 0.70 | 0.62 | 0.57 | 0.41 | 0.24 | 0.61 | 0.58 | 0.55 | 0.53 | 0.34 | 0.19 | 0.57 | 0.41 | 0.24 | 0.66 | 0.57 | n/a |
| | 12 | (305) | 0.79 | 0.72 | 0.63 | 0.64 | 0.46 | 0.27 | 0.62 | 0.59 | 0.56 | 0.62 | 0.40 | 0.22 | 0.64 | 0.46 | 0.27 | 0.70 | 0.60 | n/a |
| | 14 | (356) | 0.84 | 0.76 | 0.66 | 0.74 | 0.54 | 0.32 | 0.64 | 0.61 | 0.57 | 0.78 | 0.51 | 0.28 | 0.74 | 0.54 | 0.32 | 0.75 | 0.65 | n/a |
| | 16 | (406) | 0.89 | 0.80 | 0.68 | 0.85 | 0.62 | 0.36 | 0.66 | 0.62 | 0.58 | 0.96 | 0.62 | 0.34 | 0.85 | 0.62 | 0.36 | 0.80 | 0.70 | n/a |
| | 16-3/4 | (425) | 0.90 | 0.81 | 0.69 | 0.89 | 0.65 | 0.38 | 0.67 | 0.63 | 0.58 | 1.00 | 0.67 | 0.36 | 0.89 | 0.65 | 0.38 | 0.82 | 0.71 | 0.58 |
| | 18 | (457) | 0.93 | 0.83 | 0.70 | 0.96 | 0.69 | 0.41 | 0.68 | 0.64 | 0.59 | | 0.74 | 0.40 | 0.96 | 0.69 | 0.41 | 0.85 | 0.74 | 0.60 |
| | 20 | (508) | 0.98 | 0.87 | 0.72 | 1.00 | 0.77 | 0.45 | 0.70 | 0.65 | 0.60 | | 0.87 | 0.47 | 1.00 | 0.77 | 0.45 | 0.90 | 0.78 | 0.64 |
| | 22 | (559) | 1.00 | 0.91 | 0.74 | | 0.85 | 0.50 | 0.72 | 0.67 | 0.61 | | 1.00 | 0.54 | | 0.85 | 0.50 | 0.94 | 0.82 | 0.67 |
| | 24 | (610) | | 0.94 | 0.77 | | 0.93 | 0.54 | 0.74 | 0.68 | 0.62 | | | 0.62 | | 0.93 | 0.54 | 0.99 | 0.85 | 0.70 |
| | 26 | (660) | | 0.98 | 0.79 | | 1.00 | 0.59 | 0.76 | 0.70 | 0.63 | | | 0.70 | | 1.00 | 0.59 | 1.00 | 0.89 | 0.72 |
| | 28 | (711) | | 1.00 | 0.81 | | | 0.63 | 0.78 | 0.71 | 0.64 | | | 0.78 | | | 0.63 | | 0.92 | 0.75 |
| | 30 | (762) | | | 0.83 | | | 0.68 | 0.80 | 0.73 | 0.65 | | | 0.87 | | | 0.68 | | 0.95 | 0.78 |
| | 36 | (914) | | | 0.90 | | | 0.81 | 0.86 | 0.77 | 0.68 | | | 1.00 | | | 0.81 | | 1.00 | 0.85 |
| | > 48 | (1219) | | | 1.00 | | | 1.00 | 0.99 | 0.86 | 0.74 | | | | | | 1.00 | | | 0.98 |

### Table 15 — Load adjustment factors for #6 rebar in cracked concrete[1,2,3]

| #6 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment | in. | | 6-3/4 | 9 | 15 | 6-3/4 | 9 | 15 | 6-3/4 | 9 | 15 | 6-3/4 | 9 | 15 | 6-3/4 | 9 | 15 | 6-3/4 | 9 | 15 |
| $h_{ef}$ | (mm) | | (171) | (229) | (381) | (171) | (229) | (381) | (171) | (229) | (381) | (171) | (229) | (381) | (171) | (229) | (381) | (171) | (229) | (381) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.44 | 0.42 | 0.39 | n/a | n/a | n/a | 0.03 | 0.02 | 0.01 | 0.07 | 0.05 | 0.02 | n/a | n/a | n/a |
| | 3-3/4 | (95) | 0.59 | 0.57 | 0.54 | 0.55 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.03 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 4 | (102) | 0.60 | 0.57 | 0.54 | 0.57 | 0.51 | 0.44 | 0.54 | 0.53 | 0.52 | 0.12 | 0.08 | 0.04 | 0.24 | 0.16 | 0.07 | n/a | n/a | n/a |
| | 5 | (127) | 0.62 | 0.59 | 0.56 | 0.63 | 0.56 | 0.47 | 0.55 | 0.54 | 0.52 | 0.17 | 0.11 | 0.05 | 0.34 | 0.22 | 0.10 | n/a | n/a | n/a |
| | 6 | (152) | 0.64 | 0.61 | 0.57 | 0.69 | 0.60 | 0.49 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.44 | 0.29 | 0.13 | n/a | n/a | n/a |
| | 7 | (178) | 0.67 | 0.63 | 0.58 | 0.76 | 0.65 | 0.52 | 0.57 | 0.55 | 0.53 | 0.28 | 0.18 | 0.08 | 0.56 | 0.36 | 0.17 | n/a | n/a | n/a |
| | 8 | (203) | 0.69 | 0.65 | 0.59 | 0.82 | 0.70 | 0.55 | 0.58 | 0.56 | 0.54 | 0.34 | 0.22 | 0.10 | 0.68 | 0.44 | 0.21 | n/a | n/a | n/a |
| | 8-1/2 | (216) | 0.70 | 0.66 | 0.59 | 0.86 | 0.72 | 0.56 | 0.59 | 0.56 | 0.54 | 0.37 | 0.24 | 0.11 | 0.75 | 0.49 | 0.23 | 0.59 | n/a | n/a |
| | 9 | (229) | 0.72 | 0.67 | 0.60 | 0.90 | 0.75 | 0.57 | 0.59 | 0.57 | 0.54 | 0.41 | 0.26 | 0.12 | 0.82 | 0.53 | 0.25 | 0.61 | n/a | n/a |
| | 10 | (254) | 0.74 | 0.69 | 0.61 | 0.97 | 0.80 | 0.60 | 0.60 | 0.58 | 0.55 | 0.48 | 0.31 | 0.14 | 0.95 | 0.62 | 0.29 | 0.64 | n/a | n/a |
| | 10-3/4 | (273) | 0.76 | 0.70 | 0.62 | 1.00 | 0.84 | 0.62 | 0.61 | 0.58 | 0.55 | 0.53 | 0.35 | 0.16 | 1.00 | 0.69 | 0.32 | 0.66 | 0.57 | n/a |
| | 12 | (305) | 0.79 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.62 | 0.59 | 0.55 | 0.63 | 0.41 | 0.19 | | 0.82 | 0.38 | 0.70 | 0.61 | n/a |
| | 14 | (356) | 0.84 | 0.76 | 0.66 | | 1.00 | 0.72 | 0.64 | 0.61 | 0.56 | 0.79 | 0.51 | 0.24 | | 1.00 | 0.48 | 0.76 | 0.65 | n/a |
| | 16 | (406) | 0.89 | 0.80 | 0.68 | | | 0.78 | 0.66 | 0.62 | 0.57 | 0.97 | 0.63 | 0.29 | | | 0.58 | 0.81 | 0.70 | n/a |
| | 16-3/4 | (425) | 0.90 | 0.81 | 0.69 | | | 0.81 | 0.67 | 0.63 | 0.58 | 1.00 | 0.67 | 0.31 | | | 0.62 | 0.83 | 0.72 | 0.55 |
| | 18 | (457) | 0.93 | 0.83 | 0.70 | | | 0.85 | 0.68 | 0.64 | 0.58 | | 0.75 | 0.35 | | | 0.70 | 0.86 | 0.74 | 0.57 |
| | 20 | (508) | 0.98 | 0.87 | 0.72 | | | 0.91 | 0.70 | 0.65 | 0.59 | | 0.88 | 0.41 | | | 0.82 | 0.90 | 0.78 | 0.61 |
| | 22 | (559) | 1.00 | 0.91 | 0.74 | | | 0.98 | 0.72 | 0.67 | 0.60 | | 1.00 | 0.47 | | | 0.94 | 0.95 | 0.82 | 0.63 |
| | 24 | (610) | | 0.94 | 0.77 | | | 1.00 | 0.74 | 0.68 | 0.61 | | | 0.54 | | | 1.00 | 0.99 | 0.86 | 0.66 |
| | 26 | (660) | | 0.98 | 0.79 | | | | 0.76 | 0.70 | 0.62 | | | 0.60 | | | | 1.00 | 0.89 | 0.69 |
| | 28 | (711) | | 1.00 | 0.81 | | | | 0.79 | 0.71 | 0.63 | | | 0.68 | | | | | 0.92 | 0.72 |
| | 30 | (762) | | | 0.83 | | | | 0.81 | 0.73 | 0.64 | | | 0.75 | | | | | 0.96 | 0.74 |
| | 36 | (914) | | | 0.90 | | | | 0.87 | 0.77 | 0.66 | | | 0.98 | | | | | 1.00 | 0.81 |
| | > 48 | (1219) | | | 1.00 | | | | 0.99 | 0.87 | 0.72 | | | 1.00 | | | | | | 0.94 |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 16 — Load adjustment factors for #7 rebar in uncracked concrete[1,2,3]

| #7 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | ∥ To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.24 | 0.17 | 0.10 | n/a | n/a | n/a | 0.03 | 0.02 | 0.01 | 0.05 | 0.04 | 0.02 | n/a | n/a | n/a |
| | 4-3/8 | (111) | 0.59 | 0.57 | 0.54 | 0.31 | 0.22 | 0.13 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.04 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 5 | (127) | 0.60 | 0.58 | 0.55 | 0.33 | 0.23 | 0.14 | 0.54 | 0.53 | 0.52 | 0.13 | 0.09 | 0.04 | 0.27 | 0.17 | 0.09 | n/a | n/a | n/a |
| | 6 | (152) | 0.62 | 0.60 | 0.56 | 0.36 | 0.25 | 0.15 | 0.55 | 0.54 | 0.52 | 0.17 | 0.11 | 0.06 | 0.35 | 0.23 | 0.12 | n/a | n/a | n/a |
| | 7 | (178) | 0.65 | 0.61 | 0.57 | 0.39 | 0.28 | 0.16 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.39 | 0.28 | 0.15 | n/a | n/a | n/a |
| | 8 | (203) | 0.67 | 0.63 | 0.58 | 0.42 | 0.30 | 0.18 | 0.57 | 0.55 | 0.53 | 0.27 | 0.17 | 0.09 | 0.42 | 0.30 | 0.18 | n/a | n/a | n/a |
| | 9 | (229) | 0.69 | 0.64 | 0.59 | 0.45 | 0.32 | 0.19 | 0.58 | 0.56 | 0.54 | 0.32 | 0.21 | 0.11 | 0.45 | 0.32 | 0.19 | n/a | n/a | n/a |
| | 9-7/8 | (251) | 0.71 | 0.66 | 0.59 | 0.48 | 0.34 | 0.20 | 0.59 | 0.56 | 0.54 | 0.37 | 0.24 | 0.12 | 0.48 | 0.34 | 0.20 | 0.59 | n/a | n/a |
| | 10 | (254) | 0.71 | 0.66 | 0.60 | 0.49 | 0.35 | 0.20 | 0.59 | 0.57 | 0.54 | 0.38 | 0.24 | 0.12 | 0.49 | 0.35 | 0.20 | 0.59 | n/a | n/a |
| | 11 | (279) | 0.73 | 0.67 | 0.60 | 0.52 | 0.37 | 0.22 | 0.60 | 0.57 | 0.55 | 0.43 | 0.28 | 0.14 | 0.52 | 0.37 | 0.22 | 0.62 | n/a | n/a |
| | 12 | (305) | 0.75 | 0.69 | 0.61 | 0.56 | 0.40 | 0.23 | 0.60 | 0.58 | 0.55 | 0.49 | 0.32 | 0.16 | 0.56 | 0.40 | 0.23 | 0.65 | n/a | n/a |
| | 12-1/2 | (318) | 0.76 | 0.70 | 0.62 | 0.59 | 0.41 | 0.24 | 0.61 | 0.58 | 0.55 | 0.52 | 0.34 | 0.17 | 0.59 | 0.41 | 0.24 | 0.66 | 0.57 | n/a |
| | 14 | (356) | 0.79 | 0.72 | 0.63 | 0.66 | 0.46 | 0.27 | 0.62 | 0.59 | 0.56 | 0.62 | 0.40 | 0.21 | 0.66 | 0.46 | 0.27 | 0.70 | 0.60 | n/a |
| | 16 | (406) | 0.83 | 0.75 | 0.65 | 0.75 | 0.53 | 0.31 | 0.64 | 0.60 | 0.57 | 0.76 | 0.49 | 0.25 | 0.75 | 0.53 | 0.31 | 0.75 | 0.65 | n/a |
| | 18 | (457) | 0.87 | 0.79 | 0.67 | 0.84 | 0.60 | 0.35 | 0.66 | 0.62 | 0.57 | 0.91 | 0.59 | 0.30 | 0.84 | 0.60 | 0.35 | 0.79 | 0.68 | n/a |
| | 19-1/2 | (495) | 0.91 | 0.81 | 0.69 | 0.92 | 0.65 | 0.38 | 0.67 | 0.63 | 0.58 | 1.00 | 0.66 | 0.34 | 0.92 | 0.65 | 0.38 | 0.82 | 0.71 | 0.57 |
| | 20 | (508) | 0.92 | 0.82 | 0.69 | 0.94 | 0.66 | 0.39 | 0.67 | 0.63 | 0.58 | | 0.69 | 0.35 | 0.94 | 0.66 | 0.39 | 0.83 | 0.72 | 0.58 |
| | 22 | (559) | 0.96 | 0.85 | 0.71 | 1.00 | 0.73 | 0.43 | 0.69 | 0.64 | 0.59 | | 0.80 | 0.40 | 1.00 | 0.73 | 0.43 | 0.87 | 0.76 | 0.60 |
| | 24 | (610) | 1.00 | 0.88 | 0.73 | | 0.80 | 0.47 | 0.71 | 0.66 | 0.60 | | 0.91 | 0.46 | | 0.80 | 0.47 | 0.91 | 0.79 | 0.63 |
| | 26 | (660) | | 0.91 | 0.75 | | 0.86 | 0.51 | 0.73 | 0.67 | 0.61 | | 1.00 | 0.52 | | 0.86 | 0.51 | 0.95 | 0.82 | 0.66 |
| | 28 | (711) | | 0.94 | 0.77 | | 0.93 | 0.54 | 0.74 | 0.68 | 0.62 | | | 0.58 | | 0.93 | 0.54 | 0.99 | 0.85 | 0.68 |
| | 30 | (762) | | 0.98 | 0.79 | | 1.00 | 0.58 | 0.76 | 0.70 | 0.62 | | | 0.64 | | 1.00 | 0.58 | 1.00 | 0.88 | 0.71 |
| | 36 | (914) | | 1.00 | 0.84 | | | 0.70 | 0.81 | 0.73 | 0.65 | | | 0.85 | | | 0.70 | | 0.97 | 0.77 |
| | > 48 | (1219) | | | 0.96 | | | 0.93 | 0.92 | 0.81 | 0.70 | | | 1.00 | | | 0.93 | | 1.00 | 0.89 |

## Table 17 — Load adjustment factors for #7 rebar in cracked concrete[1,2,3]

| #7 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | ∥ To and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.43 | 0.41 | 0.38 | n/a | n/a | n/a | 0.03 | 0.02 | 0.01 | 0.06 | 0.04 | 0.02 | n/a | n/a | n/a |
| | 4-3/8 | (111) | 0.59 | 0.57 | 0.54 | 0.55 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.03 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 5 | (127) | 0.60 | 0.58 | 0.55 | 0.58 | 0.52 | 0.45 | 0.54 | 0.53 | 0.52 | 0.13 | 0.09 | 0.04 | 0.27 | 0.17 | 0.08 | n/a | n/a | n/a |
| | 6 | (152) | 0.62 | 0.60 | 0.56 | 0.64 | 0.56 | 0.47 | 0.55 | 0.54 | 0.52 | 0.18 | 0.11 | 0.05 | 0.35 | 0.23 | 0.11 | n/a | n/a | n/a |
| | 7 | (178) | 0.65 | 0.61 | 0.57 | 0.69 | 0.60 | 0.49 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.44 | 0.29 | 0.13 | n/a | n/a | n/a |
| | 8 | (203) | 0.67 | 0.63 | 0.58 | 0.75 | 0.64 | 0.52 | 0.57 | 0.55 | 0.53 | 0.27 | 0.18 | 0.08 | 0.54 | 0.35 | 0.16 | n/a | n/a | n/a |
| | 9 | (229) | 0.69 | 0.64 | 0.59 | 0.81 | 0.68 | 0.54 | 0.58 | 0.56 | 0.54 | 0.32 | 0.21 | 0.10 | 0.65 | 0.42 | 0.20 | n/a | n/a | n/a |
| | 9-7/8 | (251) | 0.71 | 0.66 | 0.59 | 0.86 | 0.72 | 0.56 | 0.59 | 0.56 | 0.54 | 0.37 | 0.24 | 0.11 | 0.74 | 0.48 | 0.22 | 0.59 | n/a | n/a |
| | 10 | (254) | 0.71 | 0.66 | 0.60 | 0.87 | 0.73 | 0.56 | 0.59 | 0.57 | 0.54 | 0.38 | 0.25 | 0.11 | 0.76 | 0.49 | 0.23 | 0.59 | n/a | n/a |
| | 11 | (279) | 0.73 | 0.67 | 0.60 | 0.93 | 0.77 | 0.59 | 0.60 | 0.57 | 0.54 | 0.44 | 0.28 | 0.13 | 0.87 | 0.57 | 0.26 | 0.62 | n/a | n/a |
| | 12 | (305) | 0.75 | 0.69 | 0.61 | 1.00 | 0.82 | 0.61 | 0.60 | 0.58 | 0.55 | 0.50 | 0.32 | 0.15 | 1.00 | 0.65 | 0.30 | 0.65 | n/a | n/a |
| | 12-1/2 | (318) | 0.76 | 0.70 | 0.62 | | 0.84 | 0.62 | 0.61 | 0.58 | 0.55 | 0.53 | 0.34 | 0.16 | | 0.69 | 0.32 | 0.66 | 0.57 | n/a |
| | 14 | (356) | 0.79 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.62 | 0.59 | 0.55 | 0.63 | 0.41 | 0.19 | | 0.82 | 0.38 | 0.70 | 0.61 | n/a |
| | 16 | (406) | 0.83 | 0.75 | 0.65 | | 1.00 | 0.71 | 0.64 | 0.60 | 0.56 | 0.77 | 0.50 | 0.23 | | 1.00 | 0.46 | 0.75 | 0.65 | n/a |
| | 18 | (457) | 0.87 | 0.79 | 0.67 | | | 0.76 | 0.66 | 0.62 | 0.57 | 0.91 | 0.59 | 0.28 | | | 0.55 | 0.79 | 0.69 | n/a |
| | 19-1/2 | (495) | 0.91 | 0.81 | 0.69 | | | 0.80 | 0.67 | 0.63 | 0.58 | 1.00 | 0.67 | 0.31 | | | 0.62 | 0.82 | 0.71 | 0.55 |
| | 20 | (508) | 0.92 | 0.82 | 0.69 | | | 0.82 | 0.67 | 0.63 | 0.58 | | 0.70 | 0.32 | | | 0.65 | 0.84 | 0.72 | 0.56 |
| | 22 | (559) | 0.96 | 0.85 | 0.71 | | | 0.87 | 0.69 | 0.64 | 0.59 | | 0.80 | 0.37 | | | 0.75 | 0.88 | 0.76 | 0.59 |
| | 24 | (610) | 1.00 | 0.88 | 0.73 | | | 0.93 | 0.71 | 0.66 | 0.59 | | 0.91 | 0.43 | | | 0.85 | 0.92 | 0.79 | 0.61 |
| | 26 | (660) | | 0.91 | 0.75 | | | 0.99 | 0.73 | 0.67 | 0.60 | | 1.00 | 0.48 | | | 0.96 | 0.95 | 0.82 | 0.64 |
| | 28 | (711) | | 0.94 | 0.77 | | | 1.00 | 0.74 | 0.68 | 0.61 | | | 0.54 | | | 1.00 | 0.99 | 0.86 | 0.66 |
| | 30 | (762) | | 0.98 | 0.79 | | | | 0.76 | 0.70 | 0.62 | | | 0.59 | | | | 1.00 | 0.89 | 0.69 |
| | 36 | (914) | | 1.00 | 0.84 | | | | 0.81 | 0.74 | 0.64 | | | 0.78 | | | | | 0.97 | 0.75 |
| | > 48 | (1219) | | | 0.96 | | | | 0.92 | 0.81 | 0.69 | | | 1.00 | | | | | 1.00 | 0.87 |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

### Table 18 — Load adjustment factors for #8 rebar in uncracked concrete[1,2,3]

| #8 Rebar uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | 0.24 | 0.17 | 0.10 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.05 | 0.03 | 0.01 | n/a | n/a | n/a |
| | 5 (127) | 0.59 | 0.57 | 0.54 | 0.32 | 0.22 | 0.13 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.03 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 6 (152) | 0.61 | 0.58 | 0.55 | 0.34 | 0.24 | 0.14 | 0.55 | 0.53 | 0.52 | 0.14 | 0.09 | 0.04 | 0.29 | 0.19 | 0.09 | n/a | n/a | n/a |
| | 7 (178) | 0.63 | 0.60 | 0.56 | 0.37 | 0.26 | 0.15 | 0.55 | 0.54 | 0.52 | 0.18 | 0.12 | 0.06 | 0.36 | 0.23 | 0.11 | n/a | n/a | n/a |
| | 8 (203) | 0.65 | 0.61 | 0.57 | 0.40 | 0.28 | 0.16 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.40 | 0.28 | 0.14 | n/a | n/a | n/a |
| | 9 (229) | 0.67 | 0.63 | 0.58 | 0.43 | 0.30 | 0.17 | 0.57 | 0.55 | 0.53 | 0.26 | 0.17 | 0.08 | 0.43 | 0.30 | 0.17 | n/a | n/a | n/a |
| | 10 (254) | 0.68 | 0.64 | 0.58 | 0.46 | 0.32 | 0.19 | 0.58 | 0.56 | 0.54 | 0.31 | 0.20 | 0.10 | 0.46 | 0.32 | 0.19 | n/a | n/a | n/a |
| | 11 (279) | 0.70 | 0.65 | 0.59 | 0.49 | 0.34 | 0.20 | 0.58 | 0.56 | 0.54 | 0.35 | 0.23 | 0.11 | 0.49 | 0.34 | 0.20 | n/a | n/a | n/a |
| | 11-1/4 (286) | 0.71 | 0.66 | 0.59 | 0.50 | 0.34 | 0.20 | 0.59 | 0.56 | 0.54 | 0.37 | 0.24 | 0.12 | 0.50 | 0.34 | 0.20 | 0.58 | n/a | n/a |
| | 12 (305) | 0.72 | 0.67 | 0.60 | 0.52 | 0.36 | 0.21 | 0.59 | 0.57 | 0.54 | 0.40 | 0.26 | 0.13 | 0.52 | 0.36 | 0.21 | 0.60 | n/a | n/a |
| | 13 (330) | 0.74 | 0.68 | 0.61 | 0.55 | 0.38 | 0.22 | 0.60 | 0.57 | 0.55 | 0.46 | 0.30 | 0.14 | 0.55 | 0.38 | 0.22 | 0.63 | n/a | n/a |
| | 14 (356) | 0.76 | 0.69 | 0.62 | 0.59 | 0.41 | 0.24 | 0.61 | 0.58 | 0.55 | 0.51 | 0.33 | 0.16 | 0.59 | 0.41 | 0.24 | 0.65 | n/a | n/a |
| | 14-1/4 (362) | 0.76 | 0.70 | 0.62 | 0.60 | 0.42 | 0.24 | 0.61 | 0.58 | 0.55 | 0.52 | 0.34 | 0.16 | 0.60 | 0.42 | 0.24 | 0.66 | 0.57 | n/a |
| | 16 (406) | 0.79 | 0.72 | 0.63 | 0.67 | 0.47 | 0.27 | 0.62 | 0.59 | 0.56 | 0.62 | 0.40 | 0.20 | 0.67 | 0.47 | 0.27 | 0.70 | 0.60 | n/a |
| | 18 (457) | 0.83 | 0.75 | 0.65 | 0.76 | 0.53 | 0.31 | 0.64 | 0.60 | 0.56 | 0.74 | 0.48 | 0.23 | 0.76 | 0.53 | 0.31 | 0.74 | 0.64 | n/a |
| | 20 (508) | 0.87 | 0.78 | 0.67 | 0.84 | 0.58 | 0.34 | 0.65 | 0.61 | 0.57 | 0.87 | 0.56 | 0.27 | 0.84 | 0.58 | 0.34 | 0.78 | 0.67 | n/a |
| | 22 (559) | 0.90 | 0.81 | 0.68 | 0.93 | 0.64 | 0.38 | 0.67 | 0.63 | 0.58 | 1.00 | 0.65 | 0.32 | 0.93 | 0.64 | 0.38 | 0.82 | 0.71 | n/a |
| | 22-1/4 (565) | 0.91 | 0.81 | 0.69 | 0.94 | 0.65 | 0.38 | 0.67 | 0.63 | 0.58 | | 0.66 | 0.32 | 0.94 | 0.65 | 0.38 | 0.82 | 0.71 | 0.56 |
| | 24 (610) | 0.94 | 0.83 | 0.70 | 1.00 | 0.70 | 0.41 | 0.68 | 0.64 | 0.58 | | 0.74 | 0.36 | 1.00 | 0.70 | 0.41 | 0.85 | 0.74 | 0.58 |
| | 26 (660) | 0.98 | 0.86 | 0.72 | | 0.76 | 0.45 | 0.70 | 0.65 | 0.59 | | 0.84 | 0.41 | | 0.76 | 0.45 | 0.89 | 0.77 | 0.60 |
| | 28 (711) | 1.00 | 0.89 | 0.73 | | 0.82 | 0.48 | 0.71 | 0.66 | 0.60 | | 0.94 | 0.45 | | 0.82 | 0.48 | 0.92 | 0.80 | 0.63 |
| | 30 (762) | | 0.92 | 0.75 | | 0.88 | 0.51 | 0.73 | 0.67 | 0.61 | | 1.00 | 0.50 | | 0.88 | 0.51 | 0.95 | 0.83 | 0.65 |
| | 36 (914) | | 1.00 | 0.80 | | 1.00 | 0.62 | 0.77 | 0.70 | 0.63 | | | 0.66 | | 1.00 | 0.62 | 1.00 | 0.91 | 0.71 |
| | > 48 (1219) | | | 0.90 | | | 0.82 | 0.86 | 0.77 | 0.67 | | | 1.00 | | | 0.82 | | 1.00 | 0.82 |

### Table 19 — Load adjustment factors for #8 rebar in cracked concrete[1,2,3]

| #8 Rebar cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | 0.42 | 0.40 | 0.38 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.05 | 0.03 | 0.01 | n/a | n/a | n/a |
| | 5 (127) | 0.59 | 0.57 | 0.54 | 0.55 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.03 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 6 (152) | 0.61 | 0.58 | 0.55 | 0.60 | 0.53 | 0.46 | 0.55 | 0.53 | 0.52 | 0.14 | 0.09 | 0.04 | 0.29 | 0.19 | 0.09 | n/a | n/a | n/a |
| | 7 (178) | 0.63 | 0.60 | 0.56 | 0.65 | 0.57 | 0.47 | 0.55 | 0.54 | 0.52 | 0.18 | 0.12 | 0.05 | 0.36 | 0.24 | 0.11 | n/a | n/a | n/a |
| | 8 (203) | 0.65 | 0.61 | 0.57 | 0.70 | 0.60 | 0.49 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.44 | 0.29 | 0.13 | n/a | n/a | n/a |
| | 9 (229) | 0.67 | 0.63 | 0.58 | 0.75 | 0.64 | 0.51 | 0.57 | 0.55 | 0.53 | 0.26 | 0.17 | 0.08 | 0.53 | 0.34 | 0.16 | n/a | n/a | n/a |
| | 10 (254) | 0.68 | 0.64 | 0.58 | 0.80 | 0.67 | 0.53 | 0.58 | 0.56 | 0.53 | 0.31 | 0.20 | 0.09 | 0.62 | 0.40 | 0.19 | n/a | n/a | n/a |
| | 11 (279) | 0.70 | 0.65 | 0.59 | 0.85 | 0.71 | 0.55 | 0.58 | 0.56 | 0.54 | 0.36 | 0.23 | 0.11 | 0.72 | 0.46 | 0.22 | n/a | n/a | n/a |
| | 11-1/4 (286) | 0.71 | 0.66 | 0.59 | 0.87 | 0.72 | 0.56 | 0.59 | 0.56 | 0.54 | 0.37 | 0.24 | 0.11 | 0.74 | 0.48 | 0.22 | 0.59 | n/a | n/a |
| | 12 (305) | 0.72 | 0.67 | 0.60 | 0.91 | 0.75 | 0.57 | 0.59 | 0.57 | 0.54 | 0.41 | 0.26 | 0.12 | 0.82 | 0.53 | 0.25 | 0.61 | n/a | n/a |
| | 13 (330) | 0.74 | 0.68 | 0.61 | 0.96 | 0.79 | 0.59 | 0.60 | 0.57 | 0.54 | 0.46 | 0.30 | 0.14 | 0.92 | 0.60 | 0.28 | 0.63 | n/a | n/a |
| | 14 (356) | 0.76 | 0.69 | 0.62 | 1.00 | 0.83 | 0.62 | 0.61 | 0.58 | 0.55 | 0.51 | 0.33 | 0.16 | 1.00 | 0.67 | 0.31 | 0.65 | n/a | n/a |
| | 14-1/4 (362) | 0.76 | 0.70 | 0.62 | | 0.84 | 0.62 | 0.61 | 0.58 | 0.55 | 0.53 | 0.34 | 0.16 | | 0.69 | 0.32 | 0.66 | 0.57 | n/a |
| | 16 (406) | 0.79 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.62 | 0.59 | 0.55 | 0.63 | 0.41 | 0.19 | | 0.82 | 0.38 | 0.70 | 0.61 | n/a |
| | 18 (457) | 0.83 | 0.75 | 0.65 | | 1.00 | 0.70 | 0.64 | 0.60 | 0.56 | 0.75 | 0.49 | 0.23 | | 0.97 | 0.45 | 0.74 | 0.64 | n/a |
| | 20 (508) | 0.87 | 0.78 | 0.67 | | | 0.75 | 0.65 | 0.61 | 0.57 | 0.88 | 0.57 | 0.26 | | 1.00 | 0.53 | 0.78 | 0.68 | n/a |
| | 22 (559) | 0.90 | 0.81 | 0.68 | | | 0.80 | 0.67 | 0.63 | 0.58 | 1.00 | 0.66 | 0.31 | | | 0.61 | 0.82 | 0.71 | n/a |
| | 22-1/4 (565) | 0.91 | 0.81 | 0.69 | | | 0.80 | 0.67 | 0.63 | 0.58 | | 0.67 | 0.31 | | | 0.62 | 0.82 | 0.71 | 0.55 |
| | 24 (610) | 0.94 | 0.83 | 0.70 | | | 0.85 | 0.68 | 0.64 | 0.58 | | 0.75 | 0.35 | | | 0.70 | 0.86 | 0.74 | 0.57 |
| | 26 (660) | 0.98 | 0.86 | 0.72 | | | 0.90 | 0.70 | 0.65 | 0.59 | | 0.84 | 0.39 | | | 0.78 | 0.89 | 0.77 | 0.60 |
| | 28 (711) | 1.00 | 0.89 | 0.73 | | | 0.95 | 0.71 | 0.66 | 0.60 | | 0.94 | 0.44 | | | 0.88 | 0.92 | 0.80 | 0.62 |
| | 30 (762) | | 0.92 | 0.75 | | | 1.00 | 0.73 | 0.67 | 0.60 | | 1.00 | 0.49 | | | 0.97 | 0.96 | 0.83 | 0.64 |
| | 36 (914) | | 1.00 | 0.80 | | | | 0.77 | 0.71 | 0.62 | | | 0.64 | | | 1.00 | 1.00 | 0.91 | 0.70 |
| | > 48 (1219) | | | 0.90 | | | | 0.87 | 0.77 | 0.66 | | | 0.98 | | | | | 1.00 | 0.81 |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 20 — Load adjustment factors for #9 rebar in uncracked concrete[1,2,3]

| #9 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | || To and away from edge $f_{RV}$ | | | | | |
| Embedment | | in. | 10-1/8 | 13-1/2 | 22-1/2 | 10-1/8 | 13-1/2 | 22-1/2 | 10-1/8 | 13-1/2 | 22-1/2 | 10-1/8 | 13-1/2 | 22-1/2 | 10-1/8 | 13-1/2 | 22-1/2 | 10-1/8 | 13-1/2 | 22-1/2 |
| $h_{ef}$ | | (mm) | (257) | (343) | (572) | (257) | (343) | (572) | (257) | (343) | (572) | (257) | (343) | (572) | (257) | (343) | (572) | (257) | (343) | (572) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.24 | 0.17 | 0.10 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.02 | 0.01 | n/a | n/a | n/a |
| | 5-5/8 | (143) | 0.59 | 0.57 | 0.54 | 0.33 | 0.23 | 0.13 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.03 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 6 | (152) | 0.60 | 0.57 | 0.54 | 0.33 | 0.23 | 0.13 | 0.54 | 0.53 | 0.52 | 0.12 | 0.08 | 0.04 | 0.24 | 0.16 | 0.07 | n/a | n/a | n/a |
| | 7 | (178) | 0.61 | 0.59 | 0.55 | 0.36 | 0.25 | 0.14 | 0.55 | 0.54 | 0.52 | 0.15 | 0.10 | 0.05 | 0.30 | 0.20 | 0.09 | n/a | n/a | n/a |
| | 8 | (203) | 0.63 | 0.60 | 0.56 | 0.38 | 0.27 | 0.15 | 0.55 | 0.54 | 0.52 | 0.18 | 0.12 | 0.06 | 0.37 | 0.24 | 0.11 | n/a | n/a | n/a |
| | 9 | (229) | 0.65 | 0.61 | 0.57 | 0.41 | 0.28 | 0.16 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.41 | 0.28 | 0.13 | n/a | n/a | n/a |
| | 10 | (254) | 0.66 | 0.62 | 0.57 | 0.44 | 0.30 | 0.17 | 0.57 | 0.55 | 0.53 | 0.26 | 0.17 | 0.08 | 0.44 | 0.30 | 0.16 | n/a | n/a | n/a |
| | 11 | (279) | 0.68 | 0.64 | 0.58 | 0.46 | 0.32 | 0.18 | 0.57 | 0.56 | 0.53 | 0.30 | 0.19 | 0.09 | 0.46 | 0.32 | 0.18 | n/a | n/a | n/a |
| | 12 | (305) | 0.70 | 0.65 | 0.59 | 0.49 | 0.34 | 0.20 | 0.58 | 0.56 | 0.54 | 0.34 | 0.22 | 0.10 | 0.49 | 0.34 | 0.20 | n/a | n/a | n/a |
| | 12-7/8 | (327) | 0.71 | 0.66 | 0.60 | 0.52 | 0.36 | 0.21 | 0.59 | 0.57 | 0.54 | 0.38 | 0.24 | 0.11 | 0.52 | 0.36 | 0.21 | 0.59 | n/a | n/a |
| | 13 | (330) | 0.71 | 0.66 | 0.60 | 0.52 | 0.36 | 0.21 | 0.59 | 0.57 | 0.54 | 0.38 | 0.25 | 0.12 | 0.52 | 0.36 | 0.21 | 0.59 | n/a | n/a |
| | 14 | (356) | 0.73 | 0.67 | 0.60 | 0.55 | 0.38 | 0.22 | 0.59 | 0.57 | 0.54 | 0.43 | 0.28 | 0.13 | 0.55 | 0.38 | 0.22 | 0.61 | n/a | n/a |
| | 16 | (406) | 0.76 | 0.70 | 0.62 | 0.62 | 0.43 | 0.25 | 0.61 | 0.58 | 0.55 | 0.52 | 0.34 | 0.16 | 0.62 | 0.43 | 0.25 | 0.66 | n/a | n/a |
| | 16-1/4 | (413) | 0.77 | 0.70 | 0.62 | 0.63 | 0.43 | 0.25 | 0.61 | 0.58 | 0.55 | 0.53 | 0.35 | 0.16 | 0.63 | 0.43 | 0.25 | 0.66 | 0.57 | n/a |
| | 18 | (457) | 0.80 | 0.72 | 0.63 | 0.69 | 0.48 | 0.28 | 0.62 | 0.59 | 0.55 | 0.62 | 0.40 | 0.19 | 0.69 | 0.48 | 0.28 | 0.70 | 0.60 | n/a |
| | 20 | (508) | 0.83 | 0.75 | 0.65 | 0.77 | 0.54 | 0.31 | 0.63 | 0.60 | 0.56 | 0.73 | 0.47 | 0.22 | 0.77 | 0.54 | 0.31 | 0.73 | 0.64 | n/a |
| | 22 | (559) | 0.86 | 0.77 | 0.66 | 0.85 | 0.59 | 0.34 | 0.65 | 0.61 | 0.57 | 0.84 | 0.55 | 0.25 | 0.85 | 0.59 | 0.34 | 0.77 | 0.67 | n/a |
| | 24 | (610) | 0.89 | 0.80 | 0.68 | 0.93 | 0.64 | 0.37 | 0.66 | 0.62 | 0.57 | 0.96 | 0.62 | 0.29 | 0.93 | 0.64 | 0.37 | 0.80 | 0.70 | n/a |
| | 25-1/4 | (641) | 0.91 | 0.81 | 0.69 | 0.97 | 0.68 | 0.39 | 0.67 | 0.63 | 0.58 | 1.00 | 0.67 | 0.31 | 0.97 | 0.68 | 0.39 | 0.83 | 0.71 | 0.55 |
| | 26 | (660) | 0.93 | 0.82 | 0.69 | 1.00 | 0.70 | 0.40 | 0.68 | 0.63 | 0.58 | | 0.70 | 0.33 | 1.00 | 0.70 | 0.40 | 0.84 | 0.73 | 0.56 |
| | 28 | (711) | 0.96 | 0.85 | 0.71 | | 0.75 | 0.43 | 0.69 | 0.64 | 0.59 | | 0.78 | 0.36 | | 0.75 | 0.43 | 0.87 | 0.75 | 0.58 |
| | 30 | (762) | 0.99 | 0.87 | 0.72 | | 0.80 | 0.46 | 0.70 | 0.65 | 0.59 | | 0.87 | 0.40 | | 0.80 | 0.46 | 0.90 | 0.78 | 0.60 |
| | 36 | (914) | 1.00 | 0.94 | 0.77 | | 0.96 | 0.55 | 0.74 | 0.68 | 0.61 | | 1.00 | 0.53 | | 0.96 | 0.55 | 0.99 | 0.85 | 0.66 |
| | > 48 | (1219) | | 1.00 | 0.86 | | 1.00 | 0.74 | 0.82 | 0.74 | 0.65 | | | 0.82 | | 1.00 | 0.74 | 1.00 | 0.99 | 0.76 |

## Table 21 — Load adjustment factors for #9 rebar in cracked concrete[1,2,3]

| #9 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | || To and away from edge $f_{RV}$ | | | | | |
| Embedment | | in. | 10-1/8 | 13-1/2 | 22-1/2 | 10-1/8 | 13-1/2 | 22-1/2 | 10-1/8 | 13-1/2 | 22-1/2 | 10-1/8 | 13-1/2 | 22-1/2 | 10-1/8 | 13-1/2 | 22-1/2 | 10-1/8 | 13-1/2 | 22-1/2 |
| $h_{ef}$ | | (mm) | (257) | (343) | (572) | (257) | (343) | (572) | (257) | (343) | (572) | (257) | (343) | (572) | (257) | (343) | (572) | (257) | (343) | (572) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.41 | 0.39 | 0.38 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.02 | 0.01 | n/a | n/a | n/a |
| | 5-5/8 | (143) | 0.59 | 0.57 | 0.54 | 0.56 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.03 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 6 | (152) | 0.60 | 0.57 | 0.54 | 0.57 | 0.51 | 0.44 | 0.54 | 0.53 | 0.52 | 0.12 | 0.08 | 0.04 | 0.24 | 0.16 | 0.07 | n/a | n/a | n/a |
| | 7 | (178) | 0.61 | 0.59 | 0.55 | 0.61 | 0.54 | 0.46 | 0.55 | 0.54 | 0.52 | 0.15 | 0.10 | 0.05 | 0.30 | 0.20 | 0.09 | n/a | n/a | n/a |
| | 8 | (203) | 0.63 | 0.60 | 0.56 | 0.65 | 0.57 | 0.48 | 0.55 | 0.54 | 0.52 | 0.19 | 0.12 | 0.06 | 0.37 | 0.24 | 0.11 | n/a | n/a | n/a |
| | 9 | (229) | 0.65 | 0.61 | 0.57 | 0.70 | 0.60 | 0.49 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.44 | 0.29 | 0.13 | n/a | n/a | n/a |
| | 10 | (254) | 0.66 | 0.62 | 0.57 | 0.74 | 0.63 | 0.51 | 0.57 | 0.55 | 0.53 | 0.26 | 0.17 | 0.08 | 0.52 | 0.34 | 0.16 | n/a | n/a | n/a |
| | 11 | (279) | 0.68 | 0.64 | 0.58 | 0.79 | 0.67 | 0.53 | 0.57 | 0.56 | 0.53 | 0.30 | 0.19 | 0.09 | 0.60 | 0.39 | 0.18 | n/a | n/a | n/a |
| | 12 | (305) | 0.70 | 0.65 | 0.59 | 0.84 | 0.70 | 0.55 | 0.58 | 0.56 | 0.54 | 0.34 | 0.22 | 0.10 | 0.68 | 0.44 | 0.21 | n/a | n/a | n/a |
| | 12-7/8 | (327) | 0.71 | 0.66 | 0.60 | 0.88 | 0.73 | 0.56 | 0.59 | 0.57 | 0.54 | 0.38 | 0.25 | 0.11 | 0.76 | 0.49 | 0.23 | 0.59 | n/a | n/a |
| | 13 | (330) | 0.71 | 0.66 | 0.60 | 0.89 | 0.73 | 0.56 | 0.59 | 0.57 | 0.54 | 0.39 | 0.25 | 0.12 | 0.77 | 0.50 | 0.23 | 0.59 | n/a | n/a |
| | 14 | (356) | 0.73 | 0.67 | 0.60 | 0.94 | 0.77 | 0.58 | 0.60 | 0.57 | 0.54 | 0.43 | 0.28 | 0.13 | 0.86 | 0.56 | 0.26 | 0.62 | n/a | n/a |
| | 16 | (406) | 0.76 | 0.70 | 0.62 | 1.00 | 0.84 | 0.62 | 0.61 | 0.58 | 0.55 | 0.53 | 0.34 | 0.16 | 1.00 | 0.68 | 0.32 | 0.66 | n/a | n/a |
| | 16-1/4 | (413) | 0.77 | 0.70 | 0.62 | 1.00 | 0.85 | 0.63 | 0.61 | 0.58 | 0.55 | 0.54 | 0.35 | 0.16 | 1.00 | 0.70 | 0.32 | 0.66 | 0.58 | n/a |
| | 18 | (457) | 0.80 | 0.72 | 0.63 | 1.00 | 0.91 | 0.66 | 0.62 | 0.59 | 0.55 | 0.63 | 0.41 | 0.19 | 1.00 | 0.82 | 0.38 | 0.70 | 0.61 | n/a |
| | 20 | (508) | 0.83 | 0.75 | 0.65 | 1.00 | 0.99 | 0.70 | 0.64 | 0.60 | 0.56 | 0.73 | 0.48 | 0.22 | 1.00 | 0.95 | 0.44 | 0.74 | 0.64 | n/a |
| | 22 | (559) | 0.86 | 0.77 | 0.66 | 1.00 | 1.00 | 0.74 | 0.65 | 0.61 | 0.57 | 0.85 | 0.55 | 0.26 | 1.00 | 1.00 | 0.51 | 0.77 | 0.67 | n/a |
| | 24 | (610) | 0.89 | 0.80 | 0.68 | 1.00 | 1.00 | 0.78 | 0.66 | 0.62 | 0.57 | 0.97 | 0.63 | 0.29 | 1.00 | 1.00 | 0.58 | 0.81 | 0.70 | n/a |
| | 25-1/4 | (641) | 0.91 | 0.81 | 0.69 | 1.00 | 1.00 | 0.81 | 0.67 | 0.63 | 0.58 | 1.00 | 0.68 | 0.31 | 1.00 | 1.00 | 0.63 | 0.83 | 0.72 | 0.56 |
| | 26 | (660) | 0.93 | 0.82 | 0.69 | 1.00 | 1.00 | 0.82 | 0.68 | 0.63 | 0.58 | 1.00 | 0.71 | 0.33 | 1.00 | 1.00 | 0.66 | 0.84 | 0.73 | 0.56 |
| | 28 | (711) | 0.96 | 0.85 | 0.71 | 1.00 | 1.00 | 0.87 | 0.69 | 0.64 | 0.59 | 1.00 | 0.79 | 0.37 | 1.00 | 1.00 | 0.73 | 0.87 | 0.76 | 0.58 |
| | 30 | (762) | 0.99 | 0.87 | 0.72 | 1.00 | 1.00 | 0.91 | 0.70 | 0.65 | 0.59 | 1.00 | 0.88 | 0.41 | 1.00 | 1.00 | 0.82 | 0.90 | 0.78 | 0.61 |
| | 36 | (914) | 1.00 | 0.94 | 0.77 | 1.00 | 1.00 | 1.00 | 0.74 | 0.68 | 0.61 | 1.00 | 1.00 | 0.54 | 1.00 | 1.00 | 1.00 | 0.99 | 0.86 | 0.66 |
| | > 48 | (1219) | 1.00 | 1.00 | 0.86 | 1.00 | 1.00 | 1.00 | 0.83 | 0.74 | 0.65 | 1.00 | 1.00 | 0.82 | 1.00 | 1.00 | 1.00 | 1.00 | 0.99 | 0.77 |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

### Table 22 — Load adjustment factors for #10 rebar in uncracked concrete[1,2,3]

| #10 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment | | in. | 11-1/4 | 15 | 25 | 11-1/4 | 15 | 25 | 11-1/4 | 15 | 25 | 11-1/4 | 15 | 25 | 11-1/4 | 15 | 25 | 11-1/4 | 15 | 25 |
| $h_{ef}$ | | (mm) | (286) | (381) | (635) | (286) | (381) | (635) | (286) | (381) | (635) | (286) | (381) | (635) | (286) | (381) | (635) | (286) | (381) | (635) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.24 | 0.17 | 0.09 | n/a | n/a | n/a | 0.02 | 0.01 | 0.00 | 0.03 | 0.02 | 0.01 | n/a | n/a | n/a |
| | 6-1/4 | (159) | 0.59 | 0.57 | 0.54 | 0.33 | 0.23 | 0.13 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.03 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 7 | (178) | 0.60 | 0.58 | 0.55 | 0.35 | 0.24 | 0.14 | 0.54 | 0.53 | 0.52 | 0.13 | 0.08 | 0.04 | 0.26 | 0.17 | 0.08 | n/a | n/a | n/a |
| | 8 | (203) | 0.62 | 0.59 | 0.55 | 0.37 | 0.26 | 0.15 | 0.55 | 0.54 | 0.52 | 0.16 | 0.10 | 0.05 | 0.31 | 0.20 | 0.10 | n/a | n/a | n/a |
| | 9 | (229) | 0.63 | 0.60 | 0.56 | 0.39 | 0.27 | 0.15 | 0.55 | 0.54 | 0.52 | 0.19 | 0.12 | 0.06 | 0.38 | 0.24 | 0.11 | n/a | n/a | n/a |
| | 10 | (254) | 0.65 | 0.61 | 0.57 | 0.42 | 0.29 | 0.16 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.42 | 0.29 | 0.13 | n/a | n/a | n/a |
| | 11 | (279) | 0.66 | 0.62 | 0.57 | 0.44 | 0.31 | 0.17 | 0.57 | 0.55 | 0.53 | 0.25 | 0.16 | 0.08 | 0.44 | 0.31 | 0.15 | n/a | n/a | n/a |
| | 12 | (305) | 0.68 | 0.63 | 0.58 | 0.47 | 0.32 | 0.18 | 0.57 | 0.55 | 0.53 | 0.29 | 0.19 | 0.09 | 0.47 | 0.32 | 0.17 | n/a | n/a | n/a |
| | 13 | (330) | 0.69 | 0.64 | 0.59 | 0.49 | 0.34 | 0.19 | 0.58 | 0.56 | 0.54 | 0.33 | 0.21 | 0.10 | 0.49 | 0.34 | 0.19 | n/a | n/a | n/a |
| | 14 | (356) | 0.71 | 0.66 | 0.59 | 0.52 | 0.36 | 0.20 | 0.59 | 0.56 | 0.54 | 0.36 | 0.24 | 0.11 | 0.52 | 0.36 | 0.20 | n/a | n/a | n/a |
| | 14-1/4 | (362) | 0.71 | 0.66 | 0.60 | 0.52 | 0.36 | 0.21 | 0.59 | 0.56 | 0.54 | 0.37 | 0.24 | 0.11 | 0.52 | 0.36 | 0.21 | 0.59 | n/a | n/a |
| | 15 | (381) | 0.72 | 0.67 | 0.60 | 0.54 | 0.38 | 0.21 | 0.59 | 0.57 | 0.54 | 0.40 | 0.26 | 0.12 | 0.54 | 0.38 | 0.21 | 0.60 | n/a | n/a |
| | 16 | (406) | 0.74 | 0.68 | 0.61 | 0.57 | 0.40 | 0.22 | 0.60 | 0.57 | 0.54 | 0.45 | 0.29 | 0.13 | 0.57 | 0.40 | 0.22 | 0.62 | n/a | n/a |
| | 17 | (432) | 0.75 | 0.69 | 0.61 | 0.60 | 0.42 | 0.24 | 0.60 | 0.58 | 0.55 | 0.49 | 0.32 | 0.15 | 0.60 | 0.42 | 0.24 | 0.64 | n/a | n/a |
| | 18 | (457) | 0.77 | 0.70 | 0.62 | 0.64 | 0.44 | 0.25 | 0.61 | 0.58 | 0.55 | 0.53 | 0.35 | 0.16 | 0.64 | 0.44 | 0.25 | 0.66 | 0.57 | n/a |
| | 20 | (508) | 0.80 | 0.72 | 0.63 | 0.71 | 0.49 | 0.28 | 0.62 | 0.59 | 0.55 | 0.62 | 0.40 | 0.19 | 0.71 | 0.49 | 0.28 | 0.70 | 0.60 | n/a |
| | 22 | (559) | 0.83 | 0.74 | 0.65 | 0.78 | 0.54 | 0.31 | 0.63 | 0.60 | 0.56 | 0.72 | 0.47 | 0.22 | 0.78 | 0.54 | 0.31 | 0.73 | 0.63 | n/a |
| | 24 | (610) | 0.86 | 0.77 | 0.66 | 0.85 | 0.59 | 0.33 | 0.65 | 0.61 | 0.57 | 0.82 | 0.53 | 0.25 | 0.85 | 0.59 | 0.33 | 0.76 | 0.66 | n/a |
| | 26 | (660) | 0.89 | 0.79 | 0.67 | 0.92 | 0.64 | 0.36 | 0.66 | 0.62 | 0.57 | 0.92 | 0.60 | 0.28 | 0.92 | 0.64 | 0.36 | 0.79 | 0.69 | n/a |
| | 28 | (711) | 0.91 | 0.81 | 0.69 | 0.99 | 0.69 | 0.39 | 0.67 | 0.63 | 0.58 | 1.00 | 0.67 | 0.31 | 0.99 | 0.69 | 0.39 | 0.82 | 0.71 | 0.55 |
| | 30 | (762) | 0.94 | 0.83 | 0.70 | 1.00 | 0.74 | 0.42 | 0.68 | 0.64 | 0.58 | | 0.74 | 0.35 | 1.00 | 0.74 | 0.42 | 0.85 | 0.74 | 0.57 |
| | 36 | (914) | 1.00 | 0.90 | 0.74 | | 0.88 | 0.50 | 0.72 | 0.66 | 0.60 | | 0.98 | 0.45 | | 0.88 | 0.50 | 0.94 | 0.81 | 0.63 |
| | > 48 | (1219) | | 1.00 | 0.82 | | 1.00 | 0.67 | 0.79 | 0.72 | 0.63 | | 1.00 | 0.70 | | 1.00 | 0.67 | 1.00 | 0.94 | 0.72 |

### Table 23 — Load adjustment factors for #10 rebar in cracked concrete[1,2,3]

| #10 Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment | | in. | 11-1/4 | 15 | 25 | 11-1/4 | 15 | 25 | 11-1/4 | 15 | 25 | 11-1/4 | 15 | 25 | 11-1/4 | 15 | 25 | 11-1/4 | 15 | 25 |
| $h_{ef}$ | | (mm) | (286) | (381) | (635) | (286) | (381) | (635) | (286) | (381) | (635) | (286) | (381) | (635) | (286) | (381) | (635) | (286) | (381) | (635) |
| Spacing (s) / edge eistance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.40 | 0.39 | 0.37 | n/a | n/a | n/a | 0.02 | 0.01 | 0.00 | 0.03 | 0.02 | 0.01 | n/a | n/a | n/a |
| | 6-1/4 | (159) | 0.59 | 0.57 | 0.54 | 0.56 | 0.50 | 0.44 | 0.54 | 0.53 | 0.52 | 0.11 | 0.07 | 0.03 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a |
| | 7 | (178) | 0.60 | 0.58 | 0.55 | 0.58 | 0.52 | 0.45 | 0.54 | 0.53 | 0.52 | 0.13 | 0.08 | 0.04 | 0.26 | 0.17 | 0.08 | n/a | n/a | n/a |
| | 8 | (203) | 0.62 | 0.59 | 0.55 | 0.62 | 0.55 | 0.46 | 0.55 | 0.54 | 0.52 | 0.16 | 0.10 | 0.05 | 0.32 | 0.21 | 0.10 | n/a | n/a | n/a |
| | 9 | (229) | 0.63 | 0.60 | 0.56 | 0.66 | 0.57 | 0.48 | 0.55 | 0.54 | 0.52 | 0.19 | 0.12 | 0.06 | 0.38 | 0.25 | 0.11 | n/a | n/a | n/a |
| | 10 | (254) | 0.65 | 0.61 | 0.57 | 0.70 | 0.60 | 0.49 | 0.56 | 0.55 | 0.53 | 0.22 | 0.14 | 0.07 | 0.44 | 0.29 | 0.13 | n/a | n/a | n/a |
| | 11 | (279) | 0.66 | 0.62 | 0.57 | 0.74 | 0.63 | 0.51 | 0.57 | 0.55 | 0.53 | 0.26 | 0.17 | 0.08 | 0.51 | 0.33 | 0.15 | n/a | n/a | n/a |
| | 12 | (305) | 0.68 | 0.63 | 0.58 | 0.78 | 0.66 | 0.53 | 0.57 | 0.55 | 0.53 | 0.29 | 0.19 | 0.09 | 0.58 | 0.38 | 0.18 | n/a | n/a | n/a |
| | 13 | (330) | 0.69 | 0.64 | 0.59 | 0.82 | 0.69 | 0.54 | 0.58 | 0.56 | 0.54 | 0.33 | 0.21 | 0.10 | 0.66 | 0.43 | 0.20 | n/a | n/a | n/a |
| | 14 | (356) | 0.71 | 0.66 | 0.59 | 0.87 | 0.72 | 0.56 | 0.59 | 0.56 | 0.54 | 0.37 | 0.24 | 0.11 | 0.73 | 0.48 | 0.22 | n/a | n/a | n/a |
| | 14-1/4 | (362) | 0.71 | 0.66 | 0.60 | 0.88 | 0.73 | 0.56 | 0.59 | 0.57 | 0.54 | 0.38 | 0.25 | 0.11 | 0.75 | 0.49 | 0.23 | 0.59 | n/a | n/a |
| | 15 | (381) | 0.72 | 0.67 | 0.60 | 0.91 | 0.75 | 0.57 | 0.59 | 0.57 | 0.54 | 0.41 | 0.26 | 0.12 | 0.82 | 0.53 | 0.25 | 0.61 | n/a | n/a |
| | 16 | (406) | 0.74 | 0.68 | 0.61 | 0.96 | 0.78 | 0.59 | 0.60 | 0.57 | 0.54 | 0.45 | 0.29 | 0.14 | 0.90 | 0.58 | 0.27 | 0.63 | n/a | n/a |
| | 17 | (432) | 0.75 | 0.69 | 0.61 | 1.00 | 0.81 | 0.61 | 0.60 | 0.58 | 0.55 | 0.49 | 0.32 | 0.15 | 0.98 | 0.64 | 0.30 | 0.64 | n/a | n/a |
| | 18 | (457) | 0.77 | 0.70 | 0.62 | | 0.85 | 0.62 | 0.61 | 0.58 | 0.55 | 0.54 | 0.35 | 0.16 | 1.00 | 0.70 | 0.32 | 0.66 | 0.57 | n/a |
| | 20 | (508) | 0.80 | 0.72 | 0.63 | | 0.91 | 0.66 | 0.62 | 0.59 | 0.55 | 0.63 | 0.41 | 0.19 | | 0.82 | 0.38 | 0.70 | 0.61 | n/a |
| | 22 | (559) | 0.83 | 0.74 | 0.65 | | 0.98 | 0.69 | 0.63 | 0.60 | 0.56 | 0.72 | 0.47 | 0.22 | | 0.94 | 0.44 | 0.73 | 0.63 | n/a |
| | 24 | (610) | 0.86 | 0.77 | 0.66 | | 1.00 | 0.73 | 0.65 | 0.61 | 0.57 | 0.82 | 0.54 | 0.25 | | 1.00 | 0.50 | 0.77 | 0.66 | n/a |
| | 26 | (660) | 0.89 | 0.79 | 0.67 | | | 0.77 | 0.66 | 0.62 | 0.57 | 0.93 | 0.60 | 0.28 | | | 0.56 | 0.80 | 0.69 | n/a |
| | 28 | (711) | 0.91 | 0.81 | 0.69 | | | 0.81 | 0.67 | 0.63 | 0.58 | 1.00 | 0.68 | 0.31 | | | 0.63 | 0.83 | 0.72 | 0.55 |
| | 30 | (762) | 0.94 | 0.83 | 0.70 | | | 0.85 | 0.68 | 0.64 | 0.58 | | 0.75 | 0.35 | | | 0.70 | 0.86 | 0.74 | 0.57 |
| | 36 | (914) | 1.00 | 0.90 | 0.74 | | | 0.97 | 0.72 | 0.66 | 0.60 | | 0.98 | 0.46 | | | 0.91 | 0.94 | 0.81 | 0.63 |
| | > 48 | (1219) | | 1.00 | 0.82 | | | 1.00 | 0.79 | 0.72 | 0.63 | | 1.00 | 0.70 | | | 1.00 | 1.00 | 0.94 | 0.73 |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

**HIT-RE 500 V3 adhesive with HAS threaded rod**

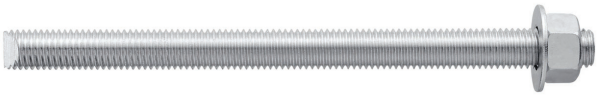


**Figure 4 — Hilti HAS threaded rod installation conditions**

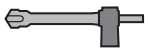
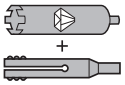
| Cracked or uncracked concrete | Permissible drilling methods | Permissible concrete conditions |
|---|---|---|
|   Cracked and uncracked concrete |  Hammer drilling with carbide-tipped drill bit |  Dry concrete<br>  Water-saturated concrete<br>  Water-filled holes<br>  Submerged (underwater) |
| |  Hilti TE-CD or TE-YD hollow drill bit and VC 20/40 Vacuum<br>  Diamond core drill bit with Hilti TE-YRT roughening tool |  Dry concrete<br>  Water-saturated concrete |
|  Uncracked concrete |  Diamond core drill bit |  Dry concrete<br>  Water-saturated concrete |

**Table 24 — Hilti HAS threaded rod installation specifications**

| Setting information | | Symbol | Units | Nominal rod diameter, d | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 |
| Nominal bit diameter | | $d_o$ | in. | 7/16 | 9/16 | 3/4 | 7/8 | 1 | 1-1/8 | 1-3/8 |
| Effective embedment | minimum | $h_{ef,min}$ | in. (mm) | 2-3/8 (60) | 2-3/4 (70) | 3-1/8 (79) | 3-1/2 (89) | 3-1/2 (89) | 4 (102) | 5 (127) |
| | maximum | $h_{ef,max}$ | in. (mm) | 7-1/2 (191) | 10 (254) | 12-1/2 (318) | 15 (381) | 17-1/2 (445) | 20 (508) | 25 (635) |
| Diameter of fixture hole | through-set |  | in. | 1/2 | 5/8 | 13/16[1] | 15/16[1] | 1-1/8[1] | 1-1/4[1] | 1-1/2[1] |
| | preset |  | in. | 7/16 | 9/16 | 11/16 | 13/16 | 15/16 | 1-1/8 | 1-3/8 |
| Installation torque | | $T_{inst}$ | ft-lb (Nm) | 15 (20) | 30 (40) | 60 (80) | 100 (136) | 125 (169) | 150 (203) | 200 (271) |
| Minimum concrete thickness | | $h_{min}$ | in. (mm) | $h_{ef}$+1-1/4 ($h_{ef}$+30) | | $h_{ef}$+2$d_o$ | | | | |
| Minimum edge distance[2] | | $c_{min}$ | in. (mm) | 1-7/8 (48) | 2-1/2 (64) | 3-1/8 (79) | 3-3/4 (95) | 4-3/8 (111) | 5 (127) | 6-1/4 (159) |
| Minimum anchor spacing | | $s_{min}$ | in. (mm) | 1-7/8 (48) | 2-1/2 (64) | 3-1/8 (79) | 3-3/4 (95) | 4-3/8 (111) | 5 (127) | 6-1/4 (159) |

1 Install using (2) washers. See Figure 5.

2 Edge distance of 1-3/4-inch (44mm) is permitted provided the installation torque is reduced to 0.30 $T_{inst}$ for 5d < s < 16-in. and to 0.5$T_{inst}$ for s >16-in.

**Figure 4 — Hilti HAS threaded rods**

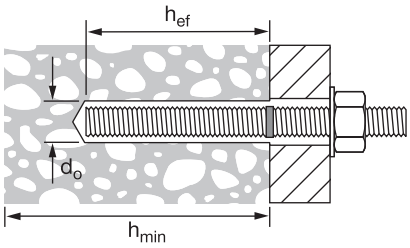



**Figure 5 — Installation with (2) washers**



## Table 25 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8,9,11]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8 | 2-3/8 (60) | 2,855 (12.7) | 3,125 (13.9) | 3,610 (16.1) | 4,425 (19.7) | 3,075 (13.7) | 3,370 (15.0) | 3,890 (17.3) | 4,765 (21.2) |
| | 3-3/8 (86) | 4,835 (21.5) | 5,300 (23.6) | 6,115 (27.2) | 7,490 (33.3) | 10,415 (46.3) | 11,410 (50.8) | 13,175 (58.6) | 16,135 (71.8) |
| | 4-1/2 (114) | 7,445 (33.1) | 8,155 (36.3) | 9,225 (41.0) | 10,210 (45.4) | 16,035 (71.3) | 17,570 (78.2) | 19,865 (88.4) | 21,985 (97.8) |
| | 7-1/2 (191) | 13,670 (60.8) | 14,305 (63.6) | 15,375 (68.4) | 17,015 (75.7) | 29,440 (131.0) | 30,815 (137.1) | 33,110 (147.3) | 36,645 (163.0) |
| 1/2 | 2-3/4 (70) | 3,555 (15.8) | 3,895 (17.3) | 4,500 (20.0) | 5,510 (24.5) | 7,660 (34.1) | 8,395 (37.3) | 9,690 (43.1) | 11,870 (52.8) |
| | 4-1/2 (114) | 7,445 (33.1) | 8,155 (36.3) | 9,420 (41.9) | 11,535 (51.3) | 16,035 (71.3) | 17,570 (78.2) | 20,285 (90.2) | 24,845 (110.5) |
| | 6 (152) | 11,465 (51.0) | 12,560 (55.9) | 14,500 (64.5) | 17,535 (78.0) | 24,690 (109.8) | 27,045 (120.3) | 31,230 (138.9) | 37,775 (168.0) |
| | 10 (254) | 23,485 (104.5) | 24,580 (109.3) | 26,410 (117.5) | 29,230 (130.0) | 50,580 (225.0) | 52,940 (235.5) | 56,885 (253.0) | 62,955 (280.0) |
| 5/8[10] | 3-1/8 (79) | 4,310 (19.2) | 4,720 (21.0) | 5,450 (24.2) | 6,675 (29.7) | 9,280 (41.3) | 10,165 (45.2) | 11,740 (52.2) | 14,380 (64.0) |
| | 5-5/8 (143) | 10,405 (46.3) | 11,400 (50.7) | 13,165 (58.6) | 16,120 (71.7) | 22,415 (99.7) | 24,550 (109.2) | 28,350 (126.1) | 34,720 (154.4) |
| | 7-1/2 (191) | 16,020 (71.3) | 17,550 (78.1) | 20,265 (90.1) | 24,820 (110.4) | 34,505 (153.5) | 37,800 (168.1) | 43,650 (194.2) | 53,455 (237.8) |
| | 12-1/2 (318) | 34,470 (153.3) | 36,900 (164.1) | 39,655 (176.4) | 43,885 (195.2) | 74,245 (330.3) | 79,480 (353.5) | 85,405 (379.9) | 94,520 (420.4) |
| 3/4[10] | 3-1/2 (89) | 5,105 (22.7) | 5,595 (24.9) | 6,460 (28.7) | 7,910 (35.2) | 11,000 (48.9) | 12,050 (53.6) | 13,915 (61.9) | 17,040 (75.8) |
| | 6-3/4 (171) | 13,680 (60.9) | 14,985 (66.7) | 17,305 (77.0) | 21,190 (94.3) | 29,460 (131.0) | 32,275 (143.6) | 37,265 (165.8) | 45,645 (203.0) |
| | 9 (229) | 21,060 (93.7) | 23,070 (102.6) | 26,640 (118.5) | 32,625 (145.1) | 45,360 (201.8) | 49,690 (221.0) | 57,375 (255.2) | 70,270 (312.6) |
| | 15 (381) | 45,315 (201.6) | 49,640 (220.8) | 55,035 (244.8) | 60,905 (270.9) | 97,600 (434.1) | 106,915 (475.6) | 118,535 (527.3) | 131,180 (583.5) |
| 7/8[10] | 3-1/2 (89) | 5,105 (22.7) | 5,595 (24.9) | 6,460 (28.7) | 7,910 (35.2) | 11,000 (48.9) | 12,050 (53.6) | 13,915 (61.9) | 17,040 (75.8) |
| | 7-7/8 (200) | 17,235 (76.7) | 18,885 (84.0) | 21,805 (97.0) | 26,705 (118.8) | 37,125 (165.1) | 40,670 (180.9) | 46,960 (208.9) | 57,515 (255.8) |
| | 10-1/2 (267) | 26,540 (118.1) | 29,070 (129.3) | 33,570 (149.3) | 41,115 (182.9) | 57,160 (254.3) | 62,615 (278.5) | 72,300 (321.6) | 88,550 (393.9) |
| | 17-1/2 (445) | 57,100 (254.0) | 62,550 (278.2) | 71,740 (319.1) | 79,395 (353.2) | 122,990 (547.1) | 134,730 (599.3) | 154,520 (687.3) | 171,005 (760.7) |
| 1[10] | 4 (102) | 6,240 (27.8) | 6,835 (30.4) | 7,895 (35.1) | 9,665 (43.0) | 13,440 (59.8) | 14,725 (65.5) | 17,000 (75.6) | 20,820 (92.6) |
| | 9 (229) | 21,060 (93.7) | 23,070 (102.6) | 26,640 (118.5) | 32,625 (145.1) | 45,360 (201.8) | 49,690 (221.0) | 57,375 (255.2) | 70,270 (312.6) |
| | 12 (305) | 32,425 (144.2) | 35,520 (158.0) | 41,015 (182.4) | 50,230 (223.4) | 69,835 (310.6) | 76,500 (340.3) | 88,335 (392.9) | 108,190 (481.3) |
| | 20 (508) | 69,765 (310.3) | 76,425 (340.0) | 88,245 (392.5) | 99,635 (443.2) | 150,265 (668.4) | 164,605 (732.2) | 190,070 (845.5) | 214,595 (954.6) |
| 1-1/4[10] | 5 (127) | 8,720 (38.8) | 9,555 (42.5) | 11,030 (49.1) | 13,510 (60.1) | 18,785 (83.6) | 20,575 (91.5) | 23,760 (105.7) | 29,100 (129.4) |
| | 11-1/4 (286) | 29,430 (130.9) | 32,240 (143.4) | 37,230 (165.6) | 45,595 (202.8) | 63,395 (282.0) | 69,445 (308.9) | 80,185 (356.7) | 98,205 (436.8) |
| | 15 (381) | 45,315 (201.6) | 49,640 (220.8) | 57,320 (255.0) | 70,200 (312.3) | 97,600 (434.1) | 106,915 (475.6) | 123,455 (549.2) | 151,200 (672.6) |
| | 25 (635) | 97,500 (433.7) | 106,805 (475.1) | 123,330 (548.6) | 142,175 (632.4) | 210,000 (934.1) | 230,045 (1023.3) | 265,630 (1181.6) | 306,220 (1362.1) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength (factored resistance) value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in Tables 30-41 as necessary to the above values. Compare to the steel values in Table 29. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.45.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. For diamond core drilling, except as indicated in note 10, multiply above values by 0.55.
Diamond core drilling is not permitted for water-filled or underwater (submerged) applications.
10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 5/8", 3/4", 7/8", 1", and 1 1/4" diameter anchors for dry and water-saturated concrete conditions. See Table 27.
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 26 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8,9,11]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8 | 2-3/8 (60) | 2,020 (9.0) | 2,215 (9.9) | 2,500 (11.1) | 2,655 (11.8) | 2,180 (9.7) | 2,385 (10.6) | 2,690 (12.0) | 2,860 (12.7) |
| | 3-3/8 (86) | 3,310 (14.7) | 3,400 (15.1) | 3,550 (15.8) | 3,770 (16.8) | 7,125 (31.7) | 7,325 (32.6) | 7,645 (34.0) | 8,125 (36.1) |
| | 4-1/2 (114) | 4,410 (19.6) | 4,535 (20.2) | 4,735 (21.1) | 5,030 (22.4) | 9,500 (42.3) | 9,765 (43.4) | 10,195 (45.3) | 10,835 (48.2) |
| | 7-1/2 (191) | 7,350 (32.7) | 7,555 (33.6) | 7,890 (35.1) | 8,385 (37.3) | 15,835 (70.4) | 16,275 (72.4) | 16,990 (75.6) | 18,055 (80.3) |
| 1/2 | 2-3/4 (70) | 2,520 (11.2) | 2,760 (12.3) | 3,185 (14.2) | 3,905 (17.4) | 5,425 (24.1) | 5,945 (26.4) | 6,865 (30.5) | 8,405 (37.4) |
| | 4-1/2 (114) | 5,275 (23.5) | 5,780 (25.7) | 6,260 (27.8) | 6,655 (29.6) | 11,360 (50.5) | 12,445 (55.4) | 13,485 (60.0) | 14,330 (63.7) |
| | 6 (152) | 7,780 (34.6) | 7,995 (35.6) | 8,350 (37.1) | 8,870 (39.5) | 16,755 (74.5) | 17,220 (76.6) | 17,980 (80.0) | 19,110 (85.0) |
| | 10 (254) | 12,965 (57.7) | 13,325 (59.3) | 13,915 (61.9) | 14,785 (65.8) | 27,930 (124.2) | 28,705 (127.7) | 29,970 (133.3) | 31,850 (141.7) |
| 5/8[10] | 3-1/8 (79) | 3,050 (13.6) | 3,345 (14.9) | 3,860 (17.2) | 4,730 (21.0) | 6,575 (29.2) | 7,200 (32.0) | 8,315 (37.0) | 10,185 (45.3) |
| | 5-5/8 (143) | 7,370 (32.8) | 8,075 (35.9) | 9,325 (41.5) | 10,315 (45.9) | 15,875 (70.6) | 17,390 (77.4) | 20,080 (89.3) | 22,215 (98.8) |
| | 7-1/2 (191) | 11,350 (50.5) | 12,395 (55.1) | 12,940 (57.6) | 13,755 (61.2) | 24,440 (108.7) | 26,695 (118.7) | 27,875 (124.0) | 29,620 (131.8) |
| | 12-1/2 (318) | 20,100 (89.4) | 20,660 (91.9) | 21,570 (95.9) | 22,920 (102.0) | 43,295 (192.6) | 44,495 (197.9) | 46,460 (206.7) | 49,370 (219.6) |
| 3/4[10] | 3-1/2 (89) | 3,620 (16.1) | 3,965 (17.6) | 4,575 (20.4) | 5,605 (24.9) | 7,790 (34.7) | 8,535 (38.0) | 9,855 (43.8) | 12,070 (53.7) |
| | 6-3/4 (171) | 9,690 (43.1) | 10,615 (47.2) | 12,255 (54.5) | 14,735 (65.5) | 20,870 (92.8) | 22,860 (101.7) | 26,395 (117.4) | 31,740 (141.2) |
| | 9 (229) | 14,920 (66.4) | 16,340 (72.7) | 18,490 (82.2) | 19,650 (87.4) | 32,130 (142.9) | 35,195 (156.6) | 39,820 (177.1) | 42,320 (188.2) |
| | 15 (381) | 28,715 (127.7) | 29,510 (131.3) | 30,815 (137.1) | 32,745 (145.7) | 61,850 (275.1) | 63,565 (282.7) | 66,370 (295.2) | 70,530 (313.7) |
| 7/8[10] | 3-1/2 (89) | 3,620 (16.1) | 3,965 (17.6) | 4,575 (20.4) | 5,605 (24.9) | 7,790 (34.7) | 8,535 (38.0) | 9,855 (43.8) | 12,070 (53.7) |
| | 7-7/8 (200) | 12,210 (54.3) | 13,375 (59.5) | 15,445 (68.7) | 18,915 (84.1) | 26,300 (117.0) | 28,810 (128.2) | 33,265 (148.0) | 40,740 (181.2) |
| | 10-1/2 (267) | 18,800 (83.6) | 20,590 (91.6) | 23,780 (105.8) | 26,530 (118.0) | 40,490 (180.1) | 44,355 (197.3) | 51,215 (227.8) | 57,140 (254.2) |
| | 17-1/2 (445) | 38,775 (172.5) | 39,850 (177.3) | 41,605 (185.1) | 44,215 (196.7) | 83,510 (371.5) | 85,825 (381.8) | 89,610 (398.6) | 95,230 (423.6) |
| 1[10] | 4 (102) | 4,420 (19.7) | 4,840 (21.5) | 5,590 (24.9) | 6,845 (30.4) | 9,520 (42.3) | 10,430 (46.4) | 12,040 (53.6) | 14,750 (65.6) |
| | 9 (229) | 14,920 (66.4) | 16,340 (72.7) | 18,870 (83.9) | 23,110 (102.8) | 32,130 (142.9) | 35,195 (156.6) | 40,640 (180.8) | 49,775 (221.4) |
| | 12 (305) | 22,965 (102.2) | 25,160 (111.9) | 29,050 (129.2) | 34,650 (154.1) | 49,465 (220.0) | 54,190 (241.0) | 62,570 (278.3) | 74,630 (332.0) |
| | 20 (508) | 49,415 (219.8) | 52,045 (231.5) | 54,340 (241.7) | 57,750 (256.9) | 106,435 (473.4) | 112,100 (498.6) | 117,045 (520.6) | 124,385 (553.3) |
| 1-1/4[10] | 5 (127) | 6,175 (27.5) | 6,765 (30.1) | 7,815 (34.8) | 9,570 (42.6) | 13,305 (59.2) | 14,575 (64.8) | 16,830 (74.9) | 20,610 (91.7) |
| | 11-1/4 (286) | 20,850 (92.7) | 22,840 (101.6) | 26,370 (117.3) | 32,295 (143.7) | 44,905 (199.7) | 49,190 (218.8) | 56,800 (252.7) | 69,565 (309.4) |
| | 15 (381) | 32,095 (142.8) | 35,160 (156.4) | 40,600 (180.6) | 49,725 (221.2) | 69,135 (307.5) | 75,730 (336.9) | 87,445 (389.0) | 107,100 (476.4) |
| | 25 (635) | 69,060 (307.2) | 75,655 (336.5) | 80,800 (359.4) | 85,865 (381.9) | 148,750 (661.7) | 162,945 (724.8) | 174,030 (774.1) | 184,945 (822.7) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 30-41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.44.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete conditions except as indicated in note 10.
10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 5/8" 3/4", 7/8", 1", and 1 1/4" diameter anchors for dry and water-saturated concrete conditions. See Table 28
11 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ indicated below.
See section 3.1.8 for additional information on seismic applications.
3/8-in. diameter - $\alpha_{seis}$ = 0.69
1/2-in. diameter - $\alpha_{seis}$ = 0.70
5/8-in. diameter - $\alpha_{seis}$ = 0.71
3/4-in. diameter and larger - $\alpha_{seis}$ = 0.75

**Table 27 — Hilti HIT-RE 500 V3 for Core Drilled Holes with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8,9]**

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 5/8 | 3-1/8 (79) | 4,310 (19.2) | 4,720 (21.0) | 5,450 (24.2) | 6,675 (29.7) | 9,280 (41.3) | 10,165 (45.2) | 11,740 (52.2) | 14,380 (64.0) |
| | 5-5/8 (143) | 10,405 (46.3) | 11,400 (50.7) | 13,165 (58.6) | 15,865 (70.6) | 22,415 (99.7) | 24,550 (109.2) | 28,350 (126.1) | 34,170 (152.0) |
| | 7-1/2 (191) | 16,020 (71.3) | 17,550 (78.1) | 20,265 (90.1) | 21,155 (94.1) | 34,505 (153.5) | 37,800 (168.1) | 43,650 (194.2) | 45,565 (202.7) |
| | 12-1/2 (318) | 34,470 (153.3) | 35,255 (156.8) | 35,255 (156.8) | 35,255 (156.8) | 74,245 (330.3) | 75,940 (337.8) | 75,940 (337.8) | 75,940 (337.8) |
| 3/4 | 3-1/2 (89) | 5,105 (22.7) | 5,595 (24.9) | 6,460 (28.7) | 7,910 (35.2) | 11,000 (48.9) | 12,050 (53.6) | 13,915 (61.9) | 17,040 (75.8) |
| | 6-3/4 (171) | 13,680 (60.9) | 14,985 (66.7) | 17,305 (77.0) | 21,190 (94.3) | 29,460 (131.0) | 32,275 (143.6) | 37,265 (165.8) | 45,645 (203.0) |
| | 9 (229) | 21,060 (93.7) | 23,070 (102.6) | 26,640 (118.5) | 29,360 (130.6) | 45,360 (201.8) | 49,690 (221.0) | 57,375 (255.2) | 63,235 (281.3) |
| | 11-1/4 (286) | 29,430 (130.9) | 32,240 (143.4) | 36,700 (163.2) | 36,700 (163.2) | 63,395 (282.0) | 69,445 (308.9) | 79,045 (351.6) | 79,045 (351.6) |
| 7/8 | 3-1/2 (89) | 5,105 (22.7) | 5,595 (24.9) | 6,460 (28.7) | 7,910 (35.2) | 11,000 (48.9) | 12,050 (53.6) | 13,915 (61.9) | 17,040 (75.8) |
| | 7-7/8 (200) | 17,235 (76.7) | 18,885 (84.0) | 21,805 (97.0) | 26,705 (118.8) | 37,125 (165.1) | 40,670 (180.9) | 46,960 (208.9) | 57,515 (255.8) |
| | 10-1/2 (267) | 26,540 (118.1) | 29,070 (129.3) | 33,570 (149.3) | 38,275 (170.3) | 57,160 (254.3) | 62,615 (278.5) | 72,300 (321.6) | 82,435 (366.7) |
| | 17-1/2 (445) | 57,100 (254.0) | 62,550 (278.2) | 63,790 (283.8) | 63,790 (283.8) | 122,990 (547.1) | 134,730 (599.3) | 137,390 (611.1) | 137,390 (611.1) |
| 1 | 4 (102) | 6,240 (27.8) | 6,835 (30.4) | 7,895 (35.1) | 9,665 (43.0) | 13,440 (59.8) | 14,725 (65.5) | 17,000 (75.6) | 20,820 (92.6) |
| | 9 (229) | 21,060 (93.7) | 23,070 (102.6) | 26,640 (118.5) | 32,625 (145.1) | 45,360 (201.8) | 49,690 (221.0) | 57,375 (255.2) | 70,270 (312.6) |
| | 12 (305) | 32,425 (144.2) | 35,520 (158.0) | 41,015 (182.4) | 48,030 (213.6) | 69,835 (310.6) | 76,500 (340.3) | 88,335 (392.9) | 103,445 (460.1) |
| | 20 (508) | 69,765 (310.3) | 76,425 (340.0) | 80,050 (356.1) | 80,050 (356.1) | 150,265 (668.4) | 164,605 (732.2) | 172,410 (766.9) | 172,410 (766.9) |
| 1-1/4 | 5 (127) | 8,720 (38.8) | 9,555 (42.5) | 11,030 (49.1) | 13,510 (60.1) | 18,785 (83.6) | 20,575 (91.5) | 23,760 (105.7) | 29,100 (129.4) |
| | 11-1/4 (286) | 29,430 (130.9) | 32,240 (143.4) | 37,230 (165.6) | 45,595 (202.8) | 63,395 (282.0) | 69,445 (308.9) | 80,185 (356.7) | 98,205 (436.8) |
| | 15 (381) | 45,315 (201.6) | 49,640 (220.8) | 57,320 (255.0) | 68,535 (304.9) | 97,600 (434.1) | 106,915 (475.6) | 123,455 (549.2) | 147,615 (656.6) |
| | 25 (635) | 97,500 (433.7) | 106,805 (475.1) | 114,225 (508.1) | 114,225 (508.1) | 210,000 (934.1) | 230,045 (1023.3) | 246,025 (1094.4) | 246,025 (1094.4) |

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 30-41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry or water saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 28 — Hilti HIT-RE 500 V3 for Core Drilled Holes with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8,9]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 5/8 | 3-1/8 (79) | 3,050 (13.6) | 3,345 (14.9) | 3,510 (15.6) | 3,510 (15.6) | 6,575 (29.2) | 7,200 (32.0) | 7,560 (33.6) | 7,560 (33.6) |
| | 5-5/8 (143) | 6,320 (28.1) | 6,320 (28.1) | 6,320 (28.1) | 6,320 (28.1) | 13,605 (60.5) | 13,605 (60.5) | 13,605 (60.5) | 13,605 (60.5) |
| | 7-1/2 (191) | 8,425 (37.5) | 8,425 (37.5) | 8,425 (37.5) | 8,425 (37.5) | 18,145 (80.7) | 18,145 (80.7) | 18,145 (80.7) | 18,145 (80.7) |
| | 12-1/2 (318) | 14,040 (62.5) | 14,040 (62.5) | 14,040 (62.5) | 14,040 (62.5) | 30,240 (134.5) | 30,240 (134.5) | 30,240 (134.5) | 30,240 (134.5) |
| 3/4 | 3-1/2 (89) | 3,620 (16.1) | 3,965 (17.6) | 4,575 (20.4) | 4,690 (20.9) | 7,790 (34.7) | 8,535 (38.0) | 9,855 (43.8) | 10,100 (44.9) |
| | 6-3/4 (171) | 9,045 (40.2) | 9,045 (40.2) | 9,045 (40.2) | 9,045 (40.2) | 19,485 (86.7) | 19,485 (86.7) | 19,485 (86.7) | 19,485 (86.7) |
| | 9 (229) | 12,060 (53.6) | 12,060 (53.6) | 12,060 (53.6) | 12,060 (53.6) | 25,975 (115.5) | 25,975 (115.5) | 25,975 (115.5) | 25,975 (115.5) |
| | 11-1/4 (286) | 15,075 (67.1) | 15,075 (67.1) | 15,075 (67.1) | 15,075 (67.1) | 32,470 (144.4) | 32,470 (144.4) | 32,470 (144.4) | 32,470 (144.4) |
| 7/8 | 3-1/2 (89) | 3,620 (16.1) | 3,965 (17.6) | 4,575 (20.4) | 5,440 (24.2) | 7,790 (34.7) | 8,535 (38.0) | 9,855 (43.8) | 11,720 (52.1) |
| | 7-7/8 (200) | 12,210 (54.3) | 12,240 (54.4) | 12,240 (54.4) | 12,240 (54.4) | 26,300 (117.0) | 26,365 (117.3) | 26,365 (117.3) | 26,365 (117.3) |
| | 10-1/2 (267) | 16,320 (72.6) | 16,320 (72.6) | 16,320 (72.6) | 16,320 (72.6) | 35,155 (156.4) | 35,155 (156.4) | 35,155 (156.4) | 35,155 (156.4) |
| | 17-1/2 (445) | 27,205 (121.0) | 27,205 (121.0) | 27,205 (121.0) | 27,205 (121.0) | 58,595 (260.6) | 58,595 (260.6) | 58,595 (260.6) | 58,595 (260.6) |
| 1 | 4 (102) | 4,420 (19.7) | 4,840 (21.5) | 5,590 (24.9) | 6,845 (30.4) | 9,520 (42.3) | 10,430 (46.4) | 12,040 (53.6) | 14,750 (65.6) |
| | 9 (229) | 14,920 (66.4) | 15,990 (71.1) | 15,990 (71.1) | 15,990 (71.1) | 32,130 (142.9) | 34,440 (153.2) | 34,440 (153.2) | 34,440 (153.2) |
| | 12 (305) | 21,320 (94.8) | 21,320 (94.8) | 21,320 (94.8) | 21,320 (94.8) | 45,920 (204.3) | 45,920 (204.3) | 45,920 (204.3) | 45,920 (204.3) |
| | 20 (508) | 35,530 (158.0) | 35,530 (158.0) | 35,530 (158.0) | 35,530 (158.0) | 76,530 (340.4) | 76,530 (340.4) | 76,530 (340.4) | 76,530 (340.4) |
| 1-1/4 | 5 (127) | 6,175 (27.5) | 6,765 (30.1) | 7,815 (34.8) | 9,570 (42.6) | 13,305 (59.2) | 14,575 (64.8) | 16,830 (74.9) | 20,610 (91.7) |
| | 11-1/4 (286) | 20,850 (92.7) | 22,840 (101.6) | 23,690 (105.4) | 23,690 (105.4) | 44,905 (199.7) | 49,190 (218.8) | 51,025 (227.0) | 51,025 (227.0) |
| | 15 (381) | 31,590 (140.5) | 31,590 (140.5) | 31,590 (140.5) | 31,590 (140.5) | 68,035 (302.6) | 68,035 (302.6) | 68,035 (302.6) | 68,035 (302.6) |
| | 25 (635) | 52,645 (234.2) | 52,645 (234.2) | 52,645 (234.2) | 52,645 (234.2) | 113,390 (504.4) | 113,390 (504.4) | 113,390 (504.4) | 113,390 (504.4) |

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 30-41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry or water saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$=0.75. See section 3.1.8 for additional information on seismic applications.

## Table 29 — Steel design strength for Hilti HAS threaded rods for use with ACI 318 Chapter 17

| Nominal anchor diameter in. | HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr.36[4,6] | | | HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6] | | | HAS-B-105 / HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6] | | | HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) |
| 3/8 | 3,370 (15.0) | 1,750 (7.8) | 1,050 (4.7) | 4,360 (19.4) | 2,270 (10.1) | 2,270 (10.1) | 7,270 (32.3) | 3,780 (16.8) | 3,780 (16.8) | 5,040 (22.4) | 2,790 (12.4) | 2,230 (9.9) |
| 1/2 | 6,175 (27.5) | 3,210 (14.3) | 1,925 (8.6) | 7,985 (35.5) | 4,150 (18.5) | 4,150 (18.5) | 13,305 (59.2) | 6,920 (30.8) | 6,920 (30.8) | 9,225 (41.0) | 5,110 (22.7) | 4,090 (18.2) |
| 5/8 | 9,835 (43.7) | 5,110 (22.7) | 3,065 (13.6) | 12,715 (56.6) | 6,610 (29.4) | 6,610 (29.4) | 21,190 (94.3) | 11,020 (49.0) | 11,020 (49.0) | 14,690 (65.3) | 8,135 (36.2) | 6,510 (29.0) |
| 3/4 | 14,550 (64.7) | 7,565 (33.7) | 4,540 (20.2) | 18,820 (83.7) | 9,785 (43.5) | 9,785 (43.5) | 31,360 (139.5) | 16,310 (72.6) | 16,310 (72.6) | 18,485 (82.2) | 10,235 (45.5) | 8,190 (36.4) |
| 7/8 | 20,085 (89.3) | 10,445 (46.5) | 6,265 (27.9) | 25,975 (115.5) | 13,505 (60.1) | 13,505 (60.1) | 43,285 (192.5) | 22,510 (100.1) | 22,510 (100.1) | 25,510 (113.5) | 14,125 (62.8) | 11,300 (50.3) |
| 1 | 26,350 (117.2) | 13,700 (60.9) | 8,220 (36.6) | 34,075 (151.6) | 17,720 (78.8) | 17,720 (78.8) | 56,785 (252.6) | 29,530 (131.4) | 29,530 (131.4) | 33,465 (148.9) | 18,535 (82.4) | 14,830 (66.0) |
| 1-1/4 | 42,160 (187.5) | 21,920 (97.5) | 13,150 (58.5) | 54,515 (242.5) | 28,345 (126.1) | 28,345 (126.1) | 90,855 (404.1) | 47,245 (210.2) | 47,245 (210.2) | 41,430 (184.3) | 21,545 (95.8) | 17,235 (76.7) |

1 Tensile = $\phi\ A_{se,N}\ f_{uta}$ as noted in ACI 318 17.4.1.2
2 Shear = $\phi$ 0.60 $A_{se,V}\ f_{uta}$ as noted in ACI 318 17.5.1.2b.
3 Seismic Shear = $\alpha_{V,seis}\ \phi\ V_{sa}$ : Reduction factor for seismic shear only. See ACI 318 for additional information on seismic applications.
4 HAS-V, HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).
5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.
6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

## Table 30 — Load adjustment factors for 3/8-in. diameter threaded rods in uncracked concrete[1,2,3]

| 3/8-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To and away from edge $f_{RV}$ | | | | | | | |
| Embedment | in. | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 |
| $h_{ef}$ | (mm) | (60) | (86) | (114) | (191) | (60) | (86) | (114) | (191) | (60) | (86) | (114) | (191) | (60) | (86) | (114) | (191) | (60) | (86) | (114) | (191) | (60) | (86) | (114) | (191) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.35 | 0.26 | 0.21 | 0.12 | n/a | n/a | n/a | n/a | 0.23 | 0.07 | 0.05 | 0.03 | 0.35 | 0.14 | 0.09 | 0.05 | n/a | n/a | n/a | n/a |
| | 1-7/8 (48) | 0.58 | 0.58 | 0.57 | 0.54 | 0.36 | 0.27 | 0.22 | 0.13 | 0.57 | 0.53 | 0.52 | 0.52 | 0.25 | 0.08 | 0.05 | 0.03 | 0.36 | 0.16 | 0.10 | 0.06 | n/a | n/a | n/a | n/a |
| | 2 (51) | 0.58 | 0.58 | 0.57 | 0.54 | 0.37 | 0.28 | 0.23 | 0.13 | 0.57 | 0.53 | 0.52 | 0.52 | 0.28 | 0.09 | 0.06 | 0.03 | 0.37 | 0.17 | 0.11 | 0.06 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.62 | 0.62 | 0.61 | 0.57 | 0.48 | 0.34 | 0.27 | 0.16 | 0.61 | 0.55 | 0.54 | 0.52 | 0.51 | 0.16 | 0.10 | 0.06 | 0.48 | 0.32 | 0.21 | 0.11 | n/a | n/a | n/a | n/a |
| | 3-5/8 (92) | 0.65 | 0.65 | 0.63 | 0.58 | 0.56 | 0.38 | 0.30 | 0.17 | 0.63 | 0.56 | 0.54 | 0.53 | 0.68 | 0.21 | 0.14 | 0.07 | 0.56 | 0.38 | 0.27 | 0.15 | 0.72 | n/a | n/a | n/a |
| | 4 (102) | 0.66 | 0.66 | 0.65 | 0.59 | 0.62 | 0.41 | 0.31 | 0.18 | 0.64 | 0.57 | 0.55 | 0.53 | 0.79 | 0.24 | 0.16 | 0.09 | 0.62 | 0.41 | 0.31 | 0.17 | 0.75 | n/a | n/a | n/a |
| | 4-5/8 (117) | 0.69 | 0.69 | 0.67 | 0.60 | 0.71 | 0.45 | 0.35 | 0.20 | 0.66 | 0.58 | 0.56 | 0.54 | 0.98 | 0.30 | 0.20 | 0.11 | 0.71 | 0.45 | 0.35 | 0.20 | 0.81 | 0.55 | n/a | n/a |
| | 5 (127) | 0.70 | 0.70 | 0.69 | 0.61 | 0.77 | 0.48 | 0.36 | 0.21 | 0.68 | 0.58 | 0.56 | 0.54 | 1.00 | 0.34 | 0.22 | 0.12 | 0.77 | 0.48 | 0.36 | 0.21 | 0.84 | 0.57 | n/a | n/a |
| | 5-3/4 (146) | 0.73 | 0.73 | 0.71 | 0.63 | 0.89 | 0.55 | 0.40 | 0.23 | 0.70 | 0.59 | 0.57 | 0.55 | | 0.42 | 0.27 | 0.15 | 0.89 | 0.55 | 0.40 | 0.23 | 0.91 | 0.61 | 0.53 | n/a |
| | 6 (152) | 0.74 | 0.74 | 0.72 | 0.63 | 0.92 | 0.58 | 0.42 | 0.24 | 0.71 | 0.60 | 0.57 | 0.55 | | 0.45 | 0.29 | 0.16 | 0.92 | 0.58 | 0.42 | 0.24 | 0.92 | 0.63 | 0.54 | n/a |
| | 7 (178) | 0.78 | 0.78 | 0.76 | 0.66 | 1.00 | 0.67 | 0.48 | 0.28 | 0.75 | 0.61 | 0.59 | 0.56 | | 0.57 | 0.37 | 0.20 | 1.00 | 0.67 | 0.48 | 0.28 | 1.00 | 0.68 | 0.58 | n/a |
| | 8 (203) | 0.82 | 0.82 | 0.80 | 0.68 | | 0.77 | 0.55 | 0.32 | 0.79 | 0.63 | 0.60 | 0.57 | | 0.69 | 0.45 | 0.24 | | 0.77 | 0.55 | 0.32 | | 0.72 | 0.63 | n/a |
| | 8-3/4 (222) | 0.86 | 0.86 | 0.82 | 0.69 | | 0.84 | 0.61 | 0.35 | 0.81 | 0.64 | 0.61 | 0.57 | | 0.79 | 0.51 | 0.28 | | 0.84 | 0.61 | 0.35 | | 0.76 | 0.65 | 0.53 |
| | 9 (229) | 0.87 | 0.87 | 0.83 | 0.70 | | 0.86 | 0.62 | 0.36 | 0.82 | 0.65 | 0.61 | 0.57 | | 0.83 | 0.54 | 0.29 | | 0.86 | 0.62 | 0.36 | | 0.77 | 0.66 | 0.54 |
| | 10 (254) | 0.91 | 0.91 | 0.87 | 0.72 | | 0.96 | 0.69 | 0.40 | 0.86 | 0.66 | 0.62 | 0.58 | | 0.97 | 0.63 | 0.34 | | 0.96 | 0.69 | 0.40 | | 0.81 | 0.70 | 0.57 |
| | 11 (279) | 0.95 | 0.95 | 0.91 | 0.74 | | 1.00 | 0.76 | 0.44 | 0.89 | 0.68 | 0.63 | 0.59 | | 1.00 | 0.72 | 0.39 | | 1.00 | 0.76 | 0.44 | | 0.85 | 0.73 | 0.60 |
| | 12 (305) | 0.99 | 0.99 | 0.94 | 0.77 | | | 0.83 | 0.48 | 0.93 | 0.70 | 0.65 | 0.60 | | | 0.83 | 0.45 | | | 0.83 | 0.48 | | 0.88 | 0.77 | 0.63 |
| | 14 (356) | 1.00 | 1.00 | 1.00 | 0.81 | | | 0.97 | 0.56 | 1.00 | 0.73 | 0.67 | 0.61 | | | 1.00 | 0.57 | | | 0.97 | 0.56 | | 0.96 | 0.83 | 0.68 |
| | 16 (406) | | | | 0.86 | | | 1.00 | 0.64 | | 0.76 | 0.70 | 0.63 | | | | 0.69 | | | 1.00 | 0.64 | | 1.00 | 0.88 | 0.72 |
| | 18 (457) | | | | 0.90 | | | | 0.72 | | 0.79 | 0.72 | 0.65 | | | | 0.83 | | | | 0.72 | | | 0.94 | 0.77 |
| | 24 (610) | | | | 1.00 | | | | 0.96 | | 0.89 | 0.79 | 0.70 | | | | 1.00 | | | | 0.96 | | | 1.00 | 0.88 |
| | 30 (762) | | | | | | | | 1.00 | | 0.99 | 0.87 | 0.74 | | | | | | | | 1.00 | | | | 0.99 |
| | 36 (914) | | | | | | | | | | 1.00 | 0.94 | 0.79 | | | | | | | | | | | | 1.00 |
| | > 48 (1219) | | | | | | | | | | | 1.00 | 0.89 | | | | | | | | | | | | |

## Table 31 — Load adjustment factors for 3/8-in. diameter threaded rods in cracked concrete[1,2,3]

| 3/8-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To and away from edge $f_{RV}$ | | | | | | | |
| Embedment | in. | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 | 2-3/8 | 3-3/8 | 4-1/2 | 7-1/2 |
| $h_{ef}$ | (mm) | (60) | (86) | (114) | (191) | (60) | (86) | (114) | (191) | (60) | (86) | (114) | (191) | (60) | (86) | (114) | (191) | (60) | (86) | (114) | (191) | (60) | (86) | (114) | (191) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.50 | 0.50 | 0.49 | 0.43 | n/a | n/a | n/a | n/a | 0.23 | 0.07 | 0.06 | 0.03 | 0.46 | 0.15 | 0.11 | 0.07 | n/a | n/a | n/a | n/a |
| | 1-7/8 (48) | 0.58 | 0.58 | 0.57 | 0.54 | 0.52 | 0.52 | 0.50 | 0.44 | 0.57 | 0.53 | 0.53 | 0.52 | 0.26 | 0.08 | 0.06 | 0.04 | 0.51 | 0.16 | 0.12 | 0.07 | n/a | n/a | n/a | n/a |
| | 2 (51) | 0.58 | 0.58 | 0.57 | 0.54 | 0.53 | 0.53 | 0.51 | 0.44 | 0.57 | 0.53 | 0.53 | 0.52 | 0.28 | 0.09 | 0.07 | 0.04 | 0.53 | 0.18 | 0.14 | 0.08 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.62 | 0.62 | 0.61 | 0.57 | 0.63 | 0.63 | 0.60 | 0.49 | 0.61 | 0.55 | 0.54 | 0.53 | 0.52 | 0.17 | 0.12 | 0.07 | 0.63 | 0.33 | 0.25 | 0.15 | n/a | n/a | n/a | n/a |
| | 3-5/8 (92) | 0.65 | 0.65 | 0.63 | 0.58 | 0.70 | 0.70 | 0.66 | 0.53 | 0.63 | 0.56 | 0.55 | 0.54 | 0.69 | 0.22 | 0.17 | 0.10 | 0.70 | 0.44 | 0.33 | 0.20 | 0.72 | n/a | n/a | n/a |
| | 4 (102) | 0.66 | 0.66 | 0.65 | 0.59 | 0.74 | 0.74 | 0.70 | 0.55 | 0.64 | 0.57 | 0.56 | 0.54 | 0.80 | 0.26 | 0.19 | 0.11 | 0.74 | 0.51 | 0.38 | 0.23 | 0.76 | n/a | n/a | n/a |
| | 4-5/8 (117) | 0.69 | 0.69 | 0.67 | 0.60 | 0.81 | 0.81 | 0.76 | 0.58 | 0.67 | 0.58 | 0.56 | 0.55 | 0.99 | 0.32 | 0.24 | 0.14 | 0.81 | 0.63 | 0.48 | 0.29 | 0.81 | 0.56 | n/a | n/a |
| | 5 (127) | 0.70 | 0.70 | 0.69 | 0.61 | 0.86 | 0.86 | 0.80 | 0.60 | 0.68 | 0.58 | 0.57 | 0.55 | 1.00 | 0.36 | 0.27 | 0.16 | 0.86 | 0.71 | 0.54 | 0.32 | 0.85 | 0.58 | n/a | n/a |
| | 5-3/4 (146) | 0.73 | 0.73 | 0.71 | 0.63 | 0.95 | 0.95 | 0.88 | 0.64 | 0.71 | 0.60 | 0.58 | 0.56 | | 0.44 | 0.33 | 0.20 | 0.95 | 0.88 | 0.66 | 0.40 | 0.91 | 0.62 | 0.56 | n/a |
| | 6 (152) | 0.74 | 0.74 | 0.72 | 0.63 | 0.98 | 0.98 | 0.91 | 0.66 | 0.71 | 0.60 | 0.58 | 0.56 | | 0.47 | 0.35 | 0.21 | 0.98 | 0.94 | 0.70 | 0.42 | 0.93 | 0.63 | 0.58 | n/a |
| | 7 (178) | 0.78 | 0.78 | 0.76 | 0.66 | 1.00 | 1.00 | 1.00 | 0.72 | 0.75 | 0.62 | 0.60 | 0.57 | | 0.59 | 0.44 | 0.27 | 1.00 | 1.00 | 0.89 | 0.53 | 1.00 | 0.69 | 0.62 | n/a |
| | 8 (203) | 0.82 | 0.82 | 0.80 | 0.68 | | | | 0.78 | 0.79 | 0.63 | 0.61 | 0.58 | | 0.72 | 0.54 | 0.32 | | | 1.00 | 0.65 | | 0.73 | 0.67 | n/a |
| | 8-3/4 (222) | 0.86 | 0.86 | 0.82 | 0.69 | | | | 0.83 | 0.81 | 0.65 | 0.62 | 0.59 | | 0.83 | 0.62 | 0.37 | | | | 0.74 | | 0.77 | 0.70 | 0.59 |
| | 9 (229) | 0.87 | 0.87 | 0.83 | 0.70 | | | | 0.85 | 0.82 | 0.65 | 0.62 | 0.59 | | 0.86 | 0.65 | 0.39 | | | | 0.78 | | 0.78 | 0.71 | 0.60 |
| | 10 (254) | 0.91 | 0.91 | 0.87 | 0.72 | | | | 0.91 | 0.86 | 0.67 | 0.64 | 0.60 | | 1.00 | 0.76 | 0.45 | | | | 0.91 | | 0.82 | 0.74 | 0.63 |
| | 11 (279) | 0.95 | 0.95 | 0.91 | 0.74 | | | | 0.98 | 0.89 | 0.68 | 0.65 | 0.61 | | | 0.87 | 0.52 | | | | 0.98 | | 0.86 | 0.78 | 0.66 |
| | 12 (305) | 0.99 | 0.99 | 0.94 | 0.77 | | | | 1.00 | 0.93 | 0.70 | 0.67 | 0.62 | | | 1.00 | 0.60 | | | | 1.00 | | 0.90 | 0.82 | 0.69 |
| | 14 (356) | 1.00 | 1.00 | 1.00 | 0.81 | | | | | 1.00 | 0.73 | 0.69 | 0.64 | | | | 0.75 | | | | | | 0.97 | 0.88 | 0.74 |
| | 16 (406) | | | | 0.86 | | | | | | 0.77 | 0.72 | 0.66 | | | | 0.92 | | | | | | 1.00 | 0.94 | 0.79 |
| | 18 (457) | | | | 0.90 | | | | | | 0.80 | 0.75 | 0.68 | | | | 1.00 | | | | | | | 1.00 | 0.84 |
| | 24 (610) | | | | 1.00 | | | | | | 0.90 | 0.83 | 0.74 | | | | | | | | | | | | 0.97 |
| | 30 (762) | | | | | | | | | | 1.00 | 0.92 | 0.80 | | | | | | | | | | | | 1.00 |
| | 36 (914) | | | | | | | | | | | 1.00 | 0.85 | | | | | | | | | | | | |
| | > 48 (1219) | | | | | | | | | | | | 0.97 | | | | | | | | | | | | |

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

### Table 32 — Load adjustment factors for 1/2-in. diameter threaded rods in uncracked concrete[1,2,3]

| 1/2-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | || To and away from edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.34 | 0.24 | 0.19 | 0.11 | n/a | n/a | n/a | n/a | 0.10 | 0.05 | 0.03 | 0.02 | 0.21 | 0.11 | 0.07 | 0.03 | n/a | n/a | n/a | n/a |
| | 2-1/2 (64) | 0.58 | 0.58 | 0.57 | 0.54 | 0.41 | 0.28 | 0.22 | 0.13 | 0.55 | 0.53 | 0.53 | 0.52 | 0.18 | 0.09 | 0.06 | 0.03 | 0.35 | 0.18 | 0.12 | 0.06 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.59 | 0.59 | 0.58 | 0.55 | 0.46 | 0.30 | 0.23 | 0.14 | 0.56 | 0.54 | 0.53 | 0.52 | 0.23 | 0.12 | 0.08 | 0.04 | 0.46 | 0.24 | 0.15 | 0.08 | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.62 | 0.62 | 0.61 | 0.57 | 0.57 | 0.35 | 0.26 | 0.15 | 0.58 | 0.55 | 0.54 | 0.53 | 0.36 | 0.18 | 0.12 | 0.06 | 0.57 | 0.35 | 0.24 | 0.12 | 0.58 | n/a | n/a | n/a |
| | 5 (127) | 0.65 | 0.65 | 0.64 | 0.58 | 0.71 | 0.40 | 0.30 | 0.17 | 0.60 | 0.57 | 0.55 | 0.53 | 0.50 | 0.26 | 0.17 | 0.08 | 0.71 | 0.40 | 0.31 | 0.16 | 0.65 | n/a | n/a | n/a |
| | 5-3/4 (146) | 0.68 | 0.68 | 0.66 | 0.60 | 0.78 | 0.44 | 0.33 | 0.19 | 0.62 | 0.58 | 0.56 | 0.54 | 0.61 | 0.32 | 0.21 | 0.10 | 0.81 | 0.44 | 0.34 | 0.20 | 0.69 | 0.56 | n/a | n/a |
| | 6 (152) | 0.69 | 0.69 | 0.67 | 0.60 | 0.80 | 0.46 | 0.33 | 0.20 | 0.63 | 0.58 | 0.56 | 0.54 | 0.65 | 0.34 | 0.22 | 0.11 | 0.85 | 0.46 | 0.35 | 0.21 | 0.71 | 0.57 | n/a | n/a |
| | 7 (178) | 0.72 | 0.72 | 0.69 | 0.62 | 0.90 | 0.52 | 0.37 | 0.22 | 0.65 | 0.59 | 0.57 | 0.54 | 0.82 | 0.42 | 0.28 | 0.13 | 0.99 | 0.52 | 0.38 | 0.27 | 0.77 | 0.61 | n/a | n/a |
| | 7-1/4 (184) | 0.72 | 0.72 | 0.70 | 0.62 | 0.92 | 0.54 | 0.38 | 0.22 | 0.65 | 0.60 | 0.57 | 0.55 | 0.87 | 0.45 | 0.29 | 0.14 | 1.00 | 0.54 | 0.39 | 0.28 | 0.78 | 0.62 | 0.54 | n/a |
| | 8 (203) | 0.75 | 0.75 | 0.72 | 0.63 | 0.99 | 0.59 | 0.41 | 0.24 | 0.67 | 0.61 | 0.58 | 0.55 | 1.00 | 0.52 | 0.34 | 0.16 | | 0.59 | 0.42 | 0.30 | 0.82 | 0.66 | 0.57 | n/a |
| | 9 (229) | 0.78 | 0.78 | 0.75 | 0.65 | 1.00 | 0.67 | 0.46 | 0.27 | 0.69 | 0.62 | 0.59 | 0.56 | | 0.62 | 0.40 | 0.20 | | 0.67 | 0.46 | 0.32 | 0.87 | 0.70 | 0.60 | n/a |
| | 10 (254) | 0.81 | 0.81 | 0.78 | 0.67 | | 0.74 | 0.52 | 0.30 | 0.71 | 0.63 | 0.60 | 0.56 | | 0.72 | 0.47 | 0.23 | | 0.74 | 0.52 | 0.34 | 0.92 | 0.73 | 0.64 | n/a |
| | 11-1/4 (286) | 0.85 | 0.85 | 0.81 | 0.69 | | 0.83 | 0.58 | 0.34 | 0.74 | 0.65 | 0.61 | 0.57 | | 0.86 | 0.56 | 0.27 | | 0.83 | 0.58 | 0.37 | 0.97 | 0.78 | 0.67 | 0.53 |
| | 12 (305) | 0.87 | 0.87 | 0.83 | 0.70 | | 0.89 | 0.62 | 0.36 | 0.75 | 0.66 | 0.62 | 0.58 | | 0.95 | 0.62 | 0.30 | | 0.89 | 0.62 | 0.38 | 1.00 | 0.80 | 0.70 | 0.55 |
| | 14 (356) | 0.93 | 0.93 | 0.89 | 0.73 | | 1.00 | 0.72 | 0.42 | 0.79 | 0.69 | 0.64 | 0.59 | | 1.00 | 0.78 | 0.38 | | 1.00 | 0.72 | 0.43 | | 0.87 | 0.75 | 0.59 |
| | 16 (406) | 1.00 | 1.00 | 0.94 | 0.77 | | | 0.82 | 0.48 | 0.83 | 0.72 | 0.66 | 0.60 | | | 0.95 | 0.47 | | | 0.82 | 0.48 | | 0.93 | 0.80 | 0.63 |
| | 18 (457) | | | 1.00 | 0.80 | | | 0.93 | 0.54 | 0.88 | 0.74 | 0.68 | 0.61 | | | 1.00 | 0.56 | | | 0.93 | 0.54 | | 0.98 | 0.85 | 0.67 |
| | 20 (508) | | | | 0.83 | | | 1.00 | 0.60 | 0.92 | 0.77 | 0.70 | 0.63 | | | | 0.65 | | | 1.00 | 0.60 | | 1.00 | 0.90 | 0.71 |
| | 22 (559) | | | | 0.87 | | | | 0.66 | 0.96 | 0.80 | 0.72 | 0.64 | | | | 0.75 | | | | 0.66 | | | 0.94 | 0.74 |
| | 24 (610) | | | | 0.90 | | | | 0.72 | 1.00 | 0.82 | 0.74 | 0.65 | | | | 0.85 | | | | 0.72 | | | 0.98 | 0.77 |
| | 30 (762) | | | | 1.00 | | | | 0.90 | | 0.90 | 0.80 | 0.69 | | | | 1.00 | | | | 0.90 | | | 1.00 | 0.87 |
| | 36 (914) | | | | | | | | 1.00 | | 0.98 | 0.86 | 0.73 | | | | | | | | 1.00 | | | | 0.95 |
| | > 48 (1219) | | | | | | | | | | 1.00 | 0.98 | 0.80 | | | | | | | | | | | | 1.00 |

### Table 33 — Load adjustment factors for 1/2-in. diameter threaded rods in cracked concrete[1,2,3]

| 1/2-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | || To and away from edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.47 | 0.47 | 0.45 | 0.41 | n/a | n/a | n/a | n/a | 0.10 | 0.05 | 0.04 | 0.02 | 0.21 | 0.11 | 0.07 | 0.04 | n/a | n/a | n/a | n/a |
| | 2-1/2 (64) | 0.58 | 0.58 | 0.57 | 0.54 | 0.52 | 0.52 | 0.50 | 0.44 | 0.55 | 0.53 | 0.53 | 0.52 | 0.18 | 0.09 | 0.06 | 0.04 | 0.35 | 0.18 | 0.12 | 0.07 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.59 | 0.59 | 0.58 | 0.55 | 0.56 | 0.56 | 0.53 | 0.46 | 0.56 | 0.54 | 0.53 | 0.52 | 0.23 | 0.12 | 0.08 | 0.05 | 0.47 | 0.24 | 0.16 | 0.10 | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.62 | 0.62 | 0.61 | 0.57 | 0.63 | 0.63 | 0.60 | 0.49 | 0.58 | 0.55 | 0.54 | 0.53 | 0.36 | 0.18 | 0.13 | 0.08 | 0.72 | 0.37 | 0.25 | 0.15 | 0.58 | n/a | n/a | n/a |
| | 5 (127) | 0.65 | 0.65 | 0.64 | 0.58 | 0.72 | 0.72 | 0.67 | 0.53 | 0.61 | 0.57 | 0.55 | 0.54 | 0.50 | 0.26 | 0.18 | 0.11 | 1.00 | 0.52 | 0.35 | 0.21 | 0.65 | n/a | n/a | n/a |
| | 5-3/4 (146) | 0.68 | 0.68 | 0.66 | 0.60 | 0.78 | 0.78 | 0.73 | 0.56 | 0.62 | 0.58 | 0.56 | 0.54 | 0.62 | 0.32 | 0.22 | 0.13 | | 0.64 | 0.43 | 0.26 | 0.70 | 0.56 | n/a | n/a |
| | 6 (152) | 0.69 | 0.69 | 0.67 | 0.60 | 0.80 | 0.80 | 0.75 | 0.57 | 0.63 | 0.58 | 0.56 | 0.54 | 0.66 | 0.34 | 0.23 | 0.14 | | 0.68 | 0.46 | 0.28 | 0.71 | 0.57 | n/a | n/a |
| | 7 (178) | 0.72 | 0.72 | 0.69 | 0.62 | 0.90 | 0.90 | 0.83 | 0.62 | 0.65 | 0.59 | 0.57 | 0.55 | 0.83 | 0.43 | 0.29 | 0.17 | | 0.86 | 0.58 | 0.35 | 0.77 | 0.62 | n/a | n/a |
| | 7-1/4 (184) | 0.72 | 0.72 | 0.70 | 0.62 | 0.92 | 0.92 | 0.85 | 0.63 | 0.65 | 0.60 | 0.58 | 0.55 | 0.88 | 0.45 | 0.31 | 0.18 | | 0.90 | 0.61 | 0.37 | 0.78 | 0.63 | 0.55 | n/a |
| | 8 (203) | 0.75 | 0.75 | 0.72 | 0.63 | 0.99 | 0.99 | 0.91 | 0.66 | 0.67 | 0.61 | 0.58 | 0.56 | 1.00 | 0.52 | 0.35 | 0.21 | | 1.00 | 0.71 | 0.43 | 0.82 | 0.66 | 0.58 | n/a |
| | 9 (229) | 0.78 | 0.78 | 0.75 | 0.65 | 1.00 | 1.00 | 1.00 | 0.70 | 0.69 | 0.62 | 0.59 | 0.57 | | 0.62 | 0.42 | 0.25 | | | 0.85 | 0.51 | 0.87 | 0.70 | 0.61 | n/a |
| | 10 (254) | 0.81 | 0.81 | 0.78 | 0.67 | | | | 0.75 | 0.71 | 0.64 | 0.60 | 0.57 | | 0.73 | 0.50 | 0.30 | | | 0.99 | 0.59 | 0.92 | 0.74 | 0.65 | n/a |
| | 11-1/4 (286) | 0.85 | 0.85 | 0.81 | 0.69 | | | | 0.81 | 0.74 | 0.65 | 0.62 | 0.58 | | 0.87 | 0.59 | 0.35 | | | 1.00 | 0.71 | 0.97 | 0.78 | 0.69 | 0.58 |
| | 12 (305) | 0.87 | 0.87 | 0.83 | 0.70 | | | | 0.85 | 0.75 | 0.66 | 0.63 | 0.59 | | 0.96 | 0.65 | 0.39 | | | | 0.78 | 1.00 | 0.81 | 0.71 | 0.60 |
| | 14 (356) | 0.93 | 0.93 | 0.89 | 0.73 | | | | 0.95 | 0.79 | 0.69 | 0.65 | 0.60 | | 1.00 | 0.82 | 0.49 | | | | 0.95 | | 0.87 | 0.76 | 0.64 |
| | 16 (406) | 1.00 | 1.00 | 0.94 | 0.77 | | | | 1.00 | 0.84 | 0.72 | 0.67 | 0.62 | | | 1.00 | 0.60 | | | | 1.00 | | 0.93 | 0.82 | 0.69 |
| | 18 (457) | | | 1.00 | 0.80 | | | | | 0.88 | 0.74 | 0.69 | 0.63 | | | | 0.72 | | | | | | 0.99 | 0.87 | 0.73 |
| | 20 (508) | | | | 0.83 | | | | | 0.92 | 0.77 | 0.71 | 0.65 | | | | 0.84 | | | | | | 1.00 | 0.91 | 0.77 |
| | 22 (559) | | | | 0.87 | | | | | 0.96 | 0.80 | 0.73 | 0.66 | | | | 0.97 | | | | | | | 0.96 | 0.81 |
| | 24 (610) | | | | 0.90 | | | | | 1.00 | 0.82 | 0.75 | 0.68 | | | | 1.00 | | | | | | | 1.00 | 0.84 |
| | 30 (762) | | | | 1.00 | | | | | | 0.91 | 0.81 | 0.72 | | | | | | | | | | | | 0.94 |
| | 36 (914) | | | | | | | | | | 0.99 | 0.88 | 0.77 | | | | | | | | | | | | 1.00 |
| | > 48 (1219) | | | | | | | | | | 1.00 | 1.00 | 0.86 | | | | | | | | | | | | |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 34 — Load adjustment factors for 5/8-in. diameter threaded rods in uncracked concrete[1,2,3]

| 5/8-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.35 | 0.24 | 0.19 | 0.11 | n/a | n/a | n/a | n/a | 0.09 | 0.04 | 0.03 | 0.01 | 0.19 | 0.08 | 0.06 | 0.03 | n/a | n/a | n/a | n/a |
| | 3-1/8 (79) | 0.58 | 0.58 | 0.57 | 0.54 | 0.47 | 0.29 | 0.22 | 0.13 | 0.56 | 0.54 | 0.53 | 0.52 | 0.22 | 0.10 | 0.07 | 0.03 | 0.45 | 0.20 | 0.13 | 0.06 | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.60 | 0.60 | 0.59 | 0.55 | 0.56 | 0.32 | 0.24 | 0.14 | 0.58 | 0.55 | 0.53 | 0.52 | 0.32 | 0.15 | 0.10 | 0.04 | 0.56 | 0.29 | 0.19 | 0.09 | n/a | n/a | n/a | n/a |
| | 4-5/8 (117) | 0.62 | 0.62 | 0.60 | 0.56 | 0.62 | 0.35 | 0.26 | 0.15 | 0.59 | 0.55 | 0.54 | 0.52 | 0.40 | 0.18 | 0.12 | 0.06 | 0.62 | 0.35 | 0.24 | 0.11 | 0.60 | n/a | n/a | n/a |
| | 5 (127) | 0.63 | 0.63 | 0.61 | 0.57 | 0.64 | 0.36 | 0.27 | 0.16 | 0.60 | 0.56 | 0.54 | 0.53 | 0.45 | 0.21 | 0.13 | 0.06 | 0.67 | 0.36 | 0.27 | 0.12 | 0.63 | n/a | n/a | n/a |
| | 6 (152) | 0.65 | 0.65 | 0.63 | 0.58 | 0.71 | 0.41 | 0.30 | 0.17 | 0.62 | 0.57 | 0.55 | 0.53 | 0.59 | 0.27 | 0.18 | 0.08 | 0.80 | 0.41 | 0.32 | 0.16 | 0.69 | n/a | n/a | n/a |
| | 7 (178) | 0.68 | 0.68 | 0.66 | 0.59 | 0.78 | 0.45 | 0.33 | 0.19 | 0.64 | 0.58 | 0.56 | 0.54 | 0.75 | 0.34 | 0.22 | 0.10 | 0.94 | 0.45 | 0.35 | 0.21 | 0.74 | n/a | n/a | n/a |
| | 7-1/8 (181) | 0.68 | 0.68 | 0.66 | 0.60 | 0.79 | 0.46 | 0.33 | 0.19 | 0.64 | 0.58 | 0.56 | 0.54 | 0.77 | 0.35 | 0.23 | 0.11 | 0.95 | 0.46 | 0.35 | 0.21 | 0.75 | 0.57 | n/a | n/a |
| | 8 (203) | 0.70 | 0.70 | 0.68 | 0.61 | 0.85 | 0.50 | 0.36 | 0.21 | 0.66 | 0.59 | 0.57 | 0.54 | 0.91 | 0.41 | 0.27 | 0.13 | 1.00 | 0.50 | 0.38 | 0.25 | 0.79 | 0.61 | n/a | n/a |
| | 9 (229) | 0.73 | 0.73 | 0.70 | 0.62 | 0.93 | 0.56 | 0.39 | 0.22 | 0.68 | 0.60 | 0.58 | 0.55 | 1.00 | 0.50 | 0.32 | 0.15 | | 0.56 | 0.41 | 0.29 | 0.84 | 0.65 | 0.56 | n/a |
| | 10 (254) | 0.75 | 0.75 | 0.72 | 0.63 | 1.00 | 0.62 | 0.43 | 0.24 | 0.70 | 0.62 | 0.59 | 0.55 | | 0.58 | 0.38 | 0.18 | | 0.62 | 0.44 | 0.30 | 0.89 | 0.68 | 0.59 | n/a |
| | 11 (279) | 0.78 | 0.78 | 0.74 | 0.65 | | 0.68 | 0.47 | 0.27 | 0.72 | 0.63 | 0.60 | 0.56 | | 0.67 | 0.43 | 0.20 | | 0.68 | 0.47 | 0.32 | 0.93 | 0.71 | 0.62 | n/a |
| | 12 (305) | 0.80 | 0.80 | 0.77 | 0.66 | | 0.74 | 0.51 | 0.29 | 0.74 | 0.64 | 0.60 | 0.56 | | 0.76 | 0.50 | 0.23 | | 0.74 | 0.51 | 0.34 | 0.97 | 0.75 | 0.65 | n/a |
| | 14 (356) | 0.85 | 0.85 | 0.81 | 0.69 | | 0.86 | 0.60 | 0.34 | 0.77 | 0.66 | 0.62 | 0.57 | | 0.96 | 0.62 | 0.29 | | 0.86 | 0.60 | 0.37 | 1.00 | 0.81 | 0.70 | 0.54 |
| | 16 (406) | 0.90 | 0.90 | 0.86 | 0.71 | | 0.99 | 0.68 | 0.39 | 0.81 | 0.69 | 0.64 | 0.58 | | 1.00 | 0.76 | 0.35 | | 0.99 | 0.68 | 0.41 | | 0.86 | 0.75 | 0.58 |
| | 18 (457) | 0.96 | 0.96 | 0.90 | 0.74 | | 1.00 | 0.77 | 0.44 | 0.85 | 0.71 | 0.66 | 0.59 | | | 0.91 | 0.42 | | 1.00 | 0.77 | 0.44 | | 0.91 | 0.79 | 0.61 |
| | 20 (508) | 1.00 | 1.00 | 0.94 | 0.77 | | | 0.86 | 0.49 | 0.89 | 0.73 | 0.67 | 0.60 | | | 1.00 | 0.50 | | | 0.86 | 0.49 | | 0.96 | 0.83 | 0.65 |
| | 22 (559) | | | 0.99 | 0.79 | | | 0.94 | 0.54 | 0.93 | 0.75 | 0.69 | 0.61 | | | | 0.57 | | | 0.94 | 0.54 | | 1.00 | 0.87 | 0.68 |
| | 24 (610) | | | 1.00 | 0.82 | | | 1.00 | 0.59 | 0.97 | 0.78 | 0.71 | 0.63 | | | | 0.65 | | | 1.00 | 0.59 | | | 0.91 | 0.71 |
| | 26 (660) | | | | 0.85 | | | | 0.64 | 1.00 | 0.80 | 0.73 | 0.64 | | | | 0.73 | | | | 0.64 | | | 0.95 | 0.74 |
| | 28 (711) | | | | 0.87 | | | | 0.68 | | 0.82 | 0.74 | 0.65 | | | | 0.82 | | | | 0.68 | | | 0.99 | 0.76 |
| | 30 (762) | | | | 0.90 | | | | 0.73 | | 0.85 | 0.76 | 0.66 | | | | 0.91 | | | | 0.73 | | | 1.00 | 0.79 |
| | 36 (914) | | | | 0.98 | | | | 0.88 | | 0.92 | 0.81 | 0.69 | | | | 1.00 | | | | 0.88 | | | | 0.87 |
| | > 48 (1219) | | | | 1.00 | | | | 1.00 | | 1.00 | 0.92 | 0.75 | | | | | | | | 1.00 | | | | 1.00 |

## Table 35 — Load adjustment factors for 5/8-in. diameter threaded rods in cracked concrete[1,2,3]

| 5/8-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.44 | 0.44 | 0.43 | 0.40 | n/a | n/a | n/a | n/a | 0.09 | 0.04 | 0.03 | 0.02 | 0.19 | 0.09 | 0.06 | 0.03 | n/a | n/a | n/a | n/a |
| | 3-1/8 (79) | 0.58 | 0.58 | 0.57 | 0.54 | 0.52 | 0.52 | 0.50 | 0.44 | 0.56 | 0.54 | 0.53 | 0.52 | 0.22 | 0.10 | 0.07 | 0.04 | 0.45 | 0.20 | 0.13 | 0.07 | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.60 | 0.60 | 0.59 | 0.55 | 0.58 | 0.58 | 0.55 | 0.46 | 0.58 | 0.55 | 0.53 | 0.52 | 0.33 | 0.15 | 0.10 | 0.05 | 0.65 | 0.30 | 0.19 | 0.11 | n/a | n/a | n/a | n/a |
| | 4-5/8 (117) | 0.62 | 0.62 | 0.60 | 0.56 | 0.62 | 0.62 | 0.58 | 0.48 | 0.59 | 0.55 | 0.54 | 0.53 | 0.40 | 0.18 | 0.12 | 0.07 | 0.81 | 0.37 | 0.24 | 0.13 | 0.60 | n/a | n/a | n/a |
| | 5 (127) | 0.63 | 0.63 | 0.61 | 0.57 | 0.64 | 0.64 | 0.60 | 0.49 | 0.60 | 0.56 | 0.54 | 0.53 | 0.45 | 0.21 | 0.13 | 0.08 | 0.91 | 0.41 | 0.27 | 0.15 | 0.63 | n/a | n/a | n/a |
| | 6 (152) | 0.65 | 0.65 | 0.63 | 0.58 | 0.71 | 0.71 | 0.66 | 0.53 | 0.62 | 0.57 | 0.55 | 0.54 | 0.60 | 0.27 | 0.18 | 0.10 | 1.00 | 0.54 | 0.35 | 0.20 | 0.69 | n/a | n/a | n/a |
| | 7 (178) | 0.68 | 0.68 | 0.66 | 0.59 | 0.78 | 0.78 | 0.72 | 0.56 | 0.64 | 0.58 | 0.56 | 0.54 | 0.75 | 0.34 | 0.22 | 0.13 | | 0.68 | 0.44 | 0.25 | 0.74 | n/a | n/a | n/a |
| | 7-1/8 (181) | 0.68 | 0.68 | 0.66 | 0.60 | 0.79 | 0.79 | 0.73 | 0.56 | 0.64 | 0.58 | 0.56 | 0.54 | 0.77 | 0.35 | 0.23 | 0.13 | | 0.70 | 0.46 | 0.26 | 0.75 | 0.58 | n/a | n/a |
| | 8 (203) | 0.70 | 0.70 | 0.68 | 0.61 | 0.85 | 0.85 | 0.78 | 0.59 | 0.66 | 0.59 | 0.57 | 0.55 | 0.92 | 0.42 | 0.27 | 0.15 | | 0.84 | 0.54 | 0.31 | 0.79 | 0.61 | n/a | n/a |
| | 9 (229) | 0.73 | 0.73 | 0.70 | 0.62 | 0.93 | 0.93 | 0.85 | 0.62 | 0.68 | 0.60 | 0.58 | 0.55 | 1.00 | 0.50 | 0.32 | 0.18 | | 1.00 | 0.65 | 0.37 | 0.84 | 0.65 | 0.56 | n/a |
| | 10 (254) | 0.75 | 0.75 | 0.72 | 0.63 | 1.00 | 1.00 | 0.91 | 0.66 | 0.70 | 0.62 | 0.59 | 0.56 | | 0.58 | 0.38 | 0.21 | | | 0.76 | 0.43 | 0.89 | 0.68 | 0.59 | n/a |
| | 11 (279) | 0.78 | 0.78 | 0.74 | 0.65 | | | 0.98 | 0.69 | 0.72 | 0.63 | 0.60 | 0.57 | | 0.67 | 0.44 | 0.25 | | | 0.88 | 0.49 | 0.93 | 0.72 | 0.62 | n/a |
| | 12 (305) | 0.80 | 0.80 | 0.77 | 0.66 | | | 1.00 | 0.73 | 0.74 | 0.64 | 0.60 | 0.57 | | 0.77 | 0.50 | 0.28 | | | 1.00 | 0.56 | 0.97 | 0.75 | 0.65 | n/a |
| | 14 (356) | 0.85 | 0.85 | 0.81 | 0.69 | | | | 0.81 | 0.78 | 0.66 | 0.62 | 0.58 | | 0.97 | 0.63 | 0.36 | | | | 0.71 | 1.00 | 0.81 | 0.70 | 0.58 |
| | 16 (406) | 0.90 | 0.90 | 0.86 | 0.71 | | | | 0.89 | 0.82 | 0.69 | 0.64 | 0.60 | | 1.00 | 0.77 | 0.43 | | | | 0.87 | | 0.86 | 0.75 | 0.62 |
| | 18 (457) | 0.96 | 0.96 | 0.90 | 0.74 | | | | 0.97 | 0.85 | 0.71 | 0.66 | 0.61 | | | 0.92 | 0.52 | | | | 0.97 | | 0.92 | 0.79 | 0.66 |
| | 20 (508) | 1.00 | 1.00 | 0.94 | 0.77 | | | | 1.00 | 0.89 | 0.73 | 0.67 | 0.62 | | | 1.00 | 0.61 | | | | 1.00 | | 0.97 | 0.84 | 0.69 |
| | 22 (559) | | | 0.99 | 0.79 | | | | | 0.93 | 0.76 | 0.69 | 0.63 | | | | 0.70 | | | | | | 1.00 | 0.88 | 0.72 |
| | 24 (610) | | | 1.00 | 0.82 | | | | | 0.97 | 0.78 | 0.71 | 0.64 | | | | 0.80 | | | | | | | 0.92 | 0.76 |
| | 26 (660) | | | | 0.85 | | | | | 1.00 | 0.80 | 0.73 | 0.66 | | | | 0.90 | | | | | | | 0.95 | 0.79 |
| | 28 (711) | | | | 0.87 | | | | | | 0.83 | 0.74 | 0.67 | | | | 1.00 | | | | | | | 0.99 | 0.82 |
| | 30 (762) | | | | 0.90 | | | | | | 0.85 | 0.76 | 0.68 | | | | | | | | | | | 1.00 | 0.85 |
| | 36 (914) | | | | 0.98 | | | | | | 0.92 | 0.81 | 0.71 | | | | | | | | | | | | 0.93 |
| | > 48 (1219) | | | | 1.00 | | | | | | 1.00 | 0.92 | 0.79 | | | | | | | | | | | | 1.00 |

1 Linear interpolation not permitted

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

### Table 36 — Load adjustment factors for 3/4-in. diameter threaded rods in uncracked concrete[1,2,3]

| 3/4-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.35 | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | n/a | 0.09 | 0.03 | 0.02 | 0.01 | 0.17 | 0.07 | 0.05 | 0.02 | n/a | n/a | n/a | n/a |
| | 3-3/4 (95) | 0.58 | 0.58 | 0.57 | 0.54 | 0.52 | 0.30 | 0.23 | 0.13 | 0.57 | 0.54 | 0.53 | 0.52 | 0.27 | 0.11 | 0.07 | 0.03 | 0.52 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.59 | 0.59 | 0.57 | 0.54 | 0.54 | 0.31 | 0.23 | 0.13 | 0.57 | 0.54 | 0.53 | 0.52 | 0.29 | 0.12 | 0.08 | 0.04 | 0.54 | 0.24 | 0.16 | 0.07 | n/a | n/a | n/a | n/a |
| | 5 (127) | 0.61 | 0.61 | 0.59 | 0.56 | 0.59 | 0.34 | 0.25 | 0.14 | 0.59 | 0.55 | 0.54 | 0.52 | 0.41 | 0.17 | 0.11 | 0.05 | 0.64 | 0.33 | 0.22 | 0.10 | n/a | n/a | n/a | n/a |
| | 5-1/4 (133) | 0.61 | 0.61 | 0.60 | 0.56 | 0.61 | 0.35 | 0.26 | 0.15 | 0.60 | 0.55 | 0.54 | 0.52 | 0.44 | 0.18 | 0.12 | 0.05 | 0.66 | 0.35 | 0.23 | 0.11 | 0.62 | n/a | n/a | n/a |
| | 6 (152) | 0.63 | 0.63 | 0.61 | 0.57 | 0.65 | 0.38 | 0.28 | 0.16 | 0.61 | 0.56 | 0.55 | 0.53 | 0.54 | 0.22 | 0.14 | 0.07 | 0.76 | 0.38 | 0.29 | 0.13 | 0.66 | n/a | n/a | n/a |
| | 7 (178) | 0.65 | 0.65 | 0.63 | 0.58 | 0.70 | 0.41 | 0.30 | 0.17 | 0.63 | 0.57 | 0.55 | 0.53 | 0.68 | 0.28 | 0.18 | 0.08 | 0.89 | 0.41 | 0.32 | 0.17 | 0.72 | n/a | n/a | n/a |
| | 8 (203) | 0.67 | 0.67 | 0.65 | 0.59 | 0.76 | 0.45 | 0.33 | 0.18 | 0.65 | 0.58 | 0.56 | 0.54 | 0.83 | 0.34 | 0.22 | 0.10 | 1.00 | 0.45 | 0.35 | 0.20 | 0.77 | n/a | n/a | n/a |
| | 8-1/2 (216) | 0.68 | 0.68 | 0.66 | 0.59 | 0.79 | 0.47 | 0.34 | 0.19 | 0.66 | 0.59 | 0.56 | 0.54 | 0.91 | 0.37 | 0.24 | 0.11 | | 0.47 | 0.36 | 0.22 | 0.79 | 0.59 | n/a | n/a |
| | 9 (229) | 0.69 | 0.69 | 0.67 | 0.60 | 0.83 | 0.49 | 0.35 | 0.20 | 0.67 | 0.59 | 0.57 | 0.54 | 0.99 | 0.40 | 0.26 | 0.12 | | 0.49 | 0.37 | 0.24 | 0.81 | 0.60 | n/a | n/a |
| | 10 (254) | 0.71 | 0.71 | 0.69 | 0.61 | 0.89 | 0.53 | 0.38 | 0.21 | 0.68 | 0.60 | 0.58 | 0.55 | 1.00 | 0.47 | 0.31 | 0.14 | | 0.53 | 0.40 | 0.28 | 0.86 | 0.64 | n/a | n/a |
| | 10-3/4 (273) | 0.73 | 0.73 | 0.70 | 0.62 | 0.94 | 0.57 | 0.40 | 0.23 | 0.70 | 0.61 | 0.58 | 0.55 | | 0.53 | 0.34 | 0.16 | | 0.57 | 0.42 | 0.29 | 0.89 | 0.66 | 0.57 | n/a |
| | 12 (305) | 0.76 | 0.76 | 0.72 | 0.63 | 1.00 | 0.64 | 0.44 | 0.25 | 0.72 | 0.62 | 0.59 | 0.55 | | 0.62 | 0.40 | 0.19 | | 0.64 | 0.45 | 0.31 | 0.94 | 0.70 | 0.60 | n/a |
| | 14 (356) | 0.80 | 0.80 | 0.76 | 0.66 | | 0.74 | 0.52 | 0.29 | 0.76 | 0.64 | 0.61 | 0.56 | | 0.78 | 0.51 | 0.24 | | 0.74 | 0.52 | 0.33 | 1.00 | 0.75 | 0.65 | n/a |
| | 16 (406) | 0.84 | 0.84 | 0.80 | 0.68 | | 0.85 | 0.59 | 0.33 | 0.79 | 0.66 | 0.62 | 0.57 | | 0.96 | 0.62 | 0.29 | | 0.85 | 0.59 | 0.36 | | 0.80 | 0.70 | n/a |
| | 16-3/4 (425) | 0.86 | 0.86 | 0.81 | 0.69 | | 0.89 | 0.62 | 0.35 | 0.81 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.67 | 0.31 | | 0.89 | 0.62 | 0.37 | | 0.82 | 0.71 | 0.55 |
| | 18 (457) | 0.89 | 0.89 | 0.83 | 0.70 | | 0.96 | 0.66 | 0.37 | 0.83 | 0.68 | 0.64 | 0.58 | | | 0.74 | 0.35 | | 0.96 | 0.66 | 0.39 | | 0.85 | 0.74 | 0.57 |
| | 20 (508) | 0.93 | 0.93 | 0.87 | 0.72 | | 1.00 | 0.74 | 0.41 | 0.87 | 0.70 | 0.65 | 0.59 | | | 0.87 | 0.40 | | 1.00 | 0.74 | 0.42 | | 0.90 | 0.78 | 0.60 |
| | 22 (559) | 0.97 | 0.97 | 0.91 | 0.74 | | | 0.81 | 0.45 | 0.91 | 0.72 | 0.67 | 0.60 | | | 1.00 | 0.47 | | | 0.81 | 0.46 | | 0.94 | 0.82 | 0.63 |
| | 24 (610) | 1.00 | 1.00 | 0.94 | 0.77 | | | 0.89 | 0.50 | 0.94 | 0.74 | 0.68 | 0.61 | | | | 0.53 | | | 0.89 | 0.50 | | 0.99 | 0.85 | 0.66 |
| | 26 (660) | | | 0.98 | 0.79 | | | 0.96 | 0.54 | 0.98 | 0.76 | 0.70 | 0.62 | | | | 0.60 | | | 0.96 | 0.54 | | 1.00 | 0.89 | 0.69 |
| | 28 (711) | | | 1.00 | 0.81 | | | 1.00 | 0.58 | 1.00 | 0.78 | 0.71 | 0.63 | | | | 0.67 | | | 1.00 | 0.58 | | | 0.92 | 0.71 |
| | 30 (762) | | | | 0.83 | | | | 0.62 | | 0.80 | 0.73 | 0.64 | | | | 0.74 | | | | 0.62 | | | 0.95 | 0.74 |
| | 36 (914) | | | | 0.90 | | | | 0.74 | | 0.86 | 0.77 | 0.66 | | | | 0.98 | | | | 0.74 | | | 1.00 | 0.81 |
| | > 48 (1219) | | | | 1.00 | | | | 0.99 | | 0.99 | 0.86 | 0.72 | | | | 1.00 | | | | 0.99 | | | | 0.94 |

### Table 37 — Load adjustment factors for 3/4-in. diameter threaded rods in cracked concrete[1,2,3]

| 3/4-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.43 | 0.43 | 0.42 | 0.39 | n/a | n/a | n/a | n/a | 0.09 | 0.03 | 0.02 | 0.01 | 0.17 | 0.07 | 0.05 | 0.02 | n/a | n/a | n/a | n/a |
| | 3-3/4 (95) | 0.58 | 0.58 | 0.57 | 0.54 | 0.53 | 0.53 | 0.50 | 0.44 | 0.57 | 0.54 | 0.53 | 0.52 | 0.27 | 0.11 | 0.07 | 0.04 | 0.54 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.59 | 0.59 | 0.57 | 0.54 | 0.54 | 0.54 | 0.51 | 0.44 | 0.57 | 0.54 | 0.53 | 0.52 | 0.30 | 0.12 | 0.08 | 0.04 | 0.59 | 0.24 | 0.16 | 0.08 | n/a | n/a | n/a | n/a |
| | 5 (127) | 0.61 | 0.61 | 0.59 | 0.56 | 0.59 | 0.59 | 0.56 | 0.47 | 0.59 | 0.55 | 0.54 | 0.52 | 0.41 | 0.17 | 0.11 | 0.06 | 0.83 | 0.34 | 0.22 | 0.11 | n/a | n/a | n/a | n/a |
| | 5-1/4 (133) | 0.61 | 0.61 | 0.60 | 0.56 | 0.61 | 0.61 | 0.57 | 0.47 | 0.60 | 0.55 | 0.54 | 0.53 | 0.45 | 0.18 | 0.12 | 0.06 | 0.89 | 0.36 | 0.24 | 0.12 | 0.62 | n/a | n/a | n/a |
| | 6 (152) | 0.63 | 0.63 | 0.61 | 0.57 | 0.65 | 0.65 | 0.60 | 0.49 | 0.61 | 0.56 | 0.55 | 0.53 | 0.54 | 0.22 | 0.14 | 0.07 | 1.00 | 0.44 | 0.29 | 0.15 | 0.67 | n/a | n/a | n/a |
| | 7 (178) | 0.65 | 0.65 | 0.63 | 0.58 | 0.70 | 0.70 | 0.65 | 0.52 | 0.63 | 0.57 | 0.55 | 0.53 | 0.69 | 0.28 | 0.18 | 0.09 | | 0.56 | 0.36 | 0.19 | 0.72 | n/a | n/a | n/a |
| | 8 (203) | 0.67 | 0.67 | 0.65 | 0.59 | 0.76 | 0.76 | 0.70 | 0.55 | 0.65 | 0.58 | 0.56 | 0.54 | 0.84 | 0.34 | 0.22 | 0.12 | | 0.68 | 0.44 | 0.23 | 0.77 | n/a | n/a | n/a |
| | 8-1/2 (216) | 0.68 | 0.68 | 0.66 | 0.59 | 0.79 | 0.79 | 0.72 | 0.56 | 0.66 | 0.59 | 0.56 | 0.54 | 0.92 | 0.37 | 0.24 | 0.13 | | 0.75 | 0.49 | 0.25 | 0.79 | 0.59 | n/a | n/a |
| | 9 (229) | 0.69 | 0.69 | 0.67 | 0.60 | 0.83 | 0.83 | 0.75 | 0.57 | 0.67 | 0.59 | 0.57 | 0.54 | 1.00 | 0.41 | 0.26 | 0.14 | | 0.82 | 0.53 | 0.28 | 0.82 | 0.61 | n/a | n/a |
| | 10 (254) | 0.71 | 0.71 | 0.69 | 0.61 | 0.89 | 0.89 | 0.80 | 0.60 | 0.69 | 0.60 | 0.58 | 0.55 | | 0.48 | 0.31 | 0.16 | | 0.95 | 0.62 | 0.32 | 0.86 | 0.64 | n/a | n/a |
| | 10-3/4 (273) | 0.73 | 0.73 | 0.70 | 0.62 | 0.94 | 0.94 | 0.84 | 0.62 | 0.70 | 0.61 | 0.58 | 0.55 | | 0.53 | 0.35 | 0.18 | | 1.00 | 0.69 | 0.36 | 0.89 | 0.66 | 0.57 | n/a |
| | 12 (305) | 0.76 | 0.76 | 0.72 | 0.63 | 1.00 | 1.00 | 0.91 | 0.66 | 0.72 | 0.62 | 0.59 | 0.56 | | 0.63 | 0.41 | 0.21 | | | 0.82 | 0.42 | 0.94 | 0.70 | 0.61 | n/a |
| | 14 (356) | 0.80 | 0.80 | 0.76 | 0.66 | | | 1.00 | 0.72 | 0.76 | 0.64 | 0.61 | 0.57 | | 0.79 | 0.51 | 0.27 | | | 1.00 | 0.53 | 1.00 | 0.76 | 0.65 | n/a |
| | 16 (406) | 0.84 | 0.84 | 0.80 | 0.68 | | | | 0.78 | 0.80 | 0.66 | 0.62 | 0.58 | | 0.97 | 0.63 | 0.33 | | | | 0.65 | | 0.81 | 0.70 | n/a |
| | 16-3/4 (425) | 0.86 | 0.86 | 0.81 | 0.69 | | | | 0.81 | 0.81 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.67 | 0.35 | | | | 0.70 | | 0.83 | 0.72 | 0.57 |
| | 18 (457) | 0.89 | 0.89 | 0.83 | 0.70 | | | | 0.85 | 0.83 | 0.68 | 0.64 | 0.59 | | | 0.75 | 0.39 | | | | 0.78 | | 0.86 | 0.74 | 0.60 |
| | 20 (508) | 0.93 | 0.93 | 0.87 | 0.72 | | | | 0.91 | 0.87 | 0.70 | 0.65 | 0.60 | | | 0.88 | 0.46 | | | | 0.91 | | 0.90 | 0.78 | 0.63 |
| | 22 (559) | 0.97 | 0.97 | 0.91 | 0.74 | | | | 0.98 | 0.91 | 0.72 | 0.67 | 0.61 | | | 1.00 | 0.53 | | | | 0.98 | | 0.95 | 0.82 | 0.66 |
| | 24 (610) | 1.00 | 1.00 | 0.94 | 0.77 | | | | 1.00 | 0.94 | 0.74 | 0.68 | 0.62 | | | | 0.60 | | | | 1.00 | | 0.99 | 0.86 | 0.69 |
| | 26 (660) | | | 0.98 | 0.79 | | | | | 0.98 | 0.76 | 0.70 | 0.63 | | | | 0.68 | | | | | | 1.00 | 0.89 | 0.72 |
| | 28 (711) | | | 1.00 | 0.81 | | | | | 1.00 | 0.79 | 0.71 | 0.64 | | | | 0.75 | | | | | | | 0.92 | 0.74 |
| | 30 (762) | | | | 0.83 | | | | | | 0.81 | 0.73 | 0.65 | | | | 0.84 | | | | | | | 0.96 | 0.77 |
| | 36 (914) | | | | 0.90 | | | | | | 0.87 | 0.77 | 0.68 | | | | 1.00 | | | | | | | 1.00 | 0.84 |
| | > 48 (1219) | | | | 1.00 | | | | | | 0.99 | 0.87 | 0.74 | | | | | | | | | | | | 0.97 |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 38 — Load adjustment factors for 7/8-in. diameter threaded rods in uncracked concrete[1,2,3]

| 7/8-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.39 | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | n/a | 0.09 | 0.03 | 0.02 | 0.01 | 0.18 | 0.05 | 0.04 | 0.02 | n/a | n/a | n/a | n/a |
| | 4-3/8 (111) | 0.58 | 0.58 | 0.57 | 0.54 | 0.53 | 0.31 | 0.23 | 0.13 | 0.58 | 0.54 | 0.53 | 0.52 | 0.35 | 0.11 | 0.07 | 0.03 | 0.63 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 5 (127) | 0.59 | 0.59 | 0.58 | 0.55 | 0.56 | 0.33 | 0.24 | 0.13 | 0.59 | 0.54 | 0.53 | 0.52 | 0.43 | 0.13 | 0.09 | 0.04 | 0.70 | 0.27 | 0.17 | 0.08 | n/a | n/a | n/a | n/a |
| | 5-1/2 (140) | 0.60 | 0.60 | 0.59 | 0.55 | 0.58 | 0.34 | 0.25 | 0.14 | 0.60 | 0.55 | 0.54 | 0.52 | 0.50 | 0.15 | 0.10 | 0.05 | 0.76 | 0.31 | 0.20 | 0.09 | 0.65 | n/a | n/a | n/a |
| | 6 (152) | 0.61 | 0.61 | 0.60 | 0.56 | 0.61 | 0.36 | 0.26 | 0.15 | 0.61 | 0.55 | 0.54 | 0.52 | 0.57 | 0.17 | 0.11 | 0.05 | 0.83 | 0.35 | 0.23 | 0.11 | 0.68 | n/a | n/a | n/a |
| | 7 (178) | 0.63 | 0.63 | 0.61 | 0.57 | 0.65 | 0.39 | 0.28 | 0.16 | 0.63 | 0.56 | 0.55 | 0.53 | 0.71 | 0.22 | 0.14 | 0.07 | 0.97 | 0.39 | 0.29 | 0.13 | 0.73 | n/a | n/a | n/a |
| | 8 (203) | 0.65 | 0.65 | 0.63 | 0.58 | 0.71 | 0.42 | 0.31 | 0.17 | 0.65 | 0.57 | 0.55 | 0.53 | 0.87 | 0.27 | 0.17 | 0.08 | 1.00 | 0.42 | 0.33 | 0.16 | 0.78 | n/a | n/a | n/a |
| | 9 (229) | 0.67 | 0.67 | 0.64 | 0.59 | 0.76 | 0.45 | 0.33 | 0.18 | 0.67 | 0.58 | 0.56 | 0.54 | 1.00 | 0.32 | 0.21 | 0.10 | | 0.45 | 0.35 | 0.19 | 0.83 | n/a | n/a | n/a |
| | 9-7/8 (251) | 0.69 | 0.69 | 0.66 | 0.59 | 0.80 | 0.48 | 0.35 | 0.19 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.11 | | 0.48 | 0.37 | 0.22 | 0.87 | 0.59 | n/a | n/a |
| | 10 (254) | 0.69 | 0.69 | 0.66 | 0.60 | 0.81 | 0.49 | 0.35 | 0.19 | 0.69 | 0.59 | 0.57 | 0.54 | | 0.38 | 0.24 | 0.11 | | 0.49 | 0.37 | 0.23 | 0.87 | 0.59 | n/a | n/a |
| | 11 (279) | 0.71 | 0.71 | 0.67 | 0.60 | 0.87 | 0.52 | 0.38 | 0.21 | 0.71 | 0.60 | 0.57 | 0.54 | | 0.43 | 0.28 | 0.13 | | 0.52 | 0.40 | 0.26 | 0.91 | 0.62 | n/a | n/a |
| | 12 (305) | 0.73 | 0.73 | 0.69 | 0.61 | 0.92 | 0.56 | 0.40 | 0.22 | 0.73 | 0.60 | 0.58 | 0.55 | | 0.49 | 0.32 | 0.15 | | 0.56 | 0.42 | 0.29 | 0.95 | 0.65 | n/a | n/a |
| | 12-1/2 (318) | 0.74 | 0.74 | 0.70 | 0.62 | 0.95 | 0.59 | 0.41 | 0.23 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.52 | 0.34 | 0.16 | | 0.59 | 0.43 | 0.29 | 0.97 | 0.66 | 0.57 | n/a |
| | 14 (356) | 0.76 | 0.76 | 0.72 | 0.63 | 1.00 | 0.66 | 0.46 | 0.25 | 0.77 | 0.62 | 0.59 | 0.55 | | 0.62 | 0.40 | 0.19 | | 0.66 | 0.47 | 0.31 | 1.00 | 0.70 | 0.60 | n/a |
| | 16 (406) | 0.80 | 0.80 | 0.75 | 0.65 | | 0.75 | 0.52 | 0.29 | 0.80 | 0.64 | 0.60 | 0.56 | | 0.76 | 0.49 | 0.23 | | 0.75 | 0.52 | 0.34 | | 0.75 | 0.65 | n/a |
| | 18 (457) | 0.84 | 0.84 | 0.79 | 0.67 | | 0.84 | 0.59 | 0.32 | 0.84 | 0.66 | 0.62 | 0.57 | | 0.91 | 0.59 | 0.27 | | 0.84 | 0.59 | 0.36 | | 0.79 | 0.68 | n/a |
| | 19-1/2 (495) | 0.87 | 0.87 | 0.81 | 0.69 | | 0.92 | 0.64 | 0.35 | 0.87 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.66 | 0.31 | | 0.92 | 0.64 | 0.38 | | 0.82 | 0.71 | 0.55 |
| | 20 (508) | 0.88 | 0.88 | 0.82 | 0.69 | | 0.94 | 0.65 | 0.36 | 0.88 | 0.67 | 0.63 | 0.58 | | | 0.69 | 0.32 | | 0.94 | 0.65 | 0.39 | | 0.83 | 0.72 | 0.56 |
| | 22 (559) | 0.91 | 0.91 | 0.85 | 0.71 | | 1.00 | 0.72 | 0.40 | 0.92 | 0.69 | 0.64 | 0.59 | | | 0.80 | 0.37 | | 1.00 | 0.72 | 0.41 | | 0.87 | 0.76 | 0.59 |
| | 24 (610) | 0.95 | 0.95 | 0.88 | 0.73 | | | 0.78 | 0.43 | 0.96 | 0.71 | 0.66 | 0.59 | | | 0.91 | 0.42 | | | 0.78 | 0.44 | | 0.91 | 0.79 | 0.61 |
| | 26 (660) | 0.99 | 0.99 | 0.91 | 0.75 | | | 0.85 | 0.47 | 0.99 | 0.73 | 0.67 | 0.60 | | | 1.00 | 0.48 | | | 0.85 | 0.47 | | 0.95 | 0.82 | 0.64 |
| | 28 (711) | 1.00 | 1.00 | 0.94 | 0.77 | | | 0.91 | 0.50 | 1.00 | 0.74 | 0.68 | 0.61 | | | | 0.53 | | | 0.91 | 0.50 | | 0.99 | 0.85 | 0.66 |
| | 30 (762) | | | 0.98 | 0.79 | | | 0.98 | 0.54 | | 0.76 | 0.70 | 0.62 | | | | 0.59 | | | 0.98 | 0.54 | | 1.00 | 0.88 | 0.68 |
| | 36 (914) | | | 1.00 | 0.84 | | | 1.00 | 0.65 | | 0.81 | 0.73 | 0.64 | | | | 0.77 | | | 1.00 | 0.65 | | | 0.97 | 0.75 |
| | > 48 (1219) | | | | 0.96 | | | | 0.86 | | 0.92 | 0.81 | 0.69 | | | | 1.00 | | | | 0.86 | | | 1.00 | 0.87 |

## Table 39 — Load adjustment factors for 7/8-in. diameter threaded rods in cracked concrete[1,2,3]

| 7/8-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.42 | 0.42 | 0.41 | 0.38 | n/a | n/a | n/a | n/a | 0.09 | 0.03 | 0.02 | 0.01 | 0.18 | 0.06 | 0.04 | 0.02 | n/a | n/a | n/a | n/a |
| | 4-3/8 (111) | 0.58 | 0.58 | 0.57 | 0.54 | 0.53 | 0.53 | 0.50 | 0.44 | 0.58 | 0.54 | 0.53 | 0.52 | 0.36 | 0.11 | 0.07 | 0.03 | 0.71 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 5 (127) | 0.59 | 0.59 | 0.58 | 0.55 | 0.56 | 0.56 | 0.52 | 0.45 | 0.60 | 0.54 | 0.53 | 0.52 | 0.43 | 0.13 | 0.09 | 0.04 | 0.87 | 0.27 | 0.17 | 0.08 | n/a | n/a | n/a | n/a |
| | 5-1/2 (140) | 0.60 | 0.60 | 0.59 | 0.55 | 0.58 | 0.58 | 0.54 | 0.46 | 0.61 | 0.55 | 0.54 | 0.52 | 0.50 | 0.15 | 0.10 | 0.05 | 1.00 | 0.31 | 0.20 | 0.10 | 0.65 | n/a | n/a | n/a |
| | 6 (152) | 0.61 | 0.61 | 0.60 | 0.56 | 0.61 | 0.61 | 0.56 | 0.47 | 0.61 | 0.55 | 0.54 | 0.52 | 0.57 | 0.18 | 0.11 | 0.06 | | 0.35 | 0.23 | 0.11 | 0.68 | n/a | n/a | n/a |
| | 7 (178) | 0.63 | 0.63 | 0.61 | 0.57 | 0.65 | 0.65 | 0.60 | 0.49 | 0.63 | 0.56 | 0.55 | 0.53 | 0.72 | 0.22 | 0.14 | 0.07 | | 0.44 | 0.29 | 0.14 | 0.73 | n/a | n/a | n/a |
| | 8 (203) | 0.65 | 0.65 | 0.63 | 0.58 | 0.71 | 0.71 | 0.64 | 0.52 | 0.65 | 0.57 | 0.55 | 0.53 | 0.88 | 0.27 | 0.18 | 0.09 | | 0.54 | 0.35 | 0.17 | 0.78 | n/a | n/a | n/a |
| | 9 (229) | 0.67 | 0.67 | 0.64 | 0.59 | 0.76 | 0.76 | 0.68 | 0.54 | 0.67 | 0.58 | 0.56 | 0.54 | 1.00 | 0.32 | 0.21 | 0.10 | | 0.65 | 0.42 | 0.20 | 0.83 | n/a | n/a | n/a |
| | 9-7/8 (251) | 0.69 | 0.69 | 0.66 | 0.59 | 0.80 | 0.80 | 0.72 | 0.56 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.12 | | 0.74 | 0.48 | 0.23 | 0.87 | 0.59 | n/a | n/a |
| | 10 (254) | 0.69 | 0.69 | 0.66 | 0.60 | 0.81 | 0.81 | 0.73 | 0.56 | 0.69 | 0.59 | 0.57 | 0.54 | | 0.38 | 0.25 | 0.12 | | 0.76 | 0.49 | 0.24 | 0.87 | 0.59 | n/a | n/a |
| | 11 (279) | 0.71 | 0.71 | 0.67 | 0.60 | 0.87 | 0.87 | 0.77 | 0.59 | 0.71 | 0.60 | 0.57 | 0.54 | | 0.44 | 0.28 | 0.14 | | 0.87 | 0.57 | 0.28 | 0.92 | 0.62 | n/a | n/a |
| | 12 (305) | 0.73 | 0.73 | 0.69 | 0.61 | 0.92 | 0.92 | 0.82 | 0.61 | 0.73 | 0.60 | 0.58 | 0.55 | | 0.50 | 0.32 | 0.16 | | 1.00 | 0.65 | 0.31 | 0.96 | 0.65 | n/a | n/a |
| | 12-1/2 (318) | 0.74 | 0.74 | 0.70 | 0.62 | 0.95 | 0.95 | 0.84 | 0.62 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.53 | 0.34 | 0.17 | | | 0.69 | 0.33 | 0.98 | 0.66 | 0.57 | n/a |
| | 14 (356) | 0.76 | 0.76 | 0.72 | 0.63 | 1.00 | 1.00 | 0.91 | 0.66 | 0.77 | 0.62 | 0.59 | 0.56 | | 0.63 | 0.41 | 0.20 | | | 0.82 | 0.40 | 1.00 | 0.70 | 0.61 | n/a |
| | 16 (406) | 0.80 | 0.80 | 0.75 | 0.65 | | | 1.00 | 0.71 | 0.81 | 0.64 | 0.60 | 0.56 | | 0.77 | 0.50 | 0.24 | | | 1.00 | 0.48 | | 0.75 | 0.65 | n/a |
| | 18 (457) | 0.84 | 0.84 | 0.79 | 0.67 | | | | 0.76 | 0.84 | 0.66 | 0.62 | 0.57 | | 0.91 | 0.59 | 0.29 | | | | 0.58 | | 0.79 | 0.69 | n/a |
| | 19-1/2 (495) | 0.87 | 0.87 | 0.81 | 0.69 | | | | 0.80 | 0.87 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.67 | 0.32 | | | | 0.65 | | 0.82 | 0.71 | 0.56 |
| | 20 (508) | 0.88 | 0.88 | 0.82 | 0.69 | | | | 0.82 | 0.88 | 0.67 | 0.63 | 0.58 | | | 0.70 | 0.34 | | | | 0.67 | | 0.84 | 0.72 | 0.57 |
| | 22 (559) | 0.91 | 0.91 | 0.85 | 0.71 | | | | 0.87 | 0.92 | 0.69 | 0.64 | 0.59 | | | 0.80 | 0.39 | | | | 0.78 | | 0.88 | 0.76 | 0.60 |
| | 24 (610) | 0.95 | 0.95 | 0.88 | 0.73 | | | | 0.93 | 0.96 | 0.71 | 0.66 | 0.60 | | | 0.91 | 0.44 | | | | 0.89 | | 0.92 | 0.79 | 0.62 |
| | 26 (660) | 0.99 | 0.99 | 0.91 | 0.75 | | | | 0.99 | 1.00 | 0.73 | 0.67 | 0.61 | | | 1.00 | 0.50 | | | | 0.99 | | 0.95 | 0.82 | 0.65 |
| | 28 (711) | 1.00 | 1.00 | 0.94 | 0.77 | | | | 1.00 | | 0.74 | 0.68 | 0.61 | | | | 0.56 | | | | 1.00 | | 0.99 | 0.86 | 0.67 |
| | 30 (762) | | | 0.98 | 0.79 | | | | | | 0.76 | 0.70 | 0.62 | | | | 0.62 | | | | | | 1.00 | 0.89 | 0.70 |
| | 36 (914) | | | 1.00 | 0.84 | | | | | | 0.81 | 0.74 | 0.65 | | | | 0.81 | | | | | | | 0.97 | 0.76 |
| | > 48 (1219) | | | | 0.96 | | | | | | 0.92 | 0.81 | 0.69 | | | | 1.00 | | | | | | | 1.00 | 0.88 |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

### Table 40 — Load adjustment factors for 1-in. diameter threaded rods in uncracked concrete[1,2,3]

| 1-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.38 | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | n/a | 0.08 | 0.02 | 0.01 | 0.01 | 0.15 | 0.05 | 0.03 | 0.01 | n/a | n/a | n/a | n/a |
| | 5 (127) | 0.58 | 0.58 | 0.57 | 0.54 | 0.53 | 0.32 | 0.23 | 0.13 | 0.59 | 0.54 | 0.53 | 0.52 | 0.37 | 0.11 | 0.07 | 0.03 | 0.65 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 6 (152) | 0.60 | 0.60 | 0.58 | 0.55 | 0.58 | 0.34 | 0.25 | 0.14 | 0.60 | 0.55 | 0.53 | 0.52 | 0.48 | 0.14 | 0.09 | 0.04 | 0.74 | 0.29 | 0.19 | 0.09 | n/a | n/a | n/a | n/a |
| | 6-1/4 (159) | 0.60 | 0.60 | 0.59 | 0.55 | 0.59 | 0.35 | 0.26 | 0.14 | 0.61 | 0.55 | 0.54 | 0.52 | 0.51 | 0.15 | 0.10 | 0.05 | 0.77 | 0.30 | 0.20 | 0.09 | 0.65 | n/a | n/a | n/a |
| | 7 (178) | 0.62 | 0.62 | 0.60 | 0.56 | 0.62 | 0.37 | 0.27 | 0.15 | 0.62 | 0.55 | 0.54 | 0.52 | 0.61 | 0.18 | 0.12 | 0.05 | 0.87 | 0.36 | 0.23 | 0.11 | 0.69 | n/a | n/a | n/a |
| | 8 (203) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.40 | 0.29 | 0.16 | 0.64 | 0.56 | 0.55 | 0.53 | 0.74 | 0.22 | 0.14 | 0.07 | 0.99 | 0.40 | 0.29 | 0.13 | 0.74 | n/a | n/a | n/a |
| | 9 (229) | 0.65 | 0.65 | 0.63 | 0.58 | 0.71 | 0.43 | 0.31 | 0.17 | 0.65 | 0.57 | 0.55 | 0.53 | 0.89 | 0.26 | 0.17 | 0.08 | 1.00 | 0.43 | 0.34 | 0.16 | 0.78 | n/a | n/a | n/a |
| | 10 (254) | 0.67 | 0.67 | 0.64 | 0.58 | 0.75 | 0.46 | 0.33 | 0.18 | 0.67 | 0.58 | 0.56 | 0.53 | 1.00 | 0.31 | 0.20 | 0.09 | | 0.46 | 0.35 | 0.19 | 0.83 | n/a | n/a | n/a |
| | 11 (279) | 0.68 | 0.68 | 0.65 | 0.59 | 0.80 | 0.49 | 0.35 | 0.19 | 0.69 | 0.58 | 0.56 | 0.54 | | 0.35 | 0.23 | 0.11 | | 0.49 | 0.37 | 0.21 | 0.87 | n/a | n/a | n/a |
| | 11-1/4 (286) | 0.69 | 0.69 | 0.66 | 0.59 | 0.81 | 0.50 | 0.35 | 0.19 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.11 | | 0.50 | 0.38 | 0.22 | 0.88 | 0.58 | n/a | n/a |
| | 12 (305) | 0.70 | 0.70 | 0.67 | 0.60 | 0.85 | 0.52 | 0.37 | 0.20 | 0.70 | 0.59 | 0.57 | 0.54 | | 0.40 | 0.26 | 0.12 | | 0.52 | 0.39 | 0.24 | 0.91 | 0.60 | n/a | n/a |
| | 13 (330) | 0.72 | 0.72 | 0.68 | 0.61 | 0.90 | 0.55 | 0.39 | 0.21 | 0.72 | 0.60 | 0.57 | 0.54 | | 0.46 | 0.30 | 0.14 | | 0.55 | 0.42 | 0.28 | 0.94 | 0.63 | n/a | n/a |
| | 14 (356) | 0.73 | 0.73 | 0.69 | 0.62 | 0.95 | 0.59 | 0.41 | 0.23 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.51 | 0.33 | 0.15 | | 0.59 | 0.44 | 0.30 | 0.98 | 0.65 | n/a | n/a |
| | 14-1/4 (362) | 0.74 | 0.74 | 0.70 | 0.62 | 0.97 | 0.60 | 0.42 | 0.23 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.52 | 0.34 | 0.16 | | 0.60 | 0.44 | 0.30 | 0.99 | 0.66 | 0.57 | n/a |
| | 16 (406) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 0.67 | 0.47 | 0.26 | 0.77 | 0.62 | 0.59 | 0.55 | | 0.62 | 0.40 | 0.19 | | 0.67 | 0.48 | 0.32 | 1.00 | 0.70 | 0.60 | n/a |
| | 18 (457) | 0.80 | 0.80 | 0.75 | 0.65 | | 0.76 | 0.53 | 0.29 | 0.81 | 0.64 | 0.60 | 0.56 | | 0.74 | 0.48 | 0.22 | | 0.76 | 0.53 | 0.34 | | 0.74 | 0.64 | n/a |
| | 20 (508) | 0.84 | 0.84 | 0.78 | 0.67 | | 0.84 | 0.58 | 0.32 | 0.84 | 0.65 | 0.61 | 0.57 | | 0.87 | 0.56 | 0.26 | | 0.84 | 0.58 | 0.36 | | 0.78 | 0.67 | n/a |
| | 22 (559) | 0.87 | 0.87 | 0.81 | 0.68 | | 0.93 | 0.64 | 0.35 | 0.88 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.65 | 0.30 | | 0.93 | 0.64 | 0.38 | | 0.82 | 0.71 | n/a |
| | 22-1/4 (565) | 0.87 | 0.87 | 0.81 | 0.69 | | 0.94 | 0.65 | 0.36 | 0.88 | 0.67 | 0.63 | 0.58 | | | 0.66 | 0.31 | | 0.94 | 0.65 | 0.39 | | 0.82 | 0.71 | 0.55 |
| | 24 (610) | 0.90 | 0.90 | 0.83 | 0.70 | | 1.00 | 0.70 | 0.38 | 0.91 | 0.68 | 0.64 | 0.58 | | | 0.74 | 0.35 | | 1.00 | 0.70 | 0.41 | | 0.85 | 0.74 | 0.57 |
| | 26 (660) | 0.94 | 0.94 | 0.86 | 0.72 | | | 0.76 | 0.42 | 0.94 | 0.70 | 0.65 | 0.59 | | | 0.84 | 0.39 | | | 0.76 | 0.43 | | 0.89 | 0.77 | 0.60 |
| | 28 (711) | 0.97 | 0.97 | 0.89 | 0.73 | | | 0.82 | 0.45 | 0.98 | 0.71 | 0.66 | 0.60 | | | 0.94 | 0.43 | | | 0.82 | 0.45 | | 0.92 | 0.80 | 0.62 |
| | 30 (762) | 1.00 | 1.00 | 0.92 | 0.75 | | | 0.88 | 0.48 | 1.00 | 0.73 | 0.67 | 0.60 | | | 1.00 | 0.48 | | | 0.88 | 0.48 | | 0.95 | 0.83 | 0.64 |
| | 36 (914) | | | 1.00 | 0.80 | | | 1.00 | 0.58 | | 0.77 | 0.70 | 0.62 | | | | 0.63 | | | 1.00 | 0.58 | | 1.00 | 0.91 | 0.70 |
| | > 48 (1219) | | | | 0.90 | | | | 0.77 | | 0.86 | 0.77 | 0.66 | | | | 0.98 | | | | 0.77 | | | 1.00 | 0.81 |

### Table 41 — Load adjustment factors for 1-in. diameter threaded rods in cracked concrete[1,2,3]

| 1-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.41 | 0.41 | 0.40 | 0.38 | n/a | n/a | n/a | n/a | 0.08 | 0.02 | 0.01 | 0.01 | 0.15 | 0.05 | 0.03 | 0.01 | n/a | n/a | n/a | n/a |
| | 5 (127) | 0.58 | 0.58 | 0.57 | 0.54 | 0.53 | 0.53 | 0.50 | 0.44 | 0.59 | 0.54 | 0.53 | 0.52 | 0.37 | 0.11 | 0.07 | 0.03 | 0.74 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 6 (152) | 0.60 | 0.60 | 0.58 | 0.55 | 0.58 | 0.58 | 0.53 | 0.46 | 0.60 | 0.55 | 0.53 | 0.52 | 0.49 | 0.14 | 0.09 | 0.04 | 0.97 | 0.29 | 0.19 | 0.09 | n/a | n/a | n/a | n/a |
| | 6-1/4 (159) | 0.60 | 0.60 | 0.59 | 0.55 | 0.59 | 0.59 | 0.54 | 0.46 | 0.61 | 0.55 | 0.54 | 0.52 | 0.52 | 0.15 | 0.10 | 0.05 | 1.00 | 0.31 | 0.20 | 0.09 | 0.66 | n/a | n/a | n/a |
| | 7 (178) | 0.62 | 0.62 | 0.60 | 0.56 | 0.62 | 0.62 | 0.57 | 0.47 | 0.62 | 0.55 | 0.54 | 0.52 | 0.61 | 0.18 | 0.12 | 0.05 | | 0.36 | 0.24 | 0.11 | 0.69 | n/a | n/a | n/a |
| | 8 (203) | 0.63 | 0.63 | 0.61 | 0.57 | 0.66 | 0.66 | 0.60 | 0.49 | 0.64 | 0.56 | 0.55 | 0.53 | 0.75 | 0.22 | 0.14 | 0.07 | | 0.44 | 0.29 | 0.13 | 0.74 | n/a | n/a | n/a |
| | 9 (229) | 0.65 | 0.65 | 0.63 | 0.58 | 0.71 | 0.71 | 0.64 | 0.51 | 0.65 | 0.57 | 0.55 | 0.53 | 0.89 | 0.26 | 0.17 | 0.08 | | 0.53 | 0.34 | 0.16 | 0.79 | n/a | n/a | n/a |
| | 10 (254) | 0.67 | 0.67 | 0.64 | 0.58 | 0.75 | 0.75 | 0.67 | 0.53 | 0.67 | 0.58 | 0.56 | 0.53 | 1.00 | 0.31 | 0.20 | 0.09 | | 0.62 | 0.40 | 0.19 | 0.83 | n/a | n/a | n/a |
| | 11 (279) | 0.68 | 0.68 | 0.65 | 0.59 | 0.80 | 0.80 | 0.71 | 0.55 | 0.69 | 0.58 | 0.56 | 0.54 | | 0.36 | 0.23 | 0.11 | | 0.72 | 0.46 | 0.22 | 0.87 | n/a | n/a | n/a |
| | 11-1/4 (286) | 0.69 | 0.69 | 0.66 | 0.59 | 0.81 | 0.81 | 0.72 | 0.56 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.11 | | 0.74 | 0.48 | 0.22 | 0.88 | 0.59 | n/a | n/a |
| | 12 (305) | 0.70 | 0.70 | 0.67 | 0.60 | 0.85 | 0.85 | 0.75 | 0.57 | 0.71 | 0.59 | 0.57 | 0.54 | | 0.41 | 0.26 | 0.12 | | 0.82 | 0.53 | 0.25 | 0.91 | 0.61 | n/a | n/a |
| | 13 (330) | 0.72 | 0.72 | 0.68 | 0.61 | 0.90 | 0.90 | 0.79 | 0.59 | 0.72 | 0.60 | 0.57 | 0.54 | | 0.46 | 0.30 | 0.14 | | 0.92 | 0.60 | 0.28 | 0.95 | 0.63 | n/a | n/a |
| | 14 (356) | 0.73 | 0.73 | 0.69 | 0.62 | 0.95 | 0.95 | 0.83 | 0.62 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.51 | 0.33 | 0.16 | | 1.00 | 0.67 | 0.31 | 0.98 | 0.65 | n/a | n/a |
| | 14-1/4 (362) | 0.74 | 0.74 | 0.70 | 0.62 | 0.97 | 0.97 | 0.84 | 0.62 | 0.74 | 0.61 | 0.58 | 0.55 | | 0.53 | 0.34 | 0.16 | | | 0.69 | 0.32 | 0.99 | 0.66 | 0.57 | n/a |
| | 16 (406) | 0.77 | 0.77 | 0.72 | 0.63 | 1.00 | 1.00 | 0.91 | 0.66 | 0.77 | 0.62 | 0.59 | 0.55 | | 0.63 | 0.41 | 0.19 | | | 0.82 | 0.38 | 1.00 | 0.70 | 0.61 | n/a |
| | 18 (457) | 0.80 | 0.80 | 0.75 | 0.65 | | | 1.00 | 0.70 | 0.81 | 0.64 | 0.60 | 0.56 | | 0.75 | 0.49 | 0.23 | | | 0.97 | 0.45 | | 0.74 | 0.64 | n/a |
| | 20 (508) | 0.84 | 0.84 | 0.78 | 0.67 | | | | 0.75 | 0.84 | 0.65 | 0.61 | 0.57 | | 0.88 | 0.57 | 0.26 | | | 1.00 | 0.53 | | 0.78 | 0.68 | n/a |
| | 22 (559) | 0.87 | 0.87 | 0.81 | 0.68 | | | | 0.80 | 0.88 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.66 | 0.31 | | | | 0.61 | | 0.82 | 0.71 | n/a |
| | 22-1/4 (565) | 0.87 | 0.87 | 0.81 | 0.69 | | | | 0.80 | 0.88 | 0.67 | 0.63 | 0.58 | | | 0.67 | 0.31 | | | | 0.62 | | 0.82 | 0.71 | 0.55 |
| | 24 (610) | 0.90 | 0.90 | 0.83 | 0.70 | | | | 0.85 | 0.91 | 0.68 | 0.64 | 0.58 | | | 0.75 | 0.35 | | | | 0.70 | | 0.86 | 0.74 | 0.57 |
| | 26 (660) | 0.94 | 0.94 | 0.86 | 0.72 | | | | 0.90 | 0.95 | 0.70 | 0.65 | 0.59 | | | 0.84 | 0.39 | | | | 0.78 | | 0.89 | 0.77 | 0.60 |
| | 28 (711) | 0.97 | 0.97 | 0.89 | 0.73 | | | | 0.95 | 0.98 | 0.71 | 0.66 | 0.60 | | | 0.94 | 0.44 | | | | 0.88 | | 0.92 | 0.80 | 0.62 |
| | 30 (762) | 1.00 | 1.00 | 0.92 | 0.75 | | | | 1.00 | 1.00 | 0.73 | 0.67 | 0.60 | | | 1.00 | 0.49 | | | | 0.97 | | 0.96 | 0.83 | 0.64 |
| | 36 (914) | | | 1.00 | 0.80 | | | | | | 0.77 | 0.71 | 0.62 | | | | 0.64 | | | | 1.00 | | 1.00 | 0.91 | 0.70 |
| | > 48 (1219) | | | | 0.90 | | | | | | 0.87 | 0.77 | 0.66 | | | | 0.98 | | | | | | | 1.00 | 0.81 |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 42 — Load adjustment factors for 1-1/4-in. diameter threaded rods in uncracked concrete[1,2,3]

| 1-1/4-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ∥ To and away from edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.37 | 0.24 | 0.17 | 0.09 | n/a | n/a | n/a | n/a | 0.05 | 0.02 | 0.01 | 0.00 | 0.11 | 0.03 | 0.02 | 0.01 | n/a | n/a | n/a | n/a |
| | 6-1/4 (159) | 0.59 | 0.59 | 0.57 | 0.54 | 0.54 | 0.33 | 0.24 | 0.13 | 0.59 | 0.54 | 0.53 | 0.52 | 0.37 | 0.11 | 0.07 | 0.03 | 0.67 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 7 (178) | 0.60 | 0.60 | 0.58 | 0.55 | 0.57 | 0.35 | 0.25 | 0.13 | 0.60 | 0.54 | 0.53 | 0.52 | 0.43 | 0.13 | 0.08 | 0.04 | 0.73 | 0.26 | 0.17 | 0.08 | n/a | n/a | n/a | n/a |
| | 8 (203) | 0.61 | 0.61 | 0.59 | 0.55 | 0.61 | 0.37 | 0.26 | 0.14 | 0.61 | 0.55 | 0.54 | 0.52 | 0.53 | 0.16 | 0.10 | 0.05 | 0.82 | 0.31 | 0.20 | 0.10 | 0.66 | n/a | n/a | n/a |
| | 9 (229) | 0.63 | 0.63 | 0.60 | 0.56 | 0.64 | 0.39 | 0.28 | 0.15 | 0.62 | 0.55 | 0.54 | 0.52 | 0.63 | 0.19 | 0.12 | 0.06 | 0.93 | 0.38 | 0.24 | 0.11 | 0.70 | n/a | n/a | n/a |
| | 10 (254) | 0.64 | 0.64 | 0.61 | 0.57 | 0.68 | 0.41 | 0.29 | 0.16 | 0.64 | 0.56 | 0.55 | 0.53 | 0.74 | 0.22 | 0.14 | 0.07 | 1.00 | 0.41 | 0.29 | 0.13 | 0.74 | n/a | n/a | n/a |
| | 11 (279) | 0.65 | 0.65 | 0.62 | 0.57 | 0.72 | 0.44 | 0.31 | 0.17 | 0.65 | 0.57 | 0.55 | 0.53 | 0.86 | 0.25 | 0.16 | 0.08 | | 0.44 | 0.33 | 0.15 | 0.78 | n/a | n/a | n/a |
| | 12 (305) | 0.67 | 0.67 | 0.63 | 0.58 | 0.76 | 0.46 | 0.33 | 0.18 | 0.66 | 0.57 | 0.55 | 0.53 | 0.98 | 0.29 | 0.19 | 0.09 | | 0.46 | 0.36 | 0.17 | 0.81 | n/a | n/a | n/a |
| | 13 (330) | 0.68 | 0.68 | 0.64 | 0.59 | 0.80 | 0.49 | 0.35 | 0.19 | 0.68 | 0.58 | 0.56 | 0.54 | 1.00 | 0.33 | 0.21 | 0.10 | | 0.49 | 0.38 | 0.20 | 0.84 | n/a | n/a | n/a |
| | 14 (356) | 0.70 | 0.70 | 0.66 | 0.59 | 0.84 | 0.52 | 0.36 | 0.20 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.36 | 0.24 | 0.11 | | 0.52 | 0.40 | 0.22 | 0.87 | 0.58 | n/a | n/a |
| | 14-1/4 (362) | 0.70 | 0.70 | 0.66 | 0.60 | 0.85 | 0.52 | 0.37 | 0.20 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.11 | | 0.52 | 0.40 | 0.23 | 0.88 | 0.59 | n/a | n/a |
| | 15 (381) | 0.71 | 0.71 | 0.67 | 0.60 | 0.88 | 0.54 | 0.38 | 0.21 | 0.70 | 0.59 | 0.57 | 0.54 | | 0.40 | 0.26 | 0.12 | | 0.54 | 0.41 | 0.24 | 0.91 | 0.60 | n/a | n/a |
| | 16 (406) | 0.72 | 0.72 | 0.68 | 0.61 | 0.92 | 0.57 | 0.40 | 0.22 | 0.72 | 0.60 | 0.57 | 0.54 | | 0.45 | 0.29 | 0.13 | | 0.57 | 0.43 | 0.27 | 0.94 | 0.62 | n/a | n/a |
| | 17 (432) | 0.74 | 0.74 | 0.69 | 0.61 | 0.96 | 0.60 | 0.42 | 0.23 | 0.73 | 0.60 | 0.58 | 0.55 | | 0.49 | 0.32 | 0.15 | | 0.60 | 0.45 | 0.29 | 0.96 | 0.64 | n/a | n/a |
| | 18 (457) | 0.75 | 0.75 | 0.70 | 0.62 | 1.00 | 0.63 | 0.44 | 0.24 | 0.75 | 0.61 | 0.58 | 0.55 | | 0.53 | 0.35 | 0.16 | | 0.63 | 0.47 | 0.31 | 0.99 | 0.66 | 0.57 | n/a |
| | 20 (508) | 0.78 | 0.78 | 0.72 | 0.63 | | 0.70 | 0.49 | 0.27 | 0.77 | 0.62 | 0.59 | 0.55 | | 0.62 | 0.40 | 0.19 | | 0.70 | 0.50 | 0.33 | 1.00 | 0.70 | 0.60 | n/a |
| | 22 (559) | 0.81 | 0.81 | 0.74 | 0.65 | | 0.77 | 0.54 | 0.29 | 0.80 | 0.63 | 0.60 | 0.56 | | 0.72 | 0.47 | 0.22 | | 0.77 | 0.54 | 0.35 | | 0.73 | 0.63 | n/a |
| | 24 (610) | 0.84 | 0.84 | 0.77 | 0.66 | | 0.84 | 0.59 | 0.32 | 0.83 | 0.65 | 0.61 | 0.57 | | 0.82 | 0.53 | 0.25 | | 0.84 | 0.59 | 0.36 | | 0.76 | 0.66 | n/a |
| | 26 (660) | 0.87 | 0.87 | 0.79 | 0.67 | | 0.91 | 0.64 | 0.34 | 0.86 | 0.66 | 0.62 | 0.57 | | 0.92 | 0.60 | 0.28 | | 0.91 | 0.64 | 0.38 | | 0.79 | 0.69 | n/a |
| | 28 (711) | 0.89 | 0.89 | 0.81 | 0.69 | | 0.98 | 0.68 | 0.37 | 0.88 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.67 | 0.31 | | 0.98 | 0.68 | 0.40 | | 0.82 | 0.71 | 0.55 |
| | 30 (762) | 0.92 | 0.92 | 0.83 | 0.70 | | 1.00 | 0.73 | 0.40 | 0.91 | 0.68 | 0.64 | 0.58 | | | 0.74 | 0.35 | | 1.00 | 0.73 | 0.42 | | 0.85 | 0.74 | 0.57 |
| | 36 (914) | 1.00 | 1.00 | 0.90 | 0.74 | | | 0.88 | 0.48 | 0.99 | 0.72 | 0.66 | 0.60 | | | 0.98 | 0.45 | | | 0.88 | 0.48 | | 0.94 | 0.81 | 0.63 |
| | > 48 (1219) | | | 1.00 | 0.82 | | | 1.00 | 0.64 | 1.00 | 0.79 | 0.72 | 0.63 | | | 1.00 | 0.70 | | | 1.00 | 0.64 | | 1.00 | 0.94 | 0.72 |

## Table 43 — Load adjustment factors for 1-1/4-in. diameter threaded rods in cracked concrete[1,2,3]

| 1-1/4-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ∥ To and away from edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.40 | 0.40 | 0.39 | 0.37 | n/a | n/a | n/a | n/a | 0.05 | 0.02 | 0.01 | 0.00 | 0.11 | 0.03 | 0.02 | 0.01 | n/a | n/a | n/a | n/a |
| | 6-1/4 (159) | 0.59 | 0.59 | 0.57 | 0.54 | 0.54 | 0.54 | 0.50 | 0.44 | 0.59 | 0.54 | 0.53 | 0.52 | 0.37 | 0.11 | 0.07 | 0.03 | 0.74 | 0.22 | 0.14 | 0.07 | n/a | n/a | n/a | n/a |
| | 7 (178) | 0.60 | 0.60 | 0.58 | 0.55 | 0.57 | 0.57 | 0.52 | 0.45 | 0.60 | 0.54 | 0.53 | 0.52 | 0.44 | 0.13 | 0.08 | 0.04 | 0.88 | 0.26 | 0.17 | 0.08 | n/a | n/a | n/a | n/a |
| | 8 (203) | 0.61 | 0.61 | 0.59 | 0.55 | 0.61 | 0.61 | 0.55 | 0.46 | 0.61 | 0.55 | 0.54 | 0.52 | 0.54 | 0.16 | 0.10 | 0.05 | 1.00 | 0.32 | 0.21 | 0.10 | 0.66 | n/a | n/a | n/a |
| | 9 (229) | 0.63 | 0.63 | 0.60 | 0.56 | 0.64 | 0.64 | 0.57 | 0.48 | 0.62 | 0.55 | 0.54 | 0.52 | 0.64 | 0.19 | 0.12 | 0.06 | | 0.38 | 0.25 | 0.11 | 0.70 | n/a | n/a | n/a |
| | 10 (254) | 0.64 | 0.64 | 0.61 | 0.57 | 0.68 | 0.68 | 0.60 | 0.49 | 0.64 | 0.56 | 0.55 | 0.53 | 0.75 | 0.22 | 0.14 | 0.07 | | 0.44 | 0.29 | 0.13 | 0.74 | n/a | n/a | n/a |
| | 11 (279) | 0.65 | 0.65 | 0.62 | 0.57 | 0.72 | 0.72 | 0.63 | 0.51 | 0.65 | 0.57 | 0.55 | 0.53 | 0.86 | 0.26 | 0.17 | 0.08 | | 0.51 | 0.33 | 0.15 | 0.78 | n/a | n/a | n/a |
| | 12 (305) | 0.67 | 0.67 | 0.63 | 0.58 | 0.76 | 0.76 | 0.66 | 0.53 | 0.66 | 0.57 | 0.55 | 0.53 | 0.98 | 0.29 | 0.19 | 0.09 | | 0.58 | 0.38 | 0.18 | 0.81 | n/a | n/a | n/a |
| | 13 (330) | 0.68 | 0.68 | 0.64 | 0.59 | 0.80 | 0.80 | 0.69 | 0.54 | 0.68 | 0.58 | 0.56 | 0.54 | 1.00 | 0.33 | 0.21 | 0.10 | | 0.66 | 0.43 | 0.20 | 0.85 | n/a | n/a | n/a |
| | 14 (356) | 0.70 | 0.70 | 0.66 | 0.59 | 0.84 | 0.84 | 0.72 | 0.56 | 0.69 | 0.59 | 0.56 | 0.54 | | 0.37 | 0.24 | 0.11 | | 0.73 | 0.48 | 0.22 | 0.88 | 0.58 | n/a | n/a |
| | 14-1/4 (362) | 0.70 | 0.70 | 0.66 | 0.60 | 0.85 | 0.85 | 0.73 | 0.56 | 0.70 | 0.59 | 0.57 | 0.54 | | 0.38 | 0.25 | 0.11 | | 0.75 | 0.49 | 0.23 | 0.89 | 0.59 | n/a | n/a |
| | 15 (381) | 0.71 | 0.71 | 0.67 | 0.60 | 0.88 | 0.88 | 0.75 | 0.57 | 0.71 | 0.59 | 0.57 | 0.54 | | 0.41 | 0.26 | 0.12 | | 0.82 | 0.53 | 0.25 | 0.91 | 0.61 | n/a | n/a |
| | 16 (406) | 0.72 | 0.72 | 0.68 | 0.61 | 0.92 | 0.92 | 0.78 | 0.59 | 0.72 | 0.60 | 0.57 | 0.54 | | 0.45 | 0.29 | 0.14 | | 0.90 | 0.58 | 0.27 | 0.94 | 0.63 | n/a | n/a |
| | 17 (432) | 0.74 | 0.74 | 0.69 | 0.61 | 0.96 | 0.96 | 0.81 | 0.61 | 0.73 | 0.60 | 0.58 | 0.55 | | 0.49 | 0.32 | 0.15 | | 0.98 | 0.64 | 0.30 | 0.97 | 0.64 | n/a | n/a |
| | 18 (457) | 0.75 | 0.75 | 0.70 | 0.62 | 1.00 | 1.00 | 0.85 | 0.62 | 0.75 | 0.61 | 0.58 | 0.55 | | 0.54 | 0.35 | 0.16 | | 1.00 | 0.70 | 0.32 | 0.99 | 0.66 | 0.57 | n/a |
| | 20 (508) | 0.78 | 0.78 | 0.72 | 0.63 | | | 0.91 | 0.66 | 0.77 | 0.62 | 0.59 | 0.55 | | 0.63 | 0.41 | 0.19 | | | 0.82 | 0.38 | 1.00 | 0.70 | 0.61 | n/a |
| | 22 (559) | 0.81 | 0.81 | 0.74 | 0.65 | | | 0.98 | 0.69 | 0.80 | 0.63 | 0.60 | 0.56 | | 0.72 | 0.47 | 0.22 | | | 0.94 | 0.44 | | 0.73 | 0.63 | n/a |
| | 24 (610) | 0.84 | 0.84 | 0.77 | 0.66 | | | 1.00 | 0.73 | 0.83 | 0.65 | 0.61 | 0.57 | | 0.82 | 0.54 | 0.25 | | | 1.00 | 0.50 | | 0.77 | 0.66 | n/a |
| | 26 (660) | 0.87 | 0.87 | 0.79 | 0.67 | | | | 0.77 | 0.86 | 0.66 | 0.62 | 0.57 | | 0.93 | 0.60 | 0.28 | | | | 0.56 | | 0.80 | 0.69 | n/a |
| | 28 (711) | 0.89 | 0.89 | 0.81 | 0.69 | | | | 0.81 | 0.88 | 0.67 | 0.63 | 0.58 | | 1.00 | 0.68 | 0.31 | | | | 0.63 | | 0.83 | 0.72 | 0.55 |
| | 30 (762) | 0.92 | 0.92 | 0.83 | 0.70 | | | | 0.85 | 0.91 | 0.68 | 0.64 | 0.58 | | | 0.75 | 0.35 | | | | 0.70 | | 0.86 | 0.74 | 0.57 |
| | 36 (914) | 1.00 | 1.00 | 0.90 | 0.74 | | | | 0.97 | 0.99 | 0.72 | 0.66 | 0.60 | | | 0.98 | 0.46 | | | | 0.91 | | 0.94 | 0.81 | 0.63 |
| | > 48 (1219) | | | 1.00 | 0.82 | | | | 1.00 | 1.00 | 0.79 | 0.72 | 0.63 | | | 1.00 | 0.70 | | | | 1.00 | | 1.00 | 0.94 | 0.73 |

1 Linear interpolation not permitted.

2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.

3 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.

5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

**HIT-RE 500 V3 adhesive with HIS-N and HIS-RN internally threaded insert**





**Figure 7 — Hilti HIS-N and HIS-RN internally threaded insert installation conditions**

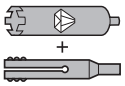
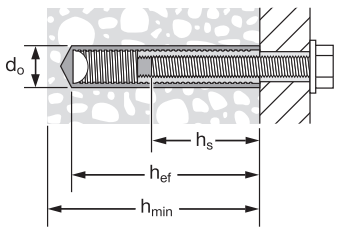
| Cracked or uncracked concrete | Permissible drilling methods | Permissible concrete conditions |
|---|---|---|
|   Cracked and uncracked concrete |  Hammer drilling with carbide-tipped drill bit |  Dry concrete<br>  Water-saturated concrete<br>  Water-filled holes<br>  Submerged (underwater) |
| |  Hilti TE-CD or TE-YD hollow drill bit<br>  Diamond core drill bit with Hilti TE-YRT roughening tool |  Dry concrete<br>  Water-saturated concrete |
|  Uncracked concrete |  Diamond core drill bit |  Dry concrete<br>  Water-saturated concrete |

**Table 44 — HIS-N and HIS-RN specifications**

| Setting information | | Symbol | Units | Thread size | | | |
|---|---|---|---|---|---|---|---|
| | | | | 3/8-16 UNC | 1/2-13 UNC | 5/8-11 UNC | 3/4-10 UNC |
| Outside diameter of insert | | | in. | 0.65 | 0.81 | 1.00 | 1.09 |
| Nominal bit diameter | | $d_o$ | in. | 11/16 | 7/8 | 1-1/8 | 1-1/4 |
| Effective embedment | | $h_{ef}$ | in.<br>(mm) | 4-3/8<br>(110) | 5<br>(125) | 6-3/4<br>(170) | 8-1/8<br>(205) |
| Thread engagement | minimum<br>maximum | $h_s$ | in.<br>in. | 3/8<br>15/16 | 1/2<br>1-3/16 | 5/8<br>1-1/2 | 3/4<br>1-7/8 |
| Installation torque | | $T_{inst}$ | ft-lb<br>(Nm) | 15<br>(20) | 30<br>(40) | 60<br>(81) | 100<br>(136) |
| Minimum concrete thickness | | $h_{min}$ | in.<br>(mm) | 5.9<br>(150) | 6.7<br>(170) | 9.1<br>(230) | 10.6<br>(270) |
| Minimum edge distance | | $c_{min}$ | in<br>(mm) | 3-1/4<br>(83) | 4<br>(102) | 5<br>(127) | 5-1/2<br>(140) |
| Minimum anchor spacing | | $s_{min}$ | in<br>(mm) | 3-1/4<br>(83) | 4<br>(102) | 5<br>(127) | 5-1/2<br>(140) |

**Figure 8 — Hilti HIS-N and HIS-RN specifications**



## Table 45 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8,9,11]

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8-16 UNC | 4-3/8 (111) | 7,140 (31.8) | 7,820 (34.8) | 9,030 (40.2) | 11,060 (49.2) | 15,375 (68.4) | 16,840 (74.9) | 19,445 (86.5) | 23,815 (105.9) |
| 1/2-13[10] UNC | 5 (127) | 8,720 (38.8) | 9,555 (42.5) | 11,030 (49.1) | 13,510 (60.1) | 18,785 (83.6) | 20,575 (91.5) | 23,760 (105.7) | 29,100 (129.4) |
| 5/8-11[10] UNC | 6-3/4 (171) | 13,680 (60.9) | 14,985 (66.7) | 17,305 (77.0) | 21,190 (94.3) | 29,460 (131.0) | 32,275 (143.6) | 37,265 (165.8) | 45,645 (203.0) |
| 3/4-10[10] UNC | 8-1/8 (206) | 18,065 (80.4) | 19,790 (88.0) | 22,850 (101.6) | 27,985 (124.5) | 38,910 (173.1) | 42,620 (189.6) | 49,215 (218.9) | 60,275 (268.1) |

## Table 46 — Hilti HIT-RE 500 V3 adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9,11]

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8-16 UNC | 4-3/8 (111) | 5,055 (22.5) | 5,540 (24.6) | 6,395 (28.4) | 7,085 (31.5) | 10,890 (48.4) | 11,930 (53.1) | 13,775 (61.3) | 15,260 (67.9) |
| 1/2-13[10] UNC | 5 (127) | 6,175 (27.5) | 6,765 (30.1) | 7,815 (34.8) | 9,570 (42.6) | 13,305 (59.2) | 14,575 (64.8) | 16,830 (74.9) | 20,610 (91.7) |
| 5/8-11[10] UNC | 6-3/4 (171) | 9,690 (43.1) | 10,615 (47.2) | 12,255 (54.5) | 15,010 (66.8) | 20,870 (92.8) | 22,860 (101.7) | 26,395 (117.4) | 32,330 (143.8) |
| 3/4-10[10] UNC | 8-1/8 (206) | 12,795 (56.9) | 14,015 (62.3) | 16,185 (72.0) | 19,825 (88.2) | 27,560 (122.6) | 30,190 (134.3) | 34,860 (155.1) | 42,695 (189.9) |

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength (factored resistance) value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 50 and 51 as necessary to the above values. Compare to the steel values in table 49. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C) multiply above values by 0.69
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete and water saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.52.
For submerged (under water) applications multiply design strength by 0.46.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete except as indicated in note 10. For diamond core drilling in uncracked concrete, except as indicated in note 10, multiply the above values by 0.57. Diamond core drilling is not permitted for water-filled or under-water (submerged) applications in uncracked concrete.

10 Diamond core drilling is permitted in uncracked and cracked concrete with use of the Hilti TE-YRT roughening tool for 1/2-13 UNC, 5/8-11 UNC, and 3/4-10 UNC anchors in dry and water-saturated concrete. See Tables 47 and 48.

11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.75. See section 3.1.8 for additional information on seismic applications.

### Table 47 — Hilti HIT-RE 500 V3 in Core Drilled Holes roughened with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8]

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 1/2-13 UNC | 5 (127) | 8,720 (38.8) | 9,555 (42.5) | 11,030 (49.1) | 13,510 (60.1) | 18,785 (83.6) | 20,575 (91.5) | 23,760 (105.7) | 29,100 (129.4) |
| 5/8-11 UNC | 6-3/4 (171) | 13,680 (60.9) | 14,985 (66.7) | 17,305 (77.0) | 21,190 (94.3) | 29,460 (131.0) | 32,275 (143.6) | 37,265 (165.8) | 45,645 (203.0) |
| 3/4-10 UNC | 8-1/8 (206) | 18,065 (80.4) | 19,790 (88.0) | 22,850 (101.6) | 27,985 (124.5) | 38,910 (173.1) | 42,620 (189.6) | 49,215 (218.9) | 60,275 (268.1) |

### Table 48 — Hilti HIT-RE 500 V3 in Core Drilled Holes roughened with TE-YRT Roughening Tool adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9]

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 1/2-13 UNC | 5 (127) | 6,175 (27.5) | 6,205 (27.6) | 6,205 (27.6) | 6,205 (27.6) | 13,305 (59.2) | 13,360 (59.4) | 13,360 (59.4) | 13,360 (59.4) |
| 5/8-11 UNC | 6-3/4 (171) | 9,690 (43.1) | 10,340 (46.0) | 10,340 (46.0) | 10,340 (46.0) | 20,870 (92.8) | 22,265 (99.0) | 22,265 (99.0) | 22,265 (99.0) |
| 3/4-10 UNC | 8-1/8 (206) | 12,795 (56.9) | 13,565 (60.3) | 13,565 (60.3) | 13,565 (60.3) | 27,560 (122.6) | 29,215 (130.0) | 29,215 (130.0) | 29,215 (130.0) |

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength (factored resistance) value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 50 and 51 as necessary to the above values. Compare to the steel values in table 49. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C).
For temperature range B: Max. short term temperature = 176° F (80° C), max. long term temperature = 110° F (43° C) multiply above values by 0.69
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete and water saturated concrete conditions. Water-filled and submerged (underwater) applications are not permitted for this hole preparation method.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.75. See section 3.1.8 for additional information on seismic applications.

### Table 49 — Steel design strength for steel bolt / cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

| Thread size | ASTM A 193 B7 | | | ASTM A 193 Grade B8M stainless steel | | |
|---|---|---|---|---|---|---|
| | Tensile[4] $\phi N_{sa}$ lb (kN) | Shear[5] $\phi V_{sa}$ lb (kN) | Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN) | Tensile[4] $\phi N_{sa}$ lb (kN) | Shear[5] $\phi V_{sa}$ lb (kN) | Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN) |
| 3/8-16 UNC | 6,300 (28.0) | 3,490 (15.5) | 2,445 (10.9) | 5,540 (24.6) | 3,070 (13.7) | 2,150 (9.6) |
| 1/2-13 UNC | 10,525 (46.8) | 6,385 (28.4) | 4,470 (19.9) | 10,145 (45.1) | 5,620 (25.0) | 3,935 (17.5) |
| 5/8-11 UNC | 17,500 (77.8) | 10,170 (45.2) | 7,120 (31.7) | 16,160 (71.9) | 8,950 (39.8) | 6,265 (27.9) |
| 3/4-10 UNC | 17,785 (79.1) | 15,055 (67.0) | 10,540 (46.9) | 23,915 (106.4) | 13,245 (58.9) | 9,270 (41.2) |

1 See Section 3.1.8 to convert design strength value to ASD value.

2 Hilti HIS-N and HIS-RN inserts with steel bolts are considered brittle steel elements.

3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.

4 Tensile = $\phi\ A_{se,N}\ f_{uta}$ as noted in ACI 318 Chapter 17.

5 Shear = $\phi$ 0.60 $A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17.

6 Seismic Shear = $\alpha_{V,seis}\ \phi\ V_{sa}$ : Reduction for seismic shear only. See section 3.1.8 for additional information on seismic applications.

## Table 50 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2]

| HIS-N and HIS-RN all diameters uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[3] $f_{AV}$ | | | | Edge Distance in Shear | | | | | | | | Concrete thickness factor in shear[4] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ∥ To and away from edge $f_{RV}$ | | | | | | | |
| Internal diameter | | in. | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 |
| | | (mm) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) |
| Embedment $h_{ef}$ | | in. | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 |
| | | (mm) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 3-1/4 | (83) | 0.59 | n/a | n/a | n/a | 0.36 | n/a | n/a | n/a | 0.55 | n/a | n/a | n/a | 0.15 | n/a | n/a | n/a | 0.31 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4 | (102) | 0.61 | 0.59 | n/a | n/a | 0.41 | 0.40 | n/a | n/a | 0.56 | 0.55 | n/a | n/a | 0.21 | 0.19 | n/a | n/a | 0.41 | 0.38 | n/a | n/a | n/a | n/a | n/a | n/a |
| | 5 | (127) | 0.64 | 0.61 | 0.59 | n/a | 0.47 | 0.45 | 0.39 | n/a | 0.57 | 0.57 | 0.55 | n/a | 0.29 | 0.26 | 0.17 | n/a | 0.47 | 0.45 | 0.33 | n/a | n/a | n/a | n/a | n/a |
| | 5-1/2 | (140) | 0.65 | 0.62 | 0.60 | 0.59 | 0.50 | 0.48 | 0.41 | 0.37 | 0.58 | 0.58 | 0.56 | 0.55 | 0.34 | 0.30 | 0.19 | 0.15 | 0.50 | 0.48 | 0.39 | 0.29 | n/a | n/a | n/a | n/a |
| | 6 | (152) | 0.66 | 0.63 | 0.61 | 0.60 | 0.53 | 0.51 | 0.43 | 0.39 | 0.59 | 0.58 | 0.56 | 0.55 | 0.39 | 0.35 | 0.22 | 0.17 | 0.53 | 0.51 | 0.43 | 0.33 | 0.60 | n/a | n/a | n/a |
| | 7 | (178) | 0.69 | 0.65 | 0.62 | 0.61 | 0.61 | 0.57 | 0.48 | 0.42 | 0.60 | 0.60 | 0.57 | 0.56 | 0.49 | 0.43 | 0.28 | 0.21 | 0.61 | 0.57 | 0.48 | 0.42 | 0.64 | 0.62 | n/a | n/a |
| | 8 | (203) | 0.72 | 0.67 | 0.64 | 0.63 | 0.70 | 0.65 | 0.52 | 0.45 | 0.62 | 0.61 | 0.58 | 0.57 | 0.60 | 0.53 | 0.34 | 0.26 | 0.70 | 0.65 | 0.52 | 0.45 | 0.69 | 0.66 | n/a | n/a |
| | 9 | (229) | 0.74 | 0.70 | 0.66 | 0.65 | 0.78 | 0.73 | 0.57 | 0.49 | 0.63 | 0.62 | 0.59 | 0.58 | 0.71 | 0.63 | 0.40 | 0.31 | 0.78 | 0.73 | 0.57 | 0.49 | 0.73 | 0.70 | n/a | n/a |
| | 10 | (254) | 0.77 | 0.72 | 0.68 | 0.66 | 0.87 | 0.81 | 0.62 | 0.53 | 0.65 | 0.64 | 0.60 | 0.58 | 0.83 | 0.74 | 0.47 | 0.36 | 0.87 | 0.81 | 0.62 | 0.53 | 0.77 | 0.74 | 0.64 | n/a |
| | 11 | (279) | 0.80 | 0.74 | 0.69 | 0.68 | 0.96 | 0.89 | 0.68 | 0.56 | 0.66 | 0.65 | 0.61 | 0.59 | 0.96 | 0.86 | 0.55 | 0.41 | 0.96 | 0.89 | 0.68 | 0.56 | 0.81 | 0.78 | 0.67 | 0.61 |
| | 12 | (305) | 0.82 | 0.76 | 0.71 | 0.69 | 1.00 | 0.97 | 0.74 | 0.60 | 0.68 | 0.66 | 0.62 | 0.60 | 1.00 | 0.98 | 0.62 | 0.47 | 1.00 | 0.97 | 0.74 | 0.60 | 0.84 | 0.81 | 0.70 | 0.64 |
| | 14 | (356) | 0.88 | 0.80 | 0.75 | 0.73 | | 1.00 | 0.86 | 0.70 | 0.71 | 0.69 | 0.64 | 0.62 | | 1.00 | 0.78 | 0.59 | | 1.00 | 0.86 | 0.70 | 0.91 | 0.87 | 0.75 | 0.69 |
| | 16 | (406) | 0.93 | 0.85 | 0.78 | 0.76 | | | 0.98 | 0.80 | 0.74 | 0.72 | 0.66 | 0.63 | | | 0.96 | 0.73 | | | 0.98 | 0.80 | 0.97 | 0.94 | 0.80 | 0.73 |
| | 18 | (457) | 0.99 | 0.89 | 0.82 | 0.79 | | | 1.00 | 0.90 | 0.77 | 0.75 | 0.68 | 0.65 | | | 1.00 | 0.87 | | | 1.00 | 0.90 | 1.00 | 0.99 | 0.85 | 0.78 |
| | 24 | (610) | 1.00 | 1.00 | 0.92 | 0.89 | | | | 1.00 | 0.85 | 0.83 | 0.74 | 0.70 | | | | 1.00 | | | | 1.00 | | 1.00 | 0.99 | 0.90 |
| | 30 | (762) | | | 1.00 | 0.98 | | | | | 0.94 | 0.91 | 0.80 | 0.75 | | | | | | | | | | | 1.00 | 1.00 |
| | 36 | (914) | | | | 1.00 | | | | | 1.00 | 0.99 | 0.86 | 0.80 | | | | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | | | | 0.99 | 0.90 | | | | | | | | | | | | |

## Table 51 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2]

| HIS-N and HIS-RN all diameters cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[3] $f_{AV}$ | | | | Edge Distance in Shear | | | | | | | | Concrete thickness factor in shear[4] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ∥ To and away from edge $f_{RV}$ | | | | | | | |
| Internal diameter | | in. | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 |
| | | (mm) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) |
| Embedment $h_{ef}$ | | in. | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 |
| | | (mm) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 3-1/4 | (83) | 0.59 | n/a | n/a | n/a | 0.54 | n/a | n/a | n/a | 0.55 | n/a | n/a | n/a | 0.16 | n/a | n/a | n/a | 0.31 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4 | (102) | 0.61 | 0.59 | n/a | n/a | 0.59 | 0.54 | n/a | n/a | 0.56 | 0.55 | n/a | n/a | 0.21 | 0.19 | n/a | n/a | 0.42 | 0.38 | n/a | n/a | n/a | n/a | n/a | n/a |
| | 5 | (127) | 0.64 | 0.61 | 0.59 | n/a | 0.66 | 0.60 | 0.54 | n/a | 0.57 | 0.57 | 0.55 | n/a | 0.30 | 0.26 | 0.17 | n/a | 0.59 | 0.53 | 0.34 | n/a | n/a | n/a | n/a | n/a |
| | 5-1/2 | (140) | 0.65 | 0.62 | 0.60 | 0.59 | 0.70 | 0.62 | 0.57 | 0.55 | 0.58 | 0.58 | 0.56 | 0.55 | 0.34 | 0.31 | 0.19 | 0.15 | 0.69 | 0.61 | 0.39 | 0.29 | n/a | n/a | n/a | n/a |
| | 6 | (152) | 0.66 | 0.63 | 0.61 | 0.60 | 0.74 | 0.65 | 0.59 | 0.57 | 0.59 | 0.58 | 0.56 | 0.55 | 0.39 | 0.35 | 0.22 | 0.17 | 0.74 | 0.65 | 0.44 | 0.34 | 0.60 | n/a | n/a | n/a |
| | 7 | (178) | 0.69 | 0.65 | 0.62 | 0.61 | 0.81 | 0.71 | 0.63 | 0.61 | 0.60 | 0.60 | 0.57 | 0.56 | 0.49 | 0.44 | 0.28 | 0.21 | 0.81 | 0.71 | 0.56 | 0.42 | 0.64 | 0.62 | n/a | n/a |
| | 8 | (203) | 0.72 | 0.67 | 0.64 | 0.63 | 0.89 | 0.77 | 0.68 | 0.65 | 0.62 | 0.61 | 0.58 | 0.57 | 0.60 | 0.54 | 0.34 | 0.26 | 0.89 | 0.77 | 0.68 | 0.52 | 0.69 | 0.66 | n/a | n/a |
| | 9 | (229) | 0.74 | 0.70 | 0.66 | 0.65 | 0.98 | 0.83 | 0.73 | 0.69 | 0.63 | 0.62 | 0.59 | 0.58 | 0.72 | 0.64 | 0.41 | 0.31 | 0.98 | 0.83 | 0.73 | 0.62 | 0.73 | 0.70 | n/a | n/a |
| | 10 | (254) | 0.77 | 0.72 | 0.68 | 0.66 | 1.00 | 0.90 | 0.78 | 0.73 | 0.65 | 0.64 | 0.60 | 0.58 | 0.84 | 0.75 | 0.48 | 0.36 | 1.00 | 0.90 | 0.78 | 0.72 | 0.77 | 0.74 | 0.64 | n/a |
| | 11 | (279) | 0.80 | 0.74 | 0.69 | 0.68 | | 0.96 | 0.83 | 0.78 | 0.66 | 0.65 | 0.61 | 0.59 | 0.97 | 0.86 | 0.55 | 0.42 | | 0.96 | 0.83 | 0.78 | 0.81 | 0.78 | 0.67 | 0.61 |
| | 12 | (305) | 0.82 | 0.76 | 0.71 | 0.69 | | 1.00 | 0.88 | 0.83 | 0.68 | 0.66 | 0.62 | 0.60 | 1.00 | 0.98 | 0.63 | 0.48 | | 1.00 | 0.88 | 0.83 | 0.84 | 0.81 | 0.70 | 0.64 |
| | 14 | (356) | 0.88 | 0.80 | 0.75 | 0.73 | | | 0.99 | 0.92 | 0.71 | 0.69 | 0.64 | 0.62 | | 1.00 | 0.79 | 0.60 | | | 0.99 | 0.92 | 0.91 | 0.88 | 0.76 | 0.69 |
| | 16 | (406) | 0.93 | 0.85 | 0.78 | 0.76 | | | 1.00 | 1.00 | 0.74 | 0.72 | 0.66 | 0.64 | | | 0.97 | 0.73 | | | 1.00 | 1.00 | 0.97 | 0.94 | 0.81 | 0.74 |
| | 18 | (457) | 0.99 | 0.89 | 0.82 | 0.79 | | | | | 0.77 | 0.75 | 0.68 | 0.65 | | | 1.00 | 0.87 | | | | | 1.00 | 0.99 | 0.86 | 0.78 |
| | 24 | (610) | 1.00 | 1.00 | 0.92 | 0.89 | | | | | 0.86 | 0.83 | 0.74 | 0.70 | | | | 1.00 | | | | | | 1.00 | 0.99 | 0.90 |
| | 30 | (762) | | | 1.00 | 0.98 | | | | | 0.95 | 0.91 | 0.81 | 0.75 | | | | | | | | | | | 1.00 | 1.00 |
| | 36 | (914) | | | | 1.00 | | | | | 1.00 | 0.99 | 0.87 | 0.80 | | | | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | | | 1.00 | 0.99 | 0.91 | | | | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with a thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using the design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

# DESIGN DATA IN CONCRETE PER CSA A23.3



### CSA A23.3 Annex D design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-3814 and ELC-3814. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

### HIT-RE 500 V3 adhesive with Deformed Reinforcing Bars (Rebar)



**Table 52 — Specifications for CA rebar installed with Hilti HIT-RE 500 V3**

| Setting information | | Symbol | Units | Rebar size | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 10M | 15M | 20M | 25M | 30M |
| Nominal bit diameter | | $d_o$ | in. | 9/16 | 3/4 | 1 | 1-1/4 | 1-1/2 |
| Effective embedment | minimum | $h_{ef,min}$ | mm | 60 | 80 | 90 | 100 | 120 |
| | maximum | $h_{ef,max}$ | mm | 226 | 320 | 390 | 504 | 598 |
| Minimum concrete member thickness | | $h_{min}$ | mm | $h_{ef}$ + 30 | $h_{ef}$ + 2$d_o$ | | | |

**Note:** The installation specifications in table 52 above and the data in tables 53 through 67 pertain to the use of Hilti HIT-RE 500 V3 with rebar designed as a post-installed anchor using the provisions of CSA A23.3 Annex D. For the use of Hilti HIT-RE 500 V3 with rebar for typical development calculations according to CSA A23.3 Chapter 12, refer to section 3.1.8 for the design method and tables 88 through 92 in section 3.2.4.

**Table 53 — Steel factored resistance for CA rebar[1]**

| Rebar size | CSA-G30.18 Grade 400[2] | | |
|---|---|---|---|
| | Tensile[3] $N_{sar}$ lb (kN) | Shear[4] $V_{sar}$ lb (kN) | Seismic shear[5] $V_{sar,eq}$ lb (kN) |
| 10M | 7,245 (32.2) | 4,035 (17.9) | 2,825 (12.6) |
| 15M | 14,525 (64.6) | 8,090 (36.0) | 5,665 (25.2) |
| 20M | 21,570 (95.9) | 12,020 (53.5) | 8,415 (37.4) |
| 25M | 36,025 (160.2) | 20,070 (89.3) | 14,050 (62.5) |
| 30M | 50,715 (225.6) | 28,255 (125.7) | 19,780 (88.0) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 CSA-G30.18 Grade 400 rebar are considered ductile steel elements.
3 Tensile = $A_{se,N}$ $\Phi_s$ $f_{uta}$ R as noted in CSA A23.3 Annex D
4 Shear = $A_{se,V}$ $\Phi_s$ 0.60 $f_{uta}$ R as noted in CSA A23.3 Annex D.
5 Seismic Shear = $\alpha_{V,seis}$ $V_{sar}$ : Reduction factor for seismic shear only. See section 3.1.8 for additional information on seismic applications.

## Table 54 — Hilti HIT-RE 500 V3 adhesive design information with CA rebar in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Rebar size | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 10M | 15M | 20M | 25M | 30M | A23.3-14 |
| Anchor O.D. | | $d_a$ | – | 11.3 | 16.0 | 19.5 | 25.2 | 29.9 | |
| Effective minimum embedment[2] | | $h_{ef}$ | – | 60 | 80 | 90 | 101 | 120 | |
| Effective maximum embedment[2] | | $h_{ef}$ | – | 226 | 320 | 390 | 504 | 598 | |
| Min. concrete thickness[2] | | $h_{min}$ | – | $h_{ef}$ + 30 | $h_{ef}$ + $2d_0$ | | | | |
| Critical edge distance | | $c_{ac}$ | – | $2h_{ef}$ | | | | | |
| Minimum edge distance[3] | | $c_{min}$ | – | 57 | 80 | 98 | 126 | 150 | |
| Minimum anchor spacing | | $s_{min}$ | – | 57 | 80 | 98 | 126 | 150 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete[4] | | $k_{c,uncr}$ | – | 10 | | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete[4] | | $k_{c,cr}$ | – | 7 | | | | | D.6.2.2 |
| Concrete material resistance factor | | ϕc | – | 0.65 | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | | | | D.5.3(c) |
| Dry concrete and water saturated | | | | | | | | | |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 1,360 (9.4) | 1,390 (9.6) | 1,410 (9.7) | 1,420 (9.8) | 1,380 (9.5) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 1,760 (12.1) | 1,720 (11.9) | 1,690 (11.7) | 1,650 (11.4) | 1,610 (11.1) | D.6.5.2 |
| Temp. range B[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 940 (6.5) | 960 (6.6) | 970 (6.7) | 980 (6.8) | 950 (6.6) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 1,210 (8.3) | 1,190 (8.2) | 1,170 (8.1) | 1,140 (7.9) | 1,110 (7.7) | D.6.5.2 |
| Anchor category, dry concrete | | – | – | 1 | 1 | 1 | 1 | 1 | D.5.3(c) |
| Resistance modification factor | | $R_{dry}$ | – | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Water-filled hole | | | | | | | | | |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 1,010 (7.0) | 1,040 (7.2) | 1,060 (7.3) | 1,080 (7.4) | 1,060 (7.3) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 1,300 (9.0) | 1,280 (8.8) | 1,270 (8.8) | 1,250 (8.6) | 1,240 (8.6) | D.6.5.2 |
| Temp. range B[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 700 (4.8) | 720 (5.0) | 730 (5.0) | 740 (5.1) | 730 (5.0) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 900 (6.2) | 890 (6.1) | 880 (6.1) | 860 (5.9) | 850 (5.9) | D.6.5.2 |
| Anchor category, water-filled hole | | – | – | 3 | 3 | 3 | 3 | 3 | D.5.3(c) |
| Resistance modification factor | | $R_{wf}$ | – | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | |
| Underwater application | | | | | | | | | |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 880 (6.1) | 920 (6.3) | 940 (6.5) | 980 (6.8) | 960 (6.6) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 1,130 (7.8) | 1,140 (7.9) | 1,140 (7.9) | 1,140 (7.9) | 1,130 (7.8) | D.6.5.2 |
| Temp. range B[6] | Characteristic bond stress in cracked concrete[7,8] | $\tau_{cr}$ | psi (MPa) | 610 (4.2) | 630 (4.3) | 650 (4.5) | 680 (4.7) | 660 (4.6) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7,8] | $\tau_{uncr}$ | psi (MPa) | 780 (5.4) | 790 (5.4) | 780 (5.4) | 780 (5.4) | 780 (5.4) | D.6.5.2 |
| Anchor category, underwater | | – | – | 3 | 3 | 3 | 3 | 3 | D.5.3(c) |
| Resistance modification factor | | $R_{uw}$ | – | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | |
| Resistance for seismic tension | | $\alpha_{N,seis}$ | – | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | |

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018,, table 23 and 24, and converted for use with CSA A23.3 Annex D.

2 See figure 2 of section 3.2.4.3.1.

3 Minimum edge distance may be reduced to 45mm provided rebar remains untorqued. See ESR-3814 section 4.1.9.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond stress values corresponding to concrete compressive stress $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of $(f'_c/2{,}500)^{0.25}$ [for SI: $(f'_c/17.2)^{0.25}$] for uncracked concrete and $(f'c/2{,}500)^{0.15}$ [for SI: $(f'c/17.2)^{0.15}$] for cracked concrete.

8 For structures assigned to Seismic Design Categories C, D, E, or F, bond stress values must be multiplied by $\alpha_{N,seis}$.

## Table 55 — Hilti HIT-RE 500 V3 adhesive design information with CA rebar in diamond core drilled holes in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Rebar size | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 10M | 15M | 20M | 25M | 30M | A23.3-14 |
| Anchor O.D. | | $d_a$ | – | 11.3 | 16.0 | 19.5 | 25.2 | 29.9 | |
| Effective minimum embedment[2] | | $h_{ef}$ | – | 60 | 80 | 90 | 101 | 120 | |
| Effective maximum embedment[2] | | $h_{ef}$ | – | 226 | 320 | 390 | 504 | 598 | |
| Min. concrete thickness[2] | | $h_{min}$ | – | $h_{ef}$ + 30 | $h_{ef}$ + $2d_0$ | | | | |
| Critical edge distance | | $c_{ac}$ | – | $2h_{ef}$ | | | | | |
| Minimum edge distance[3] | | $c_{min}$ | – | 57 | 80 | 98 | 126 | 150 | |
| Minimum anchor spacing | | $s_{min}$ | – | 57 | 80 | 98 | 126 | 150 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete[4] | | $k_{c,uncr}$ | – | 10 | | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete[4] | | $k_{c,cr}$ | – | 7 | | | | | D.6.2.2 |
| Concrete material resistance factor | | ϕc | – | 0.65 | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | | | | D.5.3(c) |
| Dry concrete and water saturated concrete | | | | | | | | | |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[7] | $T_{uncr}$ | psi (MPa) | 1,150 (7.9) | 1,150 (7.9) | 1,150 (7.9) | 1,150 (7.9) | 1,150 (7.9) | D.6.5.2 |
| Temp. range B[6] | Characteristic bond stress in uncracked concrete[7] | $T_{uncr}$ | psi (MPa) | 800 (5.5) | 800 (5.5) | 800 (5.5) | 800 (5.5) | 800 (5.5) | D.6.5.2 |
| Anchor category, dry concrete | | – | – | 2 | 3 | 3 | 3 | 3 | D.5.3(c) |
| Resistance modification factor | | $R_{dry}$ | – | 0.85 | 0.75 | 0.75 | 0.75 | 0.75 | |

1 Design information in this table is taken from ELC-3814, dated April 2018, table 23 and 25B, and converted for use with CSA A23.3 Annex D.

2 See figure 2 of section 3.2.4.3.1.

3 Minimum edge distance may be reduced to 45mm provided rebar remains untorqued. See ESR-3814 section 4.1.9.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond stress values correspond to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of $(f'_c/2{,}500)^{0.25}$ [for SI: $(f'_c/17.2)^{0.25}$] for uncracked concrete.

## Table 56 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete/bond failure for CA rebar in uncracked concrete[1,2,3,4,5,6,7,8,9,11]

| Rebar size | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 10M | 4-1/2 (115) | 7,520 (33.4) | 7,950 (35.4) | 8,320 (37.0) | 8,940 (39.8) | 15,040 (66.9) | 15,900 (70.7) | 16,645 (74.0) | 17,885 (79.6) |
| | 7-1/16 (180) | 11,770 (52.4) | 12,445 (55.4) | 13,025 (57.9) | 13,995 (62.3) | 23,540 (104.7) | 24,890 (110.7) | 26,050 (115.9) | 27,990 (124.5) |
| | 8-7/8 (226) | 14,775 (65.7) | 15,625 (69.5) | 16,355 (72.7) | 17,575 (78.2) | 29,555 (131.5) | 31,250 (139.0) | 32,705 (145.5) | 35,145 (156.3) |
| 15M[10] | 5-11/16 (145) | 11,410 (50.8) | 12,755 (56.7) | 13,975 (62.2) | 15,600 (69.4) | 22,820 (101.5) | 25,515 (113.5) | 27,950 (124.3) | 31,205 (138.8) |
| | 9-13/16 (250) | 22,620 (100.6) | 23,915 (106.4) | 25,030 (111.3) | 26,900 (119.7) | 45,240 (201.2) | 47,835 (212.8) | 50,065 (222.7) | 53,800 (239.3) |
| | 12-5/8 (320) | 28,950 (128.8) | 30,615 (136.2) | 32,040 (142.5) | 34,430 (153.2) | 57,905 (257.6) | 61,225 (272.3) | 64,080 (285.1) | 68,860 (306.3) |
| 20M[10] | 7-7/8 (200) | 18,485 (82.2) | 20,665 (91.9) | 22,640 (100.7) | 25,770 (114.6) | 36,965 (164.4) | 41,330 (183.8) | 45,275 (201.4) | 51,540 (229.3) |
| | 14 (355) | 38,460 (171.1) | 40,670 (180.9) | 42,565 (189.3) | 45,740 (203.5) | 76,925 (342.2) | 81,340 (361.8) | 85,130 (378.7) | 91,480 (406.9) |
| | 15-3/8 (390) | 42,255 (188.0) | 44,680 (198.7) | 46,760 (208.0) | 50,250 (223.5) | 84,510 (375.9) | 89,355 (397.5) | 93,525 (416.0) | 100,500 (447.0) |
| 25M | 9-1/16 (230) | 22,795 (101.4) | 25,485 (113.4) | 27,920 (124.2) | 32,235 (143.4) | 45,590 (202.8) | 50,970 (226.7) | 55,835 (248.4) | 64,475 (286.8) |
| | 15-15/16 (405) | 53,265 (236.9) | 58,540 (260.4) | 61,270 (272.5) | 65,840 (292.9) | 106,525 (473.9) | 117,080 (520.8) | 122,540 (545.1) | 131,680 (585.7) |
| | 19-13/16 (504) | 68,895 (306.5) | 72,850 (324.1) | 76,245 (339.2) | 81,935 (364.5) | 137,795 (612.9) | 145,700 (648.1) | 152,495 (678.3) | 163,865 (728.9) |
| 30M | 10-1/4 (260) | 27,395 (121.9) | 30,630 (136.3) | 33,555 (149.3) | 38,745 (172.3) | 54,795 (243.7) | 61,260 (272.5) | 67,110 (298.5) | 77,490 (344.7) |
| | 17-15/16 (455) | 63,425 (282.1) | 70,910 (315.4) | 77,680 (345.5) | 85,635 (380.9) | 126,850 (564.3) | 141,825 (630.9) | 155,360 (691.1) | 171,270 (761.8) |
| | 23-9/16 (598) | 94,640 (421.0) | 100,070 (445.1) | 104,740 (465.9) | 112,550 (500.6) | 189,285 (842.0) | 200,145 (890.3) | 209,475 (931.8) | 225,100 (1001.3) |

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 61-70 as necessary to the above values. Compare to the steel values in table 53. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete and water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.45.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. For diamond core drilling, except as indicated in note 10, multiply above values by 0.48.
Diamond core drilling is not permitted for the water-filled or under-water (submerged) applications.

10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 15M and 20M diameter anchors for dry and water-saturated concrete conditions. See Table 59.

11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 57 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete/bond failure for CA rebar in cracked concrete[1,2,3,4,5,6,7,8,9]

| Rebar size | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 10M | 4-1/2 (115) | 5,640 (25.1) | 5,920 (26.3) | 6,080 (27.1) | 6,350 (28.2) | 11,285 (50.2) | 11,835 (52.7) | 12,165 (54.1) | 12,700 (56.5) |
| | 7-1/16 (180) | 8,960 (39.8) | 9,265 (41.2) | 9,520 (42.3) | 9,940 (44.2) | 17,915 (79.7) | 18,525 (82.4) | 19,040 (84.7) | 19,880 (88.4) |
| | 8-7/8 (226) | 11,250 (50.0) | 11,630 (51.7) | 11,955 (53.2) | 12,480 (55.5) | 22,495 (100.1) | 23,260 (103.5) | 23,905 (106.3) | 24,960 (111.0) |
| 15M[10] | 5-11/16 (145) | 7,985 (35.5) | 8,930 (39.7) | 9,780 (43.5) | 11,295 (50.2) | 15,975 (71.1) | 17,860 (79.4) | 19,565 (87.0) | 22,590 (100.5) |
| | 9-13/16 (250) | 18,005 (80.1) | 18,620 (82.8) | 19,135 (85.1) | 19,980 (88.9) | 36,010 (160.2) | 37,235 (165.6) | 38,270 (170.2) | 39,955 (177.7) |
| | 12-5/8 (320) | 23,045 (102.5) | 23,830 (106.0) | 24,495 (108.9) | 25,575 (113.8) | 46,095 (205.0) | 47,665 (212.0) | 48,985 (217.9) | 51,145 (227.5) |
| 20M[10] | 7-7/8 (200) | 12,940 (57.6) | 14,465 (64.3) | 15,845 (70.5) | 18,300 (81.4) | 25,875 (115.1) | 28,930 (128.7) | 31,695 (141.0) | 36,595 (162.8) |
| | 14 (355) | 30,595 (136.1) | 32,685 (145.4) | 33,590 (149.4) | 35,075 (156.0) | 61,195 (272.2) | 65,370 (290.8) | 67,185 (298.8) | 70,145 (312.0) |
| | 15-3/8 (390) | 34,725 (154.5) | 35,910 (159.7) | 36,905 (164.2) | 38,530 (171.4) | 69,450 (308.9) | 71,815 (319.5) | 73,805 (328.3) | 77,060 (342.8) |
| 25M | 9-1/16 (230) | 15,955 (71.0) | 17,840 (79.4) | 19,540 (86.9) | 22,565 (100.4) | 31,915 (142.0) | 35,680 (158.7) | 39,085 (173.9) | 45,130 (200.8) |
| | 15-15/16 (405) | 37,285 (165.8) | 41,685 (185.4) | 45,665 (203.1) | 52,075 (231.6) | 74,570 (331.7) | 83,370 (370.8) | 91,325 (406.2) | 104,150 (463.3) |
| | 19-13/16 (504) | 51,760 (230.2) | 57,870 (257.4) | 62,070 (276.1) | 64,805 (288.3) | 103,520 (460.5) | 115,735 (514.8) | 124,135 (552.2) | 129,610 (576.5) |
| 30M | 10-1/4 (260) | 19,180 (85.3) | 21,440 (95.4) | 23,490 (104.5) | 27,120 (120.6) | 38,355 (170.6) | 42,885 (190.8) | 46,975 (209.0) | 54,245 (241.3) |
| | 17-15/16 (455) | 44,400 (197.5) | 49,640 (220.8) | 54,375 (241.9) | 62,790 (279.3) | 88,795 (395.0) | 99,275 (441.6) | 108,750 (483.7) | 125,575 (558.6) |
| | 23-9/16 (598) | 66,895 (297.6) | 74,790 (332.7) | 81,930 (364.4) | 88,665 (394.4) | 133,790 (595.1) | 149,580 (665.4) | 163,860 (728.9) | 177,325 (788.8) |

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 61-70 as necessary to the above values. Compare to the steel values in table 53. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete and water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.45.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete conditions except as indicated in note 10.

10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 15M and 20M diameter anchors for dry and water-saturated concrete conditions. See Table 60.

11 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by $\alpha_{seis}$ = 0.68. See section 3.1.8 for additional information on seismic applications.

## Table 58 — Hilti HIT-RE 500 V3 adhesive design information with CA rebar in core drilled holes roughened with the TE-YRT Roughening Tool in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Rebar size | | Ref |
|---|---|---|---|---|---|---|
| | | | | 15M | 20M | A23.3-14 |
| Anchor O.D. | | $d_a$ | – | 16.0 | 19.5 | |
| Effective minimum embedment[2] | | $h_{ef}$ | – | 80 | 90 | |
| Effective maximum embedment[2] | | $h_{ef}$ | – | 320 | 390 | |
| Min. concrete thickness[2] | | $h_{min}$ | – | $2h_{ef}$ | | |
| Critical edge distance | | $c_{ac}$ | – | $h_{ef} + 2d_0$ | | |
| Minimum edge distance[3] | | $c_{min}$ | – | 80 | 98 | |
| Minimum anchor spacing | | $s_{min}$ | – | 80 | 98 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete[4] | | $k_{c,uncr}$ | – | 10 | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete[4] | | $k_{c,cr}$ | – | 7 | | D.6.2.2 |
| Concrete material resistance factor | | ϕc | – | 0.65 | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | D.5.3 (c ) |
| Dry concrete and water saturated concrete | | | | | | |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 970 (6.7) | 985 (6.8) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,720 (11.9) | 1,690 (11.7) | D.6.5.2 |
| Temp. range B[8] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 670 (4.6) | 680 (4.7) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,190 (8.2) | 1,170 (8.1) | D.6.5.2 |
| Anchor category, dry concrete | | - | - | 1 | 1 | D.5.3(c) |
| Resistance modification factor | | $R_{dry}$ | - | 1.00 | 1.00 | |
| Reduction for Seismic Tension | | $\alpha_{N,seis}$ | - | 0.90 | 0.90 | |

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, table 23 and 25A, and converted for use with CSA A23.3 Annex D.

2 See figure 2 of section 3.2.4.3.4.

3 Minimum edge distance may be reduced to 45mm provided rebar remains untorqued. See ESR-3814 section 4.1.9.

4 For all design cases, ψc,N = 1.0. The appropriate coefficient for breakout resistance for cracked concrete (kc,cr) or uncracked concrete (kc,uncr) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C). Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond stress values correspond to concrete compressive strength in the range 2,500 psi ≤ f'c ≤ 8,000 psi.

8 For structures assigned to Seismic Design Categories C, D, E, or F, bond stress values must be multiplied by $\alpha_{N,seis}$.

## Table 59 — Hilti HIT-RE 500 V3 adhesive factored resistance for core drilled holes roughened with Hilti TE-YRT roughening tool with concrete / bond failure for CA rebar in uncracked concrete[1,2,3,4,5,6,7,8,9]

| Rebar size | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 15M | 5-11/16 (145) | 11,410 (50.8) | 12,635 (56.2) | 12,635 (56.2) | 12,635 (56.2) | 22,820 (101.5) | 25,265 (112.4) | 25,265 (112.4) | 25,265 (112.4) |
| | 9-13/16 (250) | 21,780 (96.9) | 21,780 (96.9) | 21,780 (96.9) | 21,780 (96.9) | 43,565 (193.8) | 43,565 (193.8) | 43,565 (193.8) | 43,565 (193.8) |
| | 12-5/8 (320) | 27,880 (124.0) | 27,880 (124.0) | 27,880 (124.0) | 27,880 (124.0) | 55,760 (248.0) | 55,760 (248.0) | 55,760 (248.0) | 55,760 (248.0) |
| 20M | 7-7/8 (200) | 18,485 (82.2) | 20,665 (91.9) | 20,865 (92.8) | 20,865 (92.8) | 36,965 (164.4) | 41,330 (183.8) | 41,735 (185.6) | 41,735 (185.6) |
| | 14 (355) | 37,040 (164.8) | 37,040 (164.8) | 37,040 (164.8) | 37,040 (164.8) | 74,080 (329.5) | 74,080 (329.5) | 74,080 (329.5) | 74,080 (329.5) |
| | 15-3/8 (390) | 40,690 (181.0) | 40,690 (181.0) | 40,690 (181.0) | 40,690 (181.0) | 81,380 (362.0) | 81,380 (362.0) | 81,380 (362.0) | 81,380 (362.0) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 61-70 as necessary to the above values. Compare to the steel values in table 53. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C). For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete or water-saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.51. For all lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 60 — Hilti HIT-RE 500 V3 adhesive factored resistance for core drilled holes roughened with Hilti TE-YRT roughening tool with concrete / bond failure for CA rebar in cracked concrete[1,2,3,4,5,6,7,8,9]

| Rebar size | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 15M | 5-11/16 (145) | 7,125 (31.7) | 7,125 (31.7) | 7,125 (31.7) | 7,125 (31.7) | 14,250 (63.4) | 14,250 (63.4) | 14,250 (63.4) | 14,250 (63.4) |
| | 9-13/16 (250) | 12,285 (54.6) | 12,285 (54.6) | 12,285 (54.6) | 12,285 (54.6) | 24,570 (109.3) | 24,570 (109.3) | 24,570 (109.3) | 24,570 (109.3) |
| | 12-5/8 (320) | 15,725 (69.9) | 15,725 (69.9) | 15,725 (69.9) | 15,725 (69.9) | 31,445 (139.9) | 31,445 (139.9) | 31,445 (139.9) | 31,445 (139.9) |
| 20M | 7-7/8 (200) | 12,160 (54.1) | 12,160 (54.1) | 12,160 (54.1) | 12,160 (54.1) | 24,325 (108.2) | 24,325 (108.2) | 24,325 (108.2) | 24,325 (108.2) |
| | 14 (355) | 21,590 (96.0) | 21,590 (96.0) | 21,590 (96.0) | 21,590 (96.0) | 43,175 (192.1) | 43,175 (192.1) | 43,175 (192.1) | 43,175 (192.1) |
| | 15-3/8 (390) | 23,715 (105.5) | 23,715 (105.5) | 23,715 (105.5) | 23,715 (105.5) | 47,435 (211.0) | 47,435 (211.0) | 47,435 (211.0) | 47,435 (211.0) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 61-70 as necessary to the above values. Compare to the steel values in table 53. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C). For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete or water-saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method. Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by $\alpha_{seis}$ = 0.675. See section 3.1.8 for additional information on seismic applications.

## Table 61 — Load adjustment factors for 10M rebar in uncracked concrete[1,2,3]

| 10M Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-8/9 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.24 | 0.15 | 0.12 | n/a | n/a | n/a | 0.06 | 0.04 | 0.03 | 0.11 | 0.07 | 0.06 | n/a | n/a | n/a |
| | 2-3/16 | (55) | 0.58 | 0.55 | 0.54 | 0.26 | 0.16 | 0.13 | 0.53 | 0.52 | 0.52 | 0.08 | 0.05 | 0.04 | 0.15 | 0.10 | 0.08 | n/a | n/a | n/a |
| | 3 | (76) | 0.61 | 0.57 | 0.56 | 0.30 | 0.19 | 0.15 | 0.54 | 0.53 | 0.53 | 0.12 | 0.08 | 0.06 | 0.25 | 0.16 | 0.13 | n/a | n/a | n/a |
| | 4 | (102) | 0.65 | 0.59 | 0.57 | 0.35 | 0.22 | 0.17 | 0.56 | 0.54 | 0.54 | 0.19 | 0.12 | 0.10 | 0.35 | 0.22 | 0.17 | n/a | n/a | n/a |
| | 5 | (127) | 0.68 | 0.62 | 0.59 | 0.41 | 0.25 | 0.20 | 0.57 | 0.55 | 0.54 | 0.27 | 0.17 | 0.14 | 0.41 | 0.25 | 0.20 | n/a | n/a | n/a |
| | 5-11/16 | (145) | 0.71 | 0.63 | 0.61 | 0.45 | 0.28 | 0.22 | 0.58 | 0.56 | 0.55 | 0.33 | 0.21 | 0.17 | 0.45 | 0.28 | 0.22 | 0.56 | n/a | n/a |
| | 6 | (152) | 0.72 | 0.64 | 0.61 | 0.47 | 0.29 | 0.23 | 0.58 | 0.56 | 0.55 | 0.35 | 0.22 | 0.18 | 0.47 | 0.29 | 0.23 | 0.58 | n/a | n/a |
| | 7 | (178) | 0.76 | 0.66 | 0.63 | 0.54 | 0.34 | 0.27 | 0.60 | 0.57 | 0.56 | 0.44 | 0.28 | 0.23 | 0.54 | 0.34 | 0.27 | 0.62 | n/a | n/a |
| | 8 | (203) | 0.79 | 0.69 | 0.65 | 0.62 | 0.38 | 0.30 | 0.61 | 0.58 | 0.57 | 0.54 | 0.35 | 0.28 | 0.62 | 0.38 | 0.30 | 0.67 | n/a | n/a |
| | 8-1/4 | (210) | 0.80 | 0.69 | 0.65 | 0.64 | 0.40 | 0.31 | 0.61 | 0.58 | 0.57 | 0.57 | 0.36 | 0.29 | 0.64 | 0.40 | 0.31 | 0.68 | 0.58 | n/a |
| | 9 | (229) | 0.83 | 0.71 | 0.67 | 0.70 | 0.43 | 0.34 | 0.62 | 0.59 | 0.58 | 0.65 | 0.41 | 0.33 | 0.70 | 0.43 | 0.34 | 0.71 | 0.61 | n/a |
| | 10-1/16 | (256) | 0.87 | 0.74 | 0.69 | 0.78 | 0.48 | 0.38 | 0.64 | 0.60 | 0.59 | 0.76 | 0.49 | 0.39 | 0.78 | 0.48 | 0.38 | 0.75 | 0.64 | 0.60 |
| | 11 | (279) | 0.90 | 0.76 | 0.71 | 0.85 | 0.53 | 0.42 | 0.65 | 0.61 | 0.60 | 0.87 | 0.56 | 0.44 | 0.85 | 0.53 | 0.42 | 0.78 | 0.67 | 0.62 |
| | 12 | (305) | 0.94 | 0.78 | 0.72 | 0.93 | 0.58 | 0.45 | 0.67 | 0.62 | 0.61 | 0.99 | 0.63 | 0.51 | 0.93 | 0.58 | 0.45 | 0.81 | 0.70 | 0.65 |
| | 14 | (356) | 1.00 | 0.83 | 0.76 | 1.00 | 0.67 | 0.53 | 0.69 | 0.64 | 0.62 | 1.00 | 0.80 | 0.64 | 1.00 | 0.67 | 0.53 | 0.88 | 0.76 | 0.70 |
| | 16 | (406) | | 0.88 | 0.80 | | 0.77 | 0.61 | 0.72 | 0.66 | 0.64 | | 0.98 | 0.78 | | 0.77 | 0.61 | 0.94 | 0.81 | 0.75 |
| | 18 | (457) | | 0.92 | 0.84 | | 0.87 | 0.68 | 0.75 | 0.68 | 0.66 | | 1.00 | 0.93 | | 0.87 | 0.68 | 1.00 | 0.86 | 0.80 |
| | 24 | (610) | | 1.00 | 0.95 | | 1.00 | 0.91 | 0.83 | 0.75 | 0.71 | | | 1.00 | | 1.00 | 0.91 | | 0.99 | 0.92 |
| | 30 | (762) | | | 1.00 | | | 1.00 | 0.91 | 0.81 | 0.76 | | | | | | 1.00 | | 1.00 | 1.00 |
| | 36 | (914) | | | | | | | 1.00 | 0.87 | 0.82 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | 0.99 | 0.92 | | | | | | | | | |

## Table 62 — Load adjustment factors for 10M rebar in cracked concrete[1,2,3]

| 10M Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-8/9 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.49 | 0.44 | 0.42 | n/a | n/a | n/a | 0.05 | 0.03 | 0.03 | 0.10 | 0.07 | 0.05 | n/a | n/a | n/a |
| | 2-3/16 | (55) | 0.58 | 0.55 | 0.54 | 0.52 | 0.46 | 0.43 | 0.53 | 0.52 | 0.52 | 0.07 | 0.04 | 0.04 | 0.14 | 0.09 | 0.07 | n/a | n/a | n/a |
| | 3 | (76) | 0.61 | 0.57 | 0.56 | 0.60 | 0.50 | 0.47 | 0.54 | 0.53 | 0.53 | 0.11 | 0.07 | 0.06 | 0.23 | 0.15 | 0.12 | n/a | n/a | n/a |
| | 4 | (102) | 0.65 | 0.59 | 0.57 | 0.70 | 0.56 | 0.51 | 0.55 | 0.54 | 0.53 | 0.18 | 0.11 | 0.09 | 0.35 | 0.23 | 0.18 | n/a | n/a | n/a |
| | 5 | (127) | 0.68 | 0.62 | 0.59 | 0.80 | 0.62 | 0.56 | 0.57 | 0.55 | 0.54 | 0.25 | 0.16 | 0.13 | 0.49 | 0.32 | 0.25 | n/a | n/a | n/a |
| | 5-11/16 | (145) | 0.71 | 0.63 | 0.61 | 0.88 | 0.66 | 0.59 | 0.57 | 0.56 | 0.55 | 0.30 | 0.19 | 0.15 | 0.60 | 0.39 | 0.31 | 0.55 | n/a | n/a |
| | 6 | (152) | 0.72 | 0.64 | 0.61 | 0.91 | 0.68 | 0.61 | 0.58 | 0.56 | 0.55 | 0.32 | 0.21 | 0.17 | 0.65 | 0.41 | 0.33 | 0.56 | n/a | n/a |
| | 7 | (178) | 0.76 | 0.66 | 0.63 | 1.00 | 0.74 | 0.65 | 0.59 | 0.57 | 0.56 | 0.41 | 0.26 | 0.21 | 0.82 | 0.52 | 0.42 | 0.61 | n/a | n/a |
| | 8 | (203) | 0.79 | 0.69 | 0.65 | | 0.81 | 0.70 | 0.60 | 0.58 | 0.57 | 0.50 | 0.32 | 0.25 | 1.00 | 0.64 | 0.51 | 0.65 | n/a | n/a |
| | 8-1/4 | (210) | 0.80 | 0.69 | 0.65 | | 0.83 | 0.72 | 0.61 | 0.58 | 0.57 | 0.53 | 0.34 | 0.27 | | 0.67 | 0.53 | 0.66 | 0.57 | n/a |
| | 9 | (229) | 0.83 | 0.71 | 0.67 | | 0.88 | 0.76 | 0.62 | 0.59 | 0.58 | 0.60 | 0.38 | 0.30 | | 0.76 | 0.61 | 0.69 | 0.59 | n/a |
| | 10-1/16 | (256) | 0.87 | 0.74 | 0.69 | | 0.96 | 0.81 | 0.63 | 0.60 | 0.58 | 0.71 | 0.45 | 0.36 | | 0.90 | 0.72 | 0.73 | 0.63 | 0.58 |
| | 11 | (279) | 0.90 | 0.76 | 0.71 | | 1.00 | 0.86 | 0.64 | 0.61 | 0.59 | 0.81 | 0.51 | 0.41 | | 1.00 | 0.82 | 0.76 | 0.65 | 0.61 |
| | 12 | (305) | 0.94 | 0.78 | 0.72 | | | 0.92 | 0.66 | 0.62 | 0.60 | 0.92 | 0.59 | 0.47 | | | 0.92 | 0.79 | 0.68 | 0.63 |
| | 14 | (356) | 1.00 | 0.83 | 0.76 | | | 1.00 | 0.68 | 0.64 | 0.62 | 1.00 | 0.74 | 0.59 | | | 1.00 | 0.86 | 0.74 | 0.68 |
| | 16 | (406) | | 0.88 | 0.80 | | | | 0.71 | 0.66 | 0.63 | | 0.90 | 0.72 | | | | 0.92 | 0.79 | 0.73 |
| | 18 | (457) | | 0.92 | 0.84 | | | | 0.74 | 0.68 | 0.65 | | 1.00 | 0.86 | | | | 0.97 | 0.84 | 0.78 |
| | 24 | (610) | | 1.00 | 0.95 | | | | 0.81 | 0.73 | 0.70 | | | 1.00 | | | | 1.00 | 0.97 | 0.90 |
| | 30 | (762) | | | 1.00 | | | | 0.89 | 0.79 | 0.75 | | | | | | | | 1.00 | 1.00 |
| | 36 | (914) | | | | | | | 0.97 | 0.85 | 0.80 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | 1.00 | 0.97 | 0.90 | | | | | | | | | |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 63 — Load adjustment factors for 15M rebar in uncracked concrete[1,2,3]

| 15M Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.24 | 0.14 | 0.11 | n/a | n/a | n/a | 0.04 | 0.02 | 0.02 | 0.08 | 0.04 | 0.03 | n/a | n/a | n/a |
| | 3-1/8 | (80) | 0.59 | 0.55 | 0.54 | 0.29 | 0.17 | 0.13 | 0.54 | 0.52 | 0.52 | 0.10 | 0.05 | 0.04 | 0.20 | 0.11 | 0.08 | n/a | n/a | n/a |
| | 4 | (102) | 0.61 | 0.57 | 0.55 | 0.33 | 0.19 | 0.14 | 0.55 | 0.53 | 0.53 | 0.14 | 0.08 | 0.06 | 0.29 | 0.15 | 0.12 | n/a | n/a | n/a |
| | 5 | (127) | 0.64 | 0.58 | 0.57 | 0.37 | 0.21 | 0.16 | 0.56 | 0.54 | 0.53 | 0.20 | 0.11 | 0.08 | 0.37 | 0.21 | 0.16 | n/a | n/a | n/a |
| | 6 | (152) | 0.67 | 0.60 | 0.58 | 0.41 | 0.23 | 0.18 | 0.57 | 0.54 | 0.54 | 0.27 | 0.14 | 0.11 | 0.41 | 0.23 | 0.18 | n/a | n/a | n/a |
| | 7 | (178) | 0.70 | 0.62 | 0.59 | 0.46 | 0.26 | 0.20 | 0.58 | 0.55 | 0.54 | 0.33 | 0.18 | 0.14 | 0.46 | 0.26 | 0.20 | n/a | n/a | n/a |
| | 7-1/4 | (184) | 0.71 | 0.62 | 0.60 | 0.47 | 0.26 | 0.20 | 0.58 | 0.55 | 0.55 | 0.35 | 0.18 | 0.14 | 0.47 | 0.26 | 0.20 | 0.58 | n/a | n/a |
| | 8 | (203) | 0.73 | 0.64 | 0.61 | 0.50 | 0.28 | 0.22 | 0.59 | 0.56 | 0.55 | 0.41 | 0.21 | 0.17 | 0.50 | 0.28 | 0.22 | 0.61 | n/a | n/a |
| | 9 | (229) | 0.76 | 0.65 | 0.62 | 0.56 | 0.31 | 0.24 | 0.60 | 0.57 | 0.56 | 0.49 | 0.26 | 0.20 | 0.56 | 0.31 | 0.24 | 0.64 | n/a | n/a |
| | 10 | (254) | 0.78 | 0.67 | 0.63 | 0.62 | 0.35 | 0.27 | 0.61 | 0.57 | 0.56 | 0.57 | 0.30 | 0.23 | 0.62 | 0.35 | 0.27 | 0.68 | n/a | n/a |
| | 11-3/8 | (289) | 0.82 | 0.69 | 0.65 | 0.71 | 0.40 | 0.31 | 0.63 | 0.58 | 0.57 | 0.69 | 0.36 | 0.28 | 0.71 | 0.40 | 0.31 | 0.72 | 0.58 | n/a |
| | 12 | (305) | 0.84 | 0.70 | 0.66 | 0.74 | 0.42 | 0.32 | 0.64 | 0.59 | 0.58 | 0.75 | 0.39 | 0.31 | 0.74 | 0.42 | 0.32 | 0.74 | 0.60 | n/a |
| | 14-1/8 | (359) | 0.90 | 0.74 | 0.69 | 0.88 | 0.49 | 0.38 | 0.66 | 0.61 | 0.59 | 0.96 | 0.50 | 0.39 | 0.88 | 0.49 | 0.38 | 0.81 | 0.65 | 0.60 |
| | 16 | (406) | 0.96 | 0.77 | 0.71 | 0.99 | 0.56 | 0.43 | 0.68 | 0.62 | 0.60 | 1.00 | 0.61 | 0.47 | 0.99 | 0.56 | 0.43 | 0.86 | 0.69 | 0.64 |
| | 18 | (457) | 1.00 | 0.80 | 0.74 | 1.00 | 0.63 | 0.48 | 0.71 | 0.63 | 0.61 | | 0.72 | 0.56 | 1.00 | 0.63 | 0.48 | 0.91 | 0.73 | 0.67 |
| | 20 | (508) | | 0.84 | 0.76 | | 0.70 | 0.54 | 0.73 | 0.65 | 0.63 | | 0.85 | 0.66 | | 0.70 | 0.54 | 0.96 | 0.77 | 0.71 |
| | 22 | (559) | | 0.87 | 0.79 | | 0.77 | 0.59 | 0.75 | 0.66 | 0.64 | | 0.98 | 0.76 | | 0.77 | 0.59 | 1.00 | 0.81 | 0.75 |
| | 24 | (610) | | 0.91 | 0.82 | | 0.83 | 0.65 | 0.78 | 0.68 | 0.65 | | 1.00 | 0.87 | | 0.83 | 0.65 | | 0.85 | 0.78 |
| | 30 | (762) | | 1.00 | 0.90 | | 1.00 | 0.81 | 0.84 | 0.72 | 0.69 | | | 1.00 | | 1.00 | 0.81 | | 0.95 | 0.87 |
| | 36 | (914) | | | 0.98 | | | 0.97 | 0.91 | 0.77 | 0.73 | | | | | | 0.97 | | 1.00 | 0.95 |
| | > 48 | (1219) | | | 1.00 | | | 1.00 | 1.00 | 0.86 | 0.80 | | | | | | 1.00 | | | 1.00 |

## Table 64 — Load adjustment factors for 15M rebar in cracked concrete[1,2,3]

| 15M Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) | 5-11/16 (145) | 9-13/16 (250) | 12-5/8 (320) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.46 | 0.41 | 0.40 | n/a | n/a | n/a | 0.04 | 0.02 | 0.02 | 0.09 | 0.04 | 0.03 | n/a | n/a | n/a |
| | 3-1/8 | (80) | 0.59 | 0.55 | 0.54 | 0.55 | 0.46 | 0.44 | 0.54 | 0.52 | 0.52 | 0.10 | 0.05 | 0.04 | 0.21 | 0.09 | 0.07 | n/a | n/a | n/a |
| | 4 | (102) | 0.61 | 0.57 | 0.55 | 0.61 | 0.50 | 0.46 | 0.55 | 0.53 | 0.52 | 0.15 | 0.07 | 0.05 | 0.29 | 0.13 | 0.10 | n/a | n/a | n/a |
| | 5 | (127) | 0.64 | 0.58 | 0.57 | 0.68 | 0.54 | 0.49 | 0.56 | 0.53 | 0.53 | 0.21 | 0.09 | 0.07 | 0.41 | 0.19 | 0.15 | n/a | n/a | n/a |
| | 6 | (152) | 0.67 | 0.60 | 0.58 | 0.76 | 0.58 | 0.52 | 0.57 | 0.54 | 0.53 | 0.27 | 0.12 | 0.10 | 0.54 | 0.25 | 0.19 | n/a | n/a | n/a |
| | 7 | (178) | 0.70 | 0.62 | 0.59 | 0.84 | 0.62 | 0.56 | 0.58 | 0.55 | 0.54 | 0.34 | 0.15 | 0.12 | 0.68 | 0.31 | 0.24 | n/a | n/a | n/a |
| | 7-1/4 | (184) | 0.71 | 0.62 | 0.60 | 0.86 | 0.63 | 0.56 | 0.58 | 0.55 | 0.54 | 0.36 | 0.16 | 0.13 | 0.72 | 0.33 | 0.25 | 0.58 | n/a | n/a |
| | 8 | (203) | 0.73 | 0.64 | 0.61 | 0.93 | 0.66 | 0.59 | 0.59 | 0.55 | 0.55 | 0.42 | 0.19 | 0.15 | 0.83 | 0.38 | 0.30 | 0.61 | n/a | n/a |
| | 9 | (229) | 0.76 | 0.65 | 0.62 | 1.00 | 0.71 | 0.62 | 0.60 | 0.56 | 0.55 | 0.50 | 0.23 | 0.18 | 0.99 | 0.45 | 0.35 | 0.65 | n/a | n/a |
| | 10 | (254) | 0.78 | 0.67 | 0.63 | | 0.76 | 0.66 | 0.62 | 0.57 | 0.56 | 0.58 | 0.26 | 0.21 | 1.00 | 0.53 | 0.41 | 0.68 | n/a | n/a |
| | 11-3/8 | (289) | 0.82 | 0.69 | 0.65 | | 0.82 | 0.71 | 0.63 | 0.58 | 0.57 | 0.71 | 0.32 | 0.25 | | 0.64 | 0.50 | 0.73 | 0.56 | n/a |
| | 12 | (305) | 0.84 | 0.70 | 0.66 | | 0.86 | 0.73 | 0.64 | 0.58 | 0.57 | 0.77 | 0.35 | 0.27 | | 0.69 | 0.54 | 0.75 | 0.57 | n/a |
| | 14-1/8 | (359) | 0.90 | 0.74 | 0.69 | | 0.97 | 0.81 | 0.66 | 0.60 | 0.58 | 0.98 | 0.44 | 0.35 | | 0.89 | 0.69 | 0.81 | 0.62 | 0.57 |
| | 16 | (406) | 0.96 | 0.77 | 0.71 | | 1.00 | 0.88 | 0.69 | 0.61 | 0.59 | 1.00 | 0.53 | 0.42 | | 1.00 | 0.84 | 0.86 | 0.66 | 0.61 |
| | 18 | (457) | 1.00 | 0.80 | 0.74 | | | 0.96 | 0.71 | 0.62 | 0.60 | | 0.64 | 0.50 | | | 0.96 | 0.91 | 0.70 | 0.65 |
| | 20 | (508) | | 0.84 | 0.76 | | | 1.00 | 0.73 | 0.64 | 0.62 | | 0.75 | 0.58 | | | 1.00 | 0.96 | 0.74 | 0.68 |
| | 22 | (559) | | 0.87 | 0.79 | | | | 0.76 | 0.65 | 0.63 | | 0.86 | 0.67 | | | | 1.00 | 0.78 | 0.72 |
| | 24 | (610) | | 0.91 | 0.82 | | | | 0.78 | 0.66 | 0.64 | | 0.98 | 0.77 | | | | | 0.81 | 0.75 |
| | 30 | (762) | | 1.00 | 0.90 | | | | 0.85 | 0.71 | 0.67 | | 1.00 | 1.00 | | | | | 0.91 | 0.84 |
| | 36 | (914) | | | 0.98 | | | | 0.92 | 0.75 | 0.71 | | | | | | | | 0.99 | 0.92 |
| | > 48 | (1219) | | | 1.00 | | | | 1.00 | 0.83 | 0.78 | | | | | | | | 1.00 | 1.00 |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 65 — Load adjustment factors for 20M rebar in uncracked concrete[1,2,3]

| 20M Rebar uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 |
| in. | (mm) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) |
| 1-3/4 | (44) | n/a | n/a | n/a | 0.21 | 0.11 | 0.10 | n/a | n/a | n/a | 0.03 | 0.01 | 0.01 | 0.06 | 0.03 | 0.02 | n/a | n/a | n/a |
| 3-7/8 | (98) | 0.58 | 0.55 | 0.54 | 0.26 | 0.14 | 0.13 | 0.53 | 0.52 | 0.52 | 0.09 | 0.04 | 0.04 | 0.18 | 0.09 | 0.08 | n/a | n/a | n/a |
| 4 | (102) | 0.58 | 0.55 | 0.54 | 0.27 | 0.15 | 0.13 | 0.53 | 0.52 | 0.52 | 0.10 | 0.05 | 0.04 | 0.19 | 0.09 | 0.09 | n/a | n/a | n/a |
| 5 | (127) | 0.61 | 0.56 | 0.55 | 0.30 | 0.16 | 0.15 | 0.54 | 0.53 | 0.53 | 0.13 | 0.07 | 0.06 | 0.27 | 0.13 | 0.12 | n/a | n/a | n/a |
| 6 | (152) | 0.63 | 0.57 | 0.57 | 0.33 | 0.18 | 0.16 | 0.55 | 0.53 | 0.53 | 0.17 | 0.09 | 0.08 | 0.33 | 0.17 | 0.16 | n/a | n/a | n/a |
| 7 | (178) | 0.65 | 0.58 | 0.58 | 0.36 | 0.19 | 0.18 | 0.56 | 0.54 | 0.54 | 0.22 | 0.11 | 0.10 | 0.36 | 0.19 | 0.18 | n/a | n/a | n/a |
| 8 | (203) | 0.67 | 0.60 | 0.59 | 0.39 | 0.21 | 0.19 | 0.57 | 0.54 | 0.54 | 0.27 | 0.13 | 0.12 | 0.39 | 0.21 | 0.19 | n/a | n/a | n/a |
| 9 | (229) | 0.69 | 0.61 | 0.60 | 0.42 | 0.23 | 0.21 | 0.58 | 0.55 | 0.55 | 0.32 | 0.16 | 0.15 | 0.42 | 0.23 | 0.21 | n/a | n/a | n/a |
| 10 | (254) | 0.71 | 0.62 | 0.61 | 0.46 | 0.25 | 0.23 | 0.59 | 0.55 | 0.55 | 0.38 | 0.19 | 0.17 | 0.46 | 0.25 | 0.23 | 0.59 | n/a | n/a |
| 11 | (279) | 0.73 | 0.63 | 0.62 | 0.50 | 0.27 | 0.25 | 0.60 | 0.56 | 0.56 | 0.43 | 0.22 | 0.20 | 0.50 | 0.27 | 0.25 | 0.62 | n/a | n/a |
| 12 | (305) | 0.75 | 0.64 | 0.63 | 0.54 | 0.30 | 0.27 | 0.60 | 0.57 | 0.56 | 0.49 | 0.25 | 0.22 | 0.54 | 0.30 | 0.27 | 0.65 | n/a | n/a |
| 14 | (356) | 0.80 | 0.67 | 0.65 | 0.63 | 0.34 | 0.31 | 0.62 | 0.58 | 0.57 | 0.62 | 0.31 | 0.28 | 0.63 | 0.34 | 0.31 | 0.70 | n/a | n/a |
| 16 | (406) | 0.84 | 0.69 | 0.67 | 0.72 | 0.39 | 0.36 | 0.64 | 0.59 | 0.58 | 0.76 | 0.38 | 0.34 | 0.72 | 0.39 | 0.36 | 0.74 | 0.59 | n/a |
| 18 | (457) | 0.88 | 0.71 | 0.70 | 0.81 | 0.44 | 0.40 | 0.66 | 0.60 | 0.59 | 0.91 | 0.45 | 0.41 | 0.81 | 0.44 | 0.40 | 0.79 | 0.63 | 0.61 |
| 20 | (508) | 0.92 | 0.74 | 0.72 | 0.90 | 0.49 | 0.45 | 0.67 | 0.61 | 0.60 | 1.00 | 0.53 | 0.48 | 0.90 | 0.49 | 0.45 | 0.83 | 0.66 | 0.64 |
| 22 | (559) | 0.97 | 0.76 | 0.74 | 0.99 | 0.54 | 0.49 | 0.69 | 0.62 | 0.61 | | 0.61 | 0.56 | 0.99 | 0.54 | 0.49 | 0.87 | 0.69 | 0.67 |
| 24 | (610) | 1.00 | 0.79 | 0.76 | 1.00 | 0.59 | 0.54 | 0.71 | 0.63 | 0.62 | | 0.70 | 0.63 | 1.00 | 0.59 | 0.54 | 0.91 | 0.72 | 0.70 |
| 26 | (660) | | 0.81 | 0.78 | | 0.64 | 0.58 | 0.73 | 0.64 | 0.63 | | 0.79 | 0.72 | | 0.64 | 0.58 | 0.95 | 0.75 | 0.73 |
| 28 | (711) | | 0.83 | 0.80 | | 0.69 | 0.62 | 0.74 | 0.65 | 0.64 | | 0.88 | 0.80 | | 0.69 | 0.62 | 0.99 | 0.78 | 0.76 |
| 30 | (762) | | 0.86 | 0.83 | | 0.74 | 0.67 | 0.76 | 0.66 | 0.65 | | 0.97 | 0.89 | | 0.74 | 0.67 | 1.00 | 0.81 | 0.78 |
| 36 | (914) | | 0.93 | 0.89 | | 0.89 | 0.80 | 0.81 | 0.70 | 0.68 | | 1.00 | 1.00 | | 0.89 | 0.80 | | 0.89 | 0.86 |
| > 48 | (1219) | | 1.00 | 1.00 | | 1.00 | 1.00 | 0.92 | 0.76 | 0.75 | | | | | 1.00 | 1.00 | | 1.00 | 0.99 |

Spacing (s) / edge distance ($c_{al}$) / concrete thickness (h), - in. (mm)

## Table 66 — Load adjustment factors for 20M rebar in cracked concrete[1,2,3]

| 20M Rebar cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 |
| in. | (mm) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) |
| 1-3/4 | (44) | n/a | n/a | n/a | 0.43 | 0.39 | 0.39 | n/a | n/a | n/a | 0.03 | 0.01 | 0.01 | 0.06 | 0.02 | 0.02 | n/a | n/a | n/a |
| 3-7/8 | (98) | 0.58 | 0.55 | 0.54 | 0.53 | 0.45 | 0.44 | 0.53 | 0.52 | 0.52 | 0.09 | 0.04 | 0.04 | 0.18 | 0.08 | 0.07 | n/a | n/a | n/a |
| 4 | (102) | 0.58 | 0.55 | 0.54 | 0.54 | 0.45 | 0.44 | 0.54 | 0.52 | 0.52 | 0.10 | 0.04 | 0.04 | 0.19 | 0.08 | 0.07 | n/a | n/a | n/a |
| 5 | (127) | 0.61 | 0.56 | 0.55 | 0.59 | 0.48 | 0.47 | 0.54 | 0.52 | 0.52 | 0.14 | 0.06 | 0.05 | 0.27 | 0.11 | 0.10 | n/a | n/a | n/a |
| 6 | (152) | 0.63 | 0.57 | 0.57 | 0.64 | 0.51 | 0.49 | 0.55 | 0.53 | 0.53 | 0.18 | 0.08 | 0.07 | 0.36 | 0.15 | 0.14 | n/a | n/a | n/a |
| 7 | (178) | 0.65 | 0.58 | 0.58 | 0.70 | 0.53 | 0.52 | 0.56 | 0.53 | 0.53 | 0.22 | 0.09 | 0.09 | 0.45 | 0.19 | 0.17 | n/a | n/a | n/a |
| 8 | (203) | 0.67 | 0.60 | 0.59 | 0.76 | 0.56 | 0.54 | 0.57 | 0.54 | 0.54 | 0.27 | 0.12 | 0.10 | 0.55 | 0.23 | 0.21 | n/a | n/a | n/a |
| 9 | (229) | 0.69 | 0.61 | 0.60 | 0.82 | 0.59 | 0.57 | 0.58 | 0.54 | 0.54 | 0.33 | 0.14 | 0.12 | 0.65 | 0.28 | 0.25 | n/a | n/a | n/a |
| 10 | (254) | 0.71 | 0.62 | 0.61 | 0.88 | 0.62 | 0.60 | 0.59 | 0.55 | 0.55 | 0.38 | 0.16 | 0.15 | 0.77 | 0.32 | 0.29 | 0.59 | n/a | n/a |
| 11 | (279) | 0.73 | 0.63 | 0.62 | 0.95 | 0.65 | 0.62 | 0.60 | 0.55 | 0.55 | 0.44 | 0.19 | 0.17 | 0.88 | 0.37 | 0.34 | 0.62 | n/a | n/a |
| 12 | (305) | 0.75 | 0.64 | 0.63 | 1.00 | 0.69 | 0.65 | 0.61 | 0.56 | 0.56 | 0.50 | 0.21 | 0.19 | 1.00 | 0.43 | 0.38 | 0.65 | n/a | n/a |
| 14 | (356) | 0.80 | 0.67 | 0.65 | | 0.75 | 0.71 | 0.62 | 0.57 | 0.56 | 0.64 | 0.27 | 0.24 | | 0.54 | 0.48 | 0.70 | n/a | n/a |
| 16 | (406) | 0.84 | 0.69 | 0.67 | | 0.82 | 0.77 | 0.64 | 0.58 | 0.57 | 0.77 | 0.33 | 0.30 | | 0.66 | 0.59 | 0.75 | 0.56 | n/a |
| 18 | (457) | 0.88 | 0.71 | 0.70 | | 0.89 | 0.83 | 0.66 | 0.59 | 0.58 | 0.93 | 0.39 | 0.35 | | 0.78 | 0.71 | 0.80 | 0.60 | 0.58 |
| 20 | (508) | 0.92 | 0.74 | 0.72 | | 0.96 | 0.90 | 0.68 | 0.60 | 0.59 | 1.00 | 0.46 | 0.41 | | 0.92 | 0.83 | 0.84 | 0.63 | 0.61 |
| 22 | (559) | 0.97 | 0.76 | 0.74 | | 1.00 | 0.96 | 0.69 | 0.61 | 0.60 | | 0.53 | 0.48 | | 1.00 | 0.95 | 0.88 | 0.66 | 0.64 |
| 24 | (610) | 1.00 | 0.79 | 0.76 | | | 1.00 | 0.71 | 0.62 | 0.61 | | 0.60 | 0.54 | | | 1.00 | 0.92 | 0.69 | 0.67 |
| 26 | (660) | | 0.81 | 0.78 | | | | 0.73 | 0.63 | 0.62 | | 0.68 | 0.61 | | | | 0.96 | 0.72 | 0.69 |
| 28 | (711) | | 0.83 | 0.80 | | | | 0.75 | 0.64 | 0.63 | | 0.76 | 0.68 | | | | 0.99 | 0.74 | 0.72 |
| 30 | (762) | | 0.86 | 0.83 | | | | 0.76 | 0.65 | 0.64 | | 0.84 | 0.76 | | | | 1.00 | 0.77 | 0.74 |
| 36 | (914) | | 0.93 | 0.89 | | | | 0.82 | 0.68 | 0.67 | | 1.00 | 1.00 | | | | | 0.84 | 0.82 |
| > 48 | (1219) | | 1.00 | 1.00 | | | | 0.92 | 0.74 | 0.72 | | | | | | | | 0.98 | 0.94 |

Spacing (s) / edge distance ($c_{al}$) / concrete thickness (h), - in. (mm)

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 67 — Load adjustment factors for 25M rebar in uncracked concrete[1,2,3]

| 25M Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.24 | 0.12 | 0.10 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.02 | 0.02 | n/a | n/a | n/a |
| | 5 | (127) | 0.59 | 0.55 | 0.54 | 0.32 | 0.16 | 0.13 | 0.54 | 0.52 | 0.52 | 0.11 | 0.05 | 0.04 | 0.22 | 0.09 | 0.07 | n/a | n/a | n/a |
| | 6 | (152) | 0.61 | 0.56 | 0.55 | 0.34 | 0.18 | 0.14 | 0.55 | 0.53 | 0.52 | 0.14 | 0.06 | 0.05 | 0.28 | 0.12 | 0.10 | n/a | n/a | n/a |
| | 7 | (178) | 0.63 | 0.57 | 0.56 | 0.37 | 0.19 | 0.15 | 0.55 | 0.53 | 0.53 | 0.18 | 0.08 | 0.06 | 0.36 | 0.15 | 0.12 | n/a | n/a | n/a |
| | 8 | (203) | 0.65 | 0.58 | 0.57 | 0.40 | 0.21 | 0.16 | 0.56 | 0.53 | 0.53 | 0.22 | 0.09 | 0.07 | 0.40 | 0.19 | 0.15 | n/a | n/a | n/a |
| | 9 | (229) | 0.67 | 0.59 | 0.58 | 0.43 | 0.22 | 0.18 | 0.57 | 0.54 | 0.53 | 0.26 | 0.11 | 0.09 | 0.43 | 0.22 | 0.18 | n/a | n/a | n/a |
| | 10 | (254) | 0.68 | 0.60 | 0.58 | 0.46 | 0.24 | 0.19 | 0.58 | 0.54 | 0.54 | 0.30 | 0.13 | 0.10 | 0.46 | 0.24 | 0.19 | n/a | n/a | n/a |
| | 11-9/16 | (294) | 0.71 | 0.62 | 0.60 | 0.51 | 0.26 | 0.21 | 0.59 | 0.55 | 0.54 | 0.38 | 0.16 | 0.13 | 0.51 | 0.26 | 0.21 | 0.59 | n/a | n/a |
| | 12 | (305) | 0.72 | 0.63 | 0.60 | 0.52 | 0.27 | 0.21 | 0.59 | 0.55 | 0.54 | 0.40 | 0.17 | 0.14 | 0.52 | 0.27 | 0.21 | 0.60 | n/a | n/a |
| | 14 | (356) | 0.76 | 0.65 | 0.62 | 0.59 | 0.31 | 0.24 | 0.61 | 0.56 | 0.55 | 0.50 | 0.22 | 0.17 | 0.59 | 0.31 | 0.24 | 0.65 | n/a | n/a |
| | 16 | (406) | 0.79 | 0.67 | 0.63 | 0.68 | 0.35 | 0.28 | 0.62 | 0.57 | 0.56 | 0.62 | 0.26 | 0.21 | 0.68 | 0.35 | 0.28 | 0.69 | n/a | n/a |
| | 18 | (457) | 0.83 | 0.69 | 0.65 | 0.76 | 0.39 | 0.31 | 0.64 | 0.58 | 0.57 | 0.74 | 0.31 | 0.25 | 0.76 | 0.39 | 0.31 | 0.74 | n/a | n/a |
| | 18-7/16 | (469) | 0.84 | 0.69 | 0.66 | 0.78 | 0.40 | 0.32 | 0.64 | 0.58 | 0.57 | 0.76 | 0.33 | 0.26 | 0.78 | 0.40 | 0.32 | 0.75 | 0.56 | n/a |
| | 20 | (508) | 0.87 | 0.71 | 0.67 | 0.85 | 0.44 | 0.35 | 0.65 | 0.59 | 0.57 | 0.86 | 0.37 | 0.30 | 0.85 | 0.44 | 0.35 | 0.78 | 0.59 | n/a |
| | 22-3/8 | (568) | 0.91 | 0.73 | 0.69 | 0.95 | 0.49 | 0.39 | 0.67 | 0.60 | 0.58 | 1.00 | 0.44 | 0.35 | 0.95 | 0.49 | 0.39 | 0.82 | 0.62 | 0.58 |
| | 24 | (610) | 0.94 | 0.75 | 0.70 | 1.00 | 0.52 | 0.42 | 0.68 | 0.60 | 0.59 | | 0.48 | 0.39 | 1.00 | 0.52 | 0.42 | 0.85 | 0.64 | 0.60 |
| | 26 | (660) | 0.98 | 0.77 | 0.72 | | 0.57 | 0.45 | 0.70 | 0.61 | 0.60 | | 0.55 | 0.44 | | 0.57 | 0.45 | 0.89 | 0.67 | 0.62 |
| | 28 | (711) | 1.00 | 0.79 | 0.74 | | 0.61 | 0.49 | 0.71 | 0.62 | 0.60 | | 0.61 | 0.49 | | 0.61 | 0.49 | 0.92 | 0.69 | 0.64 |
| | 30 | (762) | | 0.81 | 0.75 | | 0.66 | 0.52 | 0.73 | 0.63 | 0.61 | | 0.68 | 0.54 | | 0.66 | 0.52 | 0.95 | 0.72 | 0.67 |
| | 36 | (914) | | 0.88 | 0.80 | | 0.79 | 0.63 | 0.77 | 0.65 | 0.63 | | 0.89 | 0.71 | | 0.79 | 0.63 | 1.00 | 0.79 | 0.73 |
| | > 48 | (1219) | | 1.00 | 0.90 | | 1.00 | 0.84 | 0.86 | 0.71 | 0.68 | | 1.00 | 1.00 | | 1.00 | 0.84 | | 0.91 | 0.84 |

## Table 68 — Load adjustment factors for 25M rebar in cracked concrete[1,2,3]

| 25M Rebar cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) | 9-1/16 (230) | 15-15/16 (405) | 19-13/16 (504) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.42 | 0.39 | 0.38 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.05 | 0.02 | 0.01 | n/a | n/a | n/a |
| | 5 | (127) | 0.59 | 0.55 | 0.54 | 0.55 | 0.46 | 0.44 | 0.54 | 0.52 | 0.52 | 0.11 | 0.05 | 0.03 | 0.22 | 0.09 | 0.07 | n/a | n/a | n/a |
| | 6 | (152) | 0.61 | 0.56 | 0.55 | 0.60 | 0.48 | 0.46 | 0.55 | 0.53 | 0.52 | 0.14 | 0.06 | 0.04 | 0.29 | 0.12 | 0.09 | n/a | n/a | n/a |
| | 7 | (178) | 0.63 | 0.57 | 0.56 | 0.65 | 0.51 | 0.48 | 0.55 | 0.53 | 0.52 | 0.18 | 0.08 | 0.06 | 0.36 | 0.16 | 0.11 | n/a | n/a | n/a |
| | 8 | (203) | 0.65 | 0.58 | 0.57 | 0.70 | 0.53 | 0.50 | 0.56 | 0.53 | 0.53 | 0.22 | 0.10 | 0.07 | 0.44 | 0.19 | 0.14 | n/a | n/a | n/a |
| | 9 | (229) | 0.67 | 0.59 | 0.58 | 0.75 | 0.56 | 0.51 | 0.57 | 0.54 | 0.53 | 0.27 | 0.11 | 0.08 | 0.53 | 0.23 | 0.16 | n/a | n/a | n/a |
| | 10 | (254) | 0.68 | 0.60 | 0.58 | 0.80 | 0.59 | 0.53 | 0.58 | 0.54 | 0.53 | 0.31 | 0.13 | 0.10 | 0.62 | 0.27 | 0.19 | n/a | n/a | n/a |
| | 11-9/16 | (294) | 0.71 | 0.62 | 0.60 | 0.89 | 0.63 | 0.57 | 0.59 | 0.55 | 0.54 | 0.39 | 0.17 | 0.12 | 0.77 | 0.33 | 0.24 | 0.60 | n/a | n/a |
| | 12 | (305) | 0.72 | 0.63 | 0.60 | 0.91 | 0.64 | 0.58 | 0.59 | 0.55 | 0.54 | 0.41 | 0.17 | 0.13 | 0.82 | 0.35 | 0.25 | 0.61 | n/a | n/a |
| | 14 | (356) | 0.76 | 0.65 | 0.62 | 1.00 | 0.69 | 0.62 | 0.61 | 0.56 | 0.55 | 0.51 | 0.22 | 0.16 | 1.00 | 0.44 | 0.32 | 0.65 | n/a | n/a |
| | 16 | (406) | 0.79 | 0.67 | 0.63 | | 0.75 | 0.66 | 0.62 | 0.57 | 0.56 | 0.63 | 0.27 | 0.19 | | 0.54 | 0.39 | 0.70 | n/a | n/a |
| | 18 | (457) | 0.83 | 0.69 | 0.65 | | 0.81 | 0.71 | 0.64 | 0.58 | 0.56 | 0.75 | 0.32 | 0.23 | | 0.64 | 0.46 | 0.74 | n/a | n/a |
| | 18-7/16 | (469) | 0.84 | 0.69 | 0.66 | | 0.83 | 0.72 | 0.64 | 0.58 | 0.56 | 0.78 | 0.33 | 0.24 | | 0.67 | 0.48 | 0.75 | 0.57 | n/a |
| | 20 | (508) | 0.87 | 0.71 | 0.67 | | 0.87 | 0.75 | 0.65 | 0.59 | 0.57 | 0.88 | 0.38 | 0.27 | | 0.75 | 0.54 | 0.78 | 0.59 | n/a |
| | 22-3/8 | (568) | 0.91 | 0.73 | 0.69 | | 0.95 | 0.81 | 0.67 | 0.60 | 0.58 | 1.00 | 0.44 | 0.32 | | 0.89 | 0.64 | 0.83 | 0.62 | 0.56 |
| | 24 | (610) | 0.94 | 0.75 | 0.70 | | 1.00 | 0.85 | 0.68 | 0.60 | 0.58 | | 0.49 | 0.36 | | 0.99 | 0.71 | 0.86 | 0.65 | 0.58 |
| | 26 | (660) | 0.98 | 0.77 | 0.72 | | | 0.90 | 0.70 | 0.61 | 0.59 | | 0.56 | 0.40 | | 1.00 | 0.80 | 0.89 | 0.67 | 0.60 |
| | 28 | (711) | 1.00 | 0.79 | 0.74 | | | 0.95 | 0.71 | 0.62 | 0.60 | | 0.62 | 0.45 | | | 0.90 | 0.93 | 0.70 | 0.63 |
| | 30 | (762) | | 0.81 | 0.75 | | | 1.00 | 0.73 | 0.63 | 0.60 | | 0.69 | 0.50 | | | 1.00 | 0.96 | 0.72 | 0.65 |
| | 36 | (914) | | 0.88 | 0.80 | | | | 0.78 | 0.66 | 0.63 | | 0.91 | 0.65 | | | | 1.00 | 0.79 | 0.71 |
| | > 48 | (1219) | | 1.00 | 0.90 | | | | 0.87 | 0.71 | 0.67 | | 1.00 | 1.00 | | | | | 0.91 | 0.82 |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## Table 69 — Load adjustment factors for 30M rebar in uncracked concrete[1,2,3]

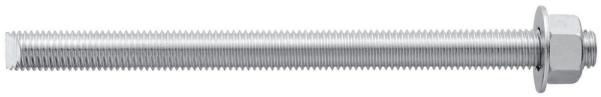
| 30M Rebar uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 |
| in. | (mm) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | 0.25 | 0.13 | 0.10 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.02 | 0.01 | n/a | n/a | n/a |
| 5-7/8 | (150) | 0.59 | 0.55 | 0.54 | 0.34 | 0.17 | 0.13 | 0.54 | 0.52 | 0.52 | 0.12 | 0.05 | 0.03 | 0.23 | 0.10 | 0.07 | n/a | n/a | n/a |
| 6 | (152) | 0.59 | 0.56 | 0.54 | 0.34 | 0.18 | 0.13 | 0.54 | 0.52 | 0.52 | 0.12 | 0.05 | 0.04 | 0.24 | 0.10 | 0.07 | n/a | n/a | n/a |
| 7 | (178) | 0.61 | 0.57 | 0.55 | 0.37 | 0.19 | 0.14 | 0.55 | 0.53 | 0.52 | 0.15 | 0.06 | 0.04 | 0.30 | 0.13 | 0.09 | n/a | n/a | n/a |
| 8 | (203) | 0.63 | 0.57 | 0.56 | 0.39 | 0.20 | 0.15 | 0.55 | 0.53 | 0.52 | 0.18 | 0.08 | 0.05 | 0.36 | 0.16 | 0.11 | n/a | n/a | n/a |
| 9 | (229) | 0.64 | 0.58 | 0.56 | 0.42 | 0.21 | 0.16 | 0.56 | 0.53 | 0.53 | 0.22 | 0.09 | 0.07 | 0.42 | 0.19 | 0.13 | n/a | n/a | n/a |
| 10 | (254) | 0.66 | 0.59 | 0.57 | 0.45 | 0.23 | 0.17 | 0.57 | 0.54 | 0.53 | 0.25 | 0.11 | 0.08 | 0.45 | 0.22 | 0.15 | n/a | n/a | n/a |
| 11 | (279) | 0.67 | 0.60 | 0.58 | 0.47 | 0.24 | 0.18 | 0.57 | 0.54 | 0.53 | 0.29 | 0.13 | 0.09 | 0.47 | 0.24 | 0.18 | n/a | n/a | n/a |
| 12 | (305) | 0.69 | 0.61 | 0.58 | 0.50 | 0.25 | 0.19 | 0.58 | 0.55 | 0.54 | 0.33 | 0.14 | 0.10 | 0.50 | 0.25 | 0.19 | n/a | n/a | n/a |
| 13-1/4 | (337) | 0.71 | 0.62 | 0.59 | 0.54 | 0.27 | 0.21 | 0.59 | 0.55 | 0.54 | 0.39 | 0.17 | 0.12 | 0.54 | 0.27 | 0.21 | 0.60 | n/a | n/a |
| 14 | (356) | 0.72 | 0.63 | 0.60 | 0.56 | 0.28 | 0.21 | 0.59 | 0.55 | 0.54 | 0.42 | 0.18 | 0.13 | 0.56 | 0.28 | 0.21 | 0.61 | n/a | n/a |
| 16 | (406) | 0.75 | 0.65 | 0.61 | 0.63 | 0.32 | 0.24 | 0.61 | 0.56 | 0.55 | 0.51 | 0.22 | 0.15 | 0.63 | 0.32 | 0.24 | 0.65 | n/a | n/a |
| 18 | (457) | 0.78 | 0.67 | 0.63 | 0.71 | 0.35 | 0.27 | 0.62 | 0.57 | 0.55 | 0.61 | 0.26 | 0.18 | 0.71 | 0.35 | 0.27 | 0.69 | n/a | n/a |
| 20 | (508) | 0.81 | 0.69 | 0.64 | 0.79 | 0.39 | 0.30 | 0.63 | 0.58 | 0.56 | 0.72 | 0.31 | 0.22 | 0.79 | 0.39 | 0.30 | 0.73 | n/a | n/a |
| 20-7/8 | (531) | 0.83 | 0.69 | 0.65 | 0.82 | 0.41 | 0.31 | 0.64 | 0.58 | 0.56 | 0.77 | 0.33 | 0.23 | 0.82 | 0.41 | 0.31 | 0.75 | n/a | n/a |
| 22 | (559) | 0.85 | 0.70 | 0.66 | 0.87 | 0.43 | 0.33 | 0.65 | 0.58 | 0.57 | 0.83 | 0.36 | 0.25 | 0.87 | 0.43 | 0.33 | 0.77 | 0.58 | n/a |
| 24 | (610) | 0.88 | 0.72 | 0.67 | 0.94 | 0.47 | 0.36 | 0.66 | 0.59 | 0.57 | 0.94 | 0.41 | 0.28 | 0.94 | 0.47 | 0.36 | 0.80 | 0.61 | n/a |
| 26-9/16 | (675) | 0.92 | 0.75 | 0.69 | 1.00 | 0.52 | 0.39 | 0.68 | 0.60 | 0.58 | 1.00 | 0.47 | 0.33 | 1.00 | 0.52 | 0.39 | 0.84 | 0.64 | 0.56 |
| 28 | (711) | 0.94 | 0.76 | 0.70 | | 0.55 | 0.42 | 0.69 | 0.61 | 0.58 | | 0.51 | 0.36 | | 0.55 | 0.42 | 0.86 | 0.65 | 0.58 |
| 30 | (762) | 0.97 | 0.78 | 0.71 | | 0.59 | 0.44 | 0.70 | 0.61 | 0.59 | | 0.57 | 0.40 | | 0.59 | 0.44 | 0.89 | 0.68 | 0.60 |
| 36 | (914) | 1.00 | 0.83 | 0.75 | | 0.71 | 0.53 | 0.74 | 0.64 | 0.61 | | 0.75 | 0.52 | | 0.71 | 0.53 | 0.98 | 0.74 | 0.66 |
| > 48 | (1219) | | 0.95 | 0.84 | | 0.95 | 0.71 | 0.82 | 0.68 | 0.64 | | 1.00 | 0.80 | | 0.95 | 0.71 | 1.00 | 0.86 | 0.76 |

## Table 70 — Load adjustment factors for 30M rebar in cracked concrete[1,2,3]

| 30M Rebar cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To and away from edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 |
| in. | (mm) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | 0.41 | 0.38 | 0.38 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.02 | 0.01 | n/a | n/a | n/a |
| 5-7/8 | (150) | 0.59 | 0.55 | 0.54 | 0.56 | 0.47 | 0.44 | 0.54 | 0.52 | 0.52 | 0.12 | 0.05 | 0.03 | 0.23 | 0.10 | 0.07 | n/a | n/a | n/a |
| 6 | (152) | 0.59 | 0.56 | 0.54 | 0.56 | 0.47 | 0.44 | 0.54 | 0.52 | 0.52 | 0.12 | 0.05 | 0.03 | 0.24 | 0.10 | 0.07 | n/a | n/a | n/a |
| 7 | (178) | 0.61 | 0.57 | 0.55 | 0.60 | 0.49 | 0.46 | 0.55 | 0.53 | 0.52 | 0.15 | 0.07 | 0.04 | 0.30 | 0.13 | 0.09 | n/a | n/a | n/a |
| 8 | (203) | 0.63 | 0.57 | 0.56 | 0.64 | 0.51 | 0.47 | 0.55 | 0.53 | 0.52 | 0.19 | 0.08 | 0.05 | 0.37 | 0.16 | 0.11 | n/a | n/a | n/a |
| 9 | (229) | 0.64 | 0.58 | 0.56 | 0.68 | 0.53 | 0.49 | 0.56 | 0.53 | 0.53 | 0.22 | 0.10 | 0.06 | 0.44 | 0.19 | 0.13 | n/a | n/a | n/a |
| 10 | (254) | 0.66 | 0.59 | 0.57 | 0.72 | 0.56 | 0.50 | 0.57 | 0.54 | 0.53 | 0.26 | 0.11 | 0.07 | 0.52 | 0.22 | 0.15 | n/a | n/a | n/a |
| 11 | (279) | 0.67 | 0.60 | 0.58 | 0.77 | 0.58 | 0.52 | 0.57 | 0.54 | 0.53 | 0.30 | 0.13 | 0.09 | 0.60 | 0.26 | 0.17 | n/a | n/a | n/a |
| 12 | (305) | 0.69 | 0.61 | 0.58 | 0.81 | 0.60 | 0.54 | 0.58 | 0.55 | 0.54 | 0.34 | 0.15 | 0.10 | 0.68 | 0.29 | 0.19 | n/a | n/a | n/a |
| 13-1/4 | (337) | 0.71 | 0.62 | 0.59 | 0.87 | 0.63 | 0.56 | 0.59 | 0.55 | 0.54 | 0.40 | 0.17 | 0.11 | 0.79 | 0.34 | 0.23 | 0.60 | n/a | n/a |
| 14 | (356) | 0.72 | 0.63 | 0.60 | 0.91 | 0.65 | 0.57 | 0.59 | 0.55 | 0.54 | 0.43 | 0.19 | 0.12 | 0.86 | 0.37 | 0.25 | 0.62 | n/a | n/a |
| 16 | (406) | 0.75 | 0.65 | 0.61 | 1.00 | 0.70 | 0.61 | 0.61 | 0.56 | 0.55 | 0.52 | 0.23 | 0.15 | 1.00 | 0.45 | 0.30 | 0.66 | n/a | n/a |
| 18 | (457) | 0.78 | 0.67 | 0.63 | | 0.75 | 0.64 | 0.62 | 0.57 | 0.55 | 0.62 | 0.27 | 0.18 | | 0.54 | 0.36 | 0.70 | n/a | n/a |
| 20 | (508) | 0.81 | 0.69 | 0.64 | | 0.81 | 0.68 | 0.64 | 0.58 | 0.56 | 0.73 | 0.32 | 0.21 | | 0.63 | 0.42 | 0.74 | n/a | n/a |
| 20-7/8 | (531) | 0.83 | 0.69 | 0.65 | | 0.83 | 0.70 | 0.64 | 0.58 | 0.56 | 0.78 | 0.34 | 0.22 | | 0.68 | 0.45 | 0.75 | n/a | n/a |
| 22 | (559) | 0.85 | 0.70 | 0.66 | | 0.86 | 0.72 | 0.65 | 0.59 | 0.56 | 0.84 | 0.36 | 0.24 | | 0.73 | 0.48 | 0.77 | 0.58 | n/a |
| 24 | (610) | 0.88 | 0.72 | 0.67 | | 0.92 | 0.76 | 0.66 | 0.59 | 0.57 | 0.96 | 0.42 | 0.28 | | 0.83 | 0.55 | 0.81 | 0.61 | n/a |
| 26-9/16 | (675) | 0.92 | 0.75 | 0.69 | | 0.99 | 0.81 | 0.68 | 0.60 | 0.58 | 1.00 | 0.48 | 0.32 | | 0.97 | 0.64 | 0.85 | 0.64 | 0.56 |
| 28 | (711) | 0.94 | 0.76 | 0.70 | | 1.00 | 0.84 | 0.69 | 0.61 | 0.58 | | 0.52 | 0.35 | | 1.00 | 0.69 | 0.87 | 0.66 | 0.57 |
| 30 | (762) | 0.97 | 0.78 | 0.71 | | | 0.88 | 0.70 | 0.62 | 0.59 | | 0.58 | 0.39 | | | 0.77 | 0.90 | 0.68 | 0.59 |
| 36 | (914) | 1.00 | 0.83 | 0.75 | | | 1.00 | 0.74 | 0.64 | 0.61 | | 0.76 | 0.51 | | | 1.00 | 0.99 | 0.75 | 0.65 |
| > 48 | (1219) | | 0.95 | 0.84 | | | | 0.82 | 0.69 | 0.64 | | 1.00 | 0.78 | | | | 1.00 | 0.86 | 0.75 |

1 Linear interpolation not permitted.
2 Shaded area with reduced edge distance is permitted provided the rebar has no installation torque.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from CSA A23.3 Annex D.
4 Spacing factor reduction in shear applicable when $c < 3*h_{ef}$. $f_{AV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

## HIT-RE 500 V3 adhesive with HAS Threaded Rod



### Table 71 — Hilti HIT-RE 500 V3 design information with Hilti HAS threaded rods in hammer drilled holes in accordance with CSA A23.3 Annex D[1,8]

| Design parameter | | Symbol | Units | Nominal rod diameter (in.) | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 | A23.3-14 |
| Nominal anchor diameter | | $d_a$ | mm | 9.5 | 12.7 | 15.9 | 19.1 | 22.2 | 25.4 | 31.8 | |
| Effective minimum embedment[2] | | $h_{ef,min}$ | mm | 60 | 70 | 79 | 89 | 89 | 102 | 127 | |
| Effective maximum embedment[2] | | $h_{ef,max}$ | mm | 191 | 254 | 318 | 381 | 445 | 508 | 635 | |
| Min. concrete thickness[2] | | $h_{min}$ | mm | $h_{ef}$ + 30 | $h_{ef}$ + $2d_0$ | | | | | | |
| Critical edge distance | | $c_{ac}$ | – | $2h_{ef}$ | | | | | | | |
| Minimum edge distance[3] | | $c_{min}$ | mm | 48 | 64 | 79 | 95 | 111 | 127 | 159 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 48 | 64 | 79 | 95 | 111 | 127 | 159 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete[4] | | $k_{c,uncr}$ | – | 10 | | | | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete[4] | | $k_{c,cr}$ | – | 7 | | | | | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_c$ | – | 0.65 | | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | | | | | | D.5.3(c) |
| Dry and water saturated concrete | | | | | | | | | | | |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 1,280 (8.8) | 1,270 (8.8) | 1,260 (8.7) | 1,250 (8.6) | 1,240 (8.6) | 1,240 (8.6) | 1,180 (8.1) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 2,380 (16.4) | 2,300 (15.9) | 2,210 (15.2) | 2,130 (14.7) | 2,040 (14.1) | 1,960 (13.5) | 1,790 (12.3) | D.6.5.2 |
| Temp. range B[6] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 880 (6.1) | 870 (6.0) | 870 (6.0) | 860 (5.9) | 860 (5.9) | 850 (5.9) | 810 (5.6) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,640 (11.3) | 1,590 (11.0) | 1,530 (10.6) | 1,470 (10.1) | 1,410 (9.7) | 1,350 (9.3) | 1,240 (8.6) | D.6.5.2 |
| Anchor category, dry concrete | | – | – | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| Resistance modification factor | | $R_{dry}$ | – | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Water-filled hole | | | | | | | | | | | |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 940 (6.5) | 940 (6.5) | 940 (6.5) | 940 (6.5) | 940 (6.5) | 950 (6.6) | 920 (6.3) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,760 (12.1) | 1,700 (11.7) | 1,660 (11.4) | 1,600 (11.0) | 1,550 (10.7) | 1,500 (10.3) | 1,400 (9.7) | D.6.5.2 |
| Temp. range B[6] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 650 (4.5) | 650 (4.5) | 650 (4.5) | 650 (4.5) | 650 (4.5) | 650 (4.5) | 640 (4.4) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,210 (8.3) | 1,170 (8.1) | 1,140 (7.9) | 1,110 (7.7) | 1,070 (7.4) | 1,040 (7.2) | 970 (6.7) | D.6.5.2 |
| Anchor category, water-filled hole | | – | – | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| Resistance modification factor | | $R_{wf}$ | – | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | |
| Submerged concrete | | | | | | | | | | | |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 820 (5.7) | 830 (5.7) | 830 (5.7) | 840 (5.8) | 850 (5.9) | 860 (5.9) | 860 (5.9) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,530 (10.6) | 1,500 (10.3) | 1,470 (10.1) | 1,430 (9.9) | 1,400 (9.7) | 1,370 (9.4) | 1,300 (9.0) | D.6.5.2 |
| Temp. range B[6] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 570 (3.9) | 570 (3.9) | 580 (4.0) | 580 (4.0) | 590 (4.1) | 590 (4.1) | 590 (4.1) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,060 (7.3) | 1,030 (7.1) | 1,010 (7.0) | 990 (6.8) | 960 (6.6) | 940 (6.5) | 900 (6.2) | D.6.5.2 |
| Anchor category, underwater | | – | – | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| Resistance modification factor | | $R_{uw}$ | | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | – | 0.92 | 0.93 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | |

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, tables 8 and 9, and converted for use with CSA A23.3 Annex D.

2 See figure 4 of section 3.2.4.3.4.

3 Minimum edge distance may be reduced to 45mm ≤ $c_{ai}$ < 5d provided $T_{inst}$ is reduced. See ESR-3814 section 4.1.9.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond stress values corresponding to concrete compressive stress $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of $(f'_c/2{,}500)^{0.25}$ [for SI: $(f'_c/17.2)^{0.25}$] for uncracked concrete and $(f'c/2{,}500)^{0.15}$ [for SI: $(f'c/17.2)^{0.15}$] for cracked concrete.

8 For structures assigned to Seismic Design Categories C, D, E, or F, bond strength values must be multiplied by $\alpha_{N,seis}$.

## Table 72 — Hilti HIT-RE 500 V3 design information with Hilti HAS threaded rods in diamond core drilled holes in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Nominal rod diameter (in.) | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 | A23.3-14 |
| Nominal anchor diameter | | $d_a$ | mm | 9.5 | 12.7 | 15.9 | 19.1 | 22.2 | 25.4 | 31.8 | |
| Effective minimum embedment[2] | | $h_{ef}$ | mm | 60 | 70 | 79 | 89 | 89 | 102 | 127 | |
| Effective maximum embedment[2] | | $h_{ef}$ | mm | 191 | 254 | 318 | 381 | 445 | 508 | 635 | |
| Minimum concrete thickness[2] | | $h_{min}$ | mm | $h_{ef}$ + 30 | | $h_{ef}$ + 2$d_o$ | | | | | |
| Critical edge distance | | $c_{ac}$ | – | 2$h_{ef}$ | | | | | | | |
| Minimum edge distance | | $c_{min}$[3] | mm | 48 | 64 | 79 | 95 | 111 | 127 | 159 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 48 | 64 | 79 | 95 | 111 | 127 | 159 | |
| Coeff. for factored concrete breakout resistance, uncracked concrete | | $k_{c,uncr}$[4] | – | 10 | | | | | | | D.6.2.2 |
| Coeff. for factored concrete breakout resistance, cracked concrete | | $k_{c,cr}$[4] | – | 7 | | | | | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_s$ | – | 0.65 | | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | | | | | | D.5.3(c) |
| Dry and water saturated concrete | | | | | | | | | | | |
| Temp. range A[6] | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi<br>(MPa) | 1,550<br>(10.7) | 1,550<br>(10.7) | 1,550<br>(10.7) | 1,550<br>(10.7) | 1,550<br>(10.7) | 1,550<br>(10.7) | 1,550<br>(10.7) | D.6.5.2 |
| Temp. range B[6] | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi<br>psi | 1,070<br>(7.4) | 1,070<br>(7.4) | 1,070<br>(7.4) | 1,070<br>(7.4) | 1,070<br>(7.4) | 1,070<br>(7.4) | 1,070<br>(7.4) | D.6.5.2 |
| Anchor category, dry concrete | | – | – | 2 | 2 | 3 | 3 | 3 | 3 | 3 | |
| Resistance modification factor | | $R_{dry}$ | – | 0.85 | 0.85 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | |

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, tables 8 and 10, and converted for use with CSA A23.3 Annex D.

2 See figure 4 of section 3.2.4.3.4.

3 Minimum edge distance may be reduced to 45mm ≤ $c_{ai}$ < 5d provided $T_{inst}$ is reduced. See ESR-3814 section 4.1.9.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond stress values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of ($f'_c$/2,500)$^{0.25}$ [for SI: ($f'_c$ / 17.2)$^{0.25}$] for uncracked concrete.

## Table 73 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete/bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8,9,11]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 2-3/8 (60) | 3,060 (13.6) | 3,425 (15.2) | 3,750 (16.7) | 4,330 (19.3) | 3,060 (13.6) | 3,425 (15.2) | 3,750 (16.7) | 4,330 (19.3) |
| | 3-3/8 (86) | 5,185 (23.1) | 5,800 (25.8) | 6,355 (28.3) | 7,335 (32.6) | 10,375 (46.1) | 11,600 (51.6) | 12,705 (56.5) | 14,670 (65.3) |
| | 4-1/2 (114) | 7,985 (35.5) | 8,930 (39.7) | 9,430 (41.9) | 10,130 (45.1) | 15,970 (71.0) | 17,855 (79.4) | 18,855 (83.9) | 20,260 (90.1) |
| | 7-1/2 (191) | 14,200 (63.2) | 15,010 (66.8) | 15,715 (69.9) | 16,885 (75.1) | 28,395 (126.3) | 30,025 (133.6) | 31,425 (139.8) | 33,770 (150.2) |
| 1/2 | 2-3/4 (70) | 3,815 (17.0) | 4,265 (19.0) | 4,670 (20.8) | 5,395 (24.0) | 7,630 (33.9) | 8,530 (37.9) | 9,345 (41.6) | 10,790 (48.0) |
| | 4-1/2 (114) | 7,985 (35.5) | 8,930 (39.7) | 9,780 (43.5) | 11,295 (50.2) | 15,970 (71.0) | 17,855 (79.4) | 19,560 (87.0) | 22,585 (100.5) |
| | 6 (152) | 12,295 (54.7) | 13,745 (61.1) | 15,060 (67.0) | 17,385 (77.3) | 24,590 (109.4) | 27,490 (122.3) | 30,115 (134.0) | 34,775 (154.7) |
| | 10 (254) | 24,390 (108.5) | 25,790 (114.7) | 26,995 (120.1) | 29,005 (129.0) | 48,785 (217.0) | 51,585 (229.5) | 53,990 (240.2) | 58,015 (258.1) |
| 5/8[10] | 3-1/8 (79) | 4,620 (20.6) | 5,165 (23.0) | 5,660 (25.2) | 6,535 (29.1) | 9,245 (41.1) | 10,335 (46.0) | 11,320 (50.4) | 13,070 (58.1) |
| | 5-5/8 (143) | 11,160 (49.6) | 12,480 (55.5) | 13,670 (60.8) | 15,785 (70.2) | 22,320 (99.3) | 24,955 (111.0) | 27,335 (121.6) | 31,565 (140.4) |
| | 7-1/2 (191) | 17,185 (76.4) | 19,210 (85.5) | 21,045 (93.6) | 24,300 (108.1) | 34,365 (152.9) | 38,420 (170.9) | 42,090 (187.2) | 48,600 (216.2) |
| | 12-1/2 (318) | 36,620 (162.9) | 38,725 (172.2) | 40,530 (180.3) | 43,550 (193.7) | 73,245 (325.8) | 77,445 (344.5) | 81,055 (360.6) | 87,100 (387.4) |
| 3/4[10] | 3-1/2 (89) | 5,480 (24.4) | 6,125 (27.2) | 6,710 (29.8) | 7,745 (34.5) | 10,955 (48.7) | 12,250 (54.5) | 13,420 (59.7) | 15,495 (68.9) |
| | 6-3/4 (171) | 14,670 (65.3) | 16,400 (73.0) | 17,970 (79.9) | 20,745 (92.3) | 29,340 (130.5) | 32,805 (145.9) | 35,935 (159.8) | 41,495 (184.6) |
| | 9 (229) | 22,585 (100.5) | 25,255 (112.3) | 27,665 (123.1) | 31,945 (142.1) | 45,175 (200.9) | 50,505 (224.7) | 55,325 (246.1) | 63,885 (284.2) |
| | 15 (381) | 48,600 (216.2) | 53,740 (239.1) | 56,250 (250.2) | 60,445 (268.9) | 97,200 (432.4) | 107,485 (478.1) | 112,495 (500.4) | 120,885 (537.7) |
| 7/8[10] | 3-1/2 (89) | 5,480 (24.4) | 6,125 (27.2) | 6,710 (29.8) | 7,745 (34.5) | 10,955 (48.7) | 12,250 (54.5) | 13,420 (59.7) | 15,495 (68.9) |
| | 7-7/8 (200) | 18,485 (82.2) | 20,670 (91.9) | 22,640 (100.7) | 26,145 (116.3) | 36,975 (164.5) | 41,340 (183.9) | 45,285 (201.4) | 52,290 (232.6) |
| | 10-1/2 (267) | 28,465 (126.6) | 31,820 (141.6) | 34,860 (155.1) | 40,255 (179.1) | 56,925 (253.2) | 63,645 (283.1) | 69,720 (310.1) | 80,505 (358.1) |
| | 17-1/2 (445) | 61,240 (272.4) | 68,470 (304.6) | 73,325 (326.2) | 78,795 (350.5) | 122,485 (544.8) | 136,940 (609.1) | 146,650 (652.3) | 157,585 (701.0) |
| 1[10] | 4 (102) | 6,690 (29.8) | 7,480 (33.3) | 8,195 (36.5) | 9,465 (42.1) | 13,385 (59.5) | 14,965 (66.6) | 16,395 (72.9) | 18,930 (84.2) |
| | 9 (229) | 22,585 (100.5) | 25,255 (112.3) | 27,665 (123.1) | 31,945 (142.1) | 45,175 (200.9) | 50,505 (224.7) | 55,325 (246.1) | 63,885 (284.2) |
| | 12 (305) | 34,775 (154.7) | 38,880 (172.9) | 42,590 (189.5) | 49,180 (218.8) | 69,550 (309.4) | 77,760 (345.9) | 85,180 (378.9) | 98,360 (437.5) |
| | 20 (508) | 74,825 (332.8) | 83,655 (372.1) | 91,640 (407.6) | 98,875 (439.8) | 149,650 (665.7) | 167,310 (744.2) | 183,280 (815.3) | 197,755 (879.7) |
| 1-1/4[10] | 5 (127) | 9,355 (41.6) | 10,455 (46.5) | 11,455 (51.0) | 13,225 (58.8) | 18,705 (83.2) | 20,915 (93.0) | 22,910 (101.9) | 26,455 (117.7) |
| | 11-1/4 (286) | 31,565 (140.4) | 35,290 (157.0) | 38,660 (172.0) | 44,640 (198.6) | 63,135 (280.8) | 70,585 (314.0) | 77,320 (343.9) | 89,285 (397.1) |
| | 15 (381) | 48,600 (216.2) | 54,335 (241.7) | 59,520 (264.8) | 68,730 (305.7) | 97,200 (432.4) | 108,670 (483.4) | 119,045 (529.5) | 137,460 (611.4) |
| | 25 (635) | 104,570 (465.1) | 116,910 (520.0) | 128,070 (569.7) | 141,095 (627.6) | 209,140 (930.3) | 233,825 (1040.1) | 256,140 (1139.4) | 282,190 (1255.2) |

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 30 - 41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete or water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.44.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. For diamond core drilling, except as indicated in note 10, multiply above values by 0.55.
Diamond core drilling is not permitted for the water-filled or under-water (submerged) applications.

10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 5/8", 3/4", 7/8", 1", and 1-1/4". See Table 76.

11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 74 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete/bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8,9,11]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 2-3/8 (60) | 2,145 (9.5) | 2,395 (10.7) | 2,530 (11.3) | 2,645 (11.8) | 2,145 (9.5) | 2,395 (10.7) | 2,530 (11.3) | 2,645 (11.8) |
| | 3-3/8 (86) | 3,385 (15.1) | 3,500 (15.6) | 3,595 (16.0) | 3,755 (16.7) | 6,770 (30.1) | 7,000 (31.1) | 7,195 (32.0) | 7,510 (33.4) |
| | 4-1/2 (114) | 4,515 (20.1) | 4,665 (20.8) | 4,795 (21.3) | 5,005 (22.3) | 9,025 (40.1) | 9,335 (41.5) | 9,590 (42.7) | 10,015 (44.5) |
| | 7-1/2 (191) | 7,520 (33.5) | 7,780 (34.6) | 7,995 (35.6) | 8,345 (37.1) | 15,045 (66.9) | 15,555 (69.2) | 15,985 (71.1) | 16,690 (74.2) |
| 1/2 | 2-3/4 (70) | 2,670 (11.9) | 2,985 (13.3) | 3,270 (14.5) | 3,775 (16.8) | 5,340 (23.8) | 5,970 (26.6) | 6,540 (29.1) | 7,555 (33.6) |
| | 4-1/2 (114) | 5,590 (24.9) | 6,175 (27.5) | 6,345 (28.2) | 6,625 (29.5) | 11,180 (49.7) | 12,345 (54.9) | 12,690 (56.4) | 13,250 (58.9) |
| | 6 (152) | 7,960 (35.4) | 8,230 (36.6) | 8,460 (37.6) | 8,830 (39.3) | 15,920 (70.8) | 16,460 (73.2) | 16,920 (75.3) | 17,665 (78.6) |
| | 10 (254) | 13,265 (59.0) | 13,720 (61.0) | 14,100 (62.7) | 14,720 (65.5) | 26,535 (118.0) | 27,435 (122.0) | 28,200 (125.4) | 29,440 (131.0) |
| 5/8[10] | 3-1/8 (79) | 3,235 (14.4) | 3,615 (16.1) | 3,960 (17.6) | 4,575 (20.4) | 6,470 (28.8) | 7,235 (32.2) | 7,925 (35.2) | 9,150 (40.7) |
| | 5-5/8 (143) | 7,810 (34.8) | 8,735 (38.9) | 9,570 (42.6) | 10,270 (45.7) | 15,625 (69.5) | 17,470 (77.7) | 19,135 (85.1) | 20,540 (91.4) |
| | 7-1/2 (191) | 12,030 (53.5) | 12,760 (56.8) | 13,115 (58.3) | 13,690 (60.9) | 24,055 (107.0) | 25,520 (113.5) | 26,230 (116.7) | 27,385 (121.8) |
| | 12-1/2 (318) | 20,565 (91.5) | 21,265 (94.6) | 21,855 (97.2) | 22,820 (101.5) | 41,135 (183.0) | 42,535 (189.2) | 43,715 (194.4) | 45,640 (203.0) |
| 3/4[10] | 3-1/2 (89) | 3,835 (17.1) | 4,285 (19.1) | 4,695 (20.9) | 5,425 (24.1) | 7,670 (34.1) | 8,575 (38.1) | 9,390 (41.8) | 10,845 (48.2) |
| | 6-3/4 (171) | 10,270 (45.7) | 11,480 (51.1) | 12,575 (55.9) | 14,525 (64.6) | 20,540 (91.4) | 22,965 (102.1) | 25,155 (111.9) | 29,045 (129.2) |
| | 9 (229) | 15,810 (70.3) | 17,675 (78.6) | 18,735 (83.3) | 19,560 (87.0) | 31,620 (140.7) | 35,355 (157.3) | 37,470 (166.7) | 39,120 (174.0) |
| | 15 (381) | 29,380 (130.7) | 30,380 (135.1) | 31,225 (138.9) | 32,600 (145.0) | 58,760 (261.4) | 60,760 (270.3) | 62,445 (277.8) | 65,200 (290.0) |
| 7/8[10] | 3-1/2 (89) | 3,835 (17.1) | 4,285 (19.1) | 4,695 (20.9) | 5,425 (24.1) | 7,670 (34.1) | 8,575 (38.1) | 9,390 (41.8) | 10,845 (48.2) |
| | 7-7/8 (200) | 12,940 (57.6) | 14,470 (64.4) | 15,850 (70.5) | 18,300 (81.4) | 25,880 (115.1) | 28,935 (128.7) | 31,700 (141.0) | 36,605 (162.8) |
| | 10-1/2 (267) | 19,925 (88.6) | 22,275 (99.1) | 24,400 (108.5) | 26,410 (117.5) | 39,850 (177.3) | 44,550 (198.2) | 48,805 (217.1) | 52,820 (235.0) |
| | 17-1/2 (445) | 39,670 (176.5) | 41,020 (182.5) | 42,160 (187.5) | 44,020 (195.8) | 79,340 (352.9) | 82,040 (364.9) | 84,315 (375.1) | 88,035 (391.6) |
| 1[10] | 4 (102) | 4,685 (20.8) | 5,240 (23.3) | 5,740 (25.5) | 6,625 (29.5) | 9,370 (41.7) | 10,475 (46.6) | 11,475 (51.0) | 13,250 (58.9) |
| | 9 (229) | 15,810 (70.3) | 17,675 (78.6) | 19,365 (86.1) | 22,360 (99.5) | 31,620 (140.7) | 35,355 (157.3) | 38,730 (172.3) | 44,720 (198.9) |
| | 12 (305) | 24,340 (108.3) | 27,215 (121.1) | 29,815 (132.6) | 34,425 (153.1) | 48,685 (216.6) | 54,430 (242.1) | 59,625 (265.2) | 68,850 (306.3) |
| | 20 (508) | 51,815 (230.5) | 53,580 (238.3) | 55,065 (244.9) | 57,490 (255.7) | 103,630 (461.0) | 107,155 (476.7) | 110,130 (489.9) | 114,985 (511.5) |
| 1-1/4[10] | 5 (127) | 6,545 (29.1) | 7,320 (32.6) | 8,020 (35.7) | 9,260 (41.2) | 13,095 (58.2) | 14,640 (65.1) | 16,035 (71.3) | 18,520 (82.4) |
| | 11-1/4 (286) | 22,095 (98.3) | 24,705 (109.9) | 27,060 (120.4) | 31,250 (139.0) | 44,195 (196.6) | 49,410 (219.8) | 54,125 (240.8) | 62,500 (278.0) |
| | 15 (381) | 34,020 (151.3) | 38,035 (169.2) | 41,665 (185.3) | 48,110 (214.0) | 68,040 (302.7) | 76,070 (338.4) | 83,330 (370.7) | 96,220 (428.0) |
| | 25 (635) | 73,200 (325.6) | 79,665 (354.4) | 81,875 (364.2) | 85,485 (380.3) | 146,395 (651.2) | 159,330 (708.7) | 163,750 (728.4) | 170,970 (760.5) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 30-41 as necessary to the above values. Compare to the steel values in table 29 to the above values. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176 °F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.51.
For submerged (under water) applications multiply design strength by 0.44.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete except as indicated in note 10.
10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 5/8", 3/4", 7/8", 1", and 1-1/4". See Table 77.
11 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by $\alpha_{seis}$ indicated below. See section 3.1.8 for additional information on seismic applications.
3/8-in. diameter - $\alpha_{seis}$ = 0.69
1/2-in. diameter - $\alpha_{seis}$ = 0.70
5/8-in. diameter - $\alpha_{seis}$ = 0.71
3/4-in. diameter and larger - $\alpha_{seis}$ = 0.75

## Table 75 — Steel factored resistance for Hilti HAS threaded rods for use with CSA A23.3 Annex D

| Nominal anchor diameter in. | HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr.36[4,6] | | | HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6] | | | HAS-B-105 / HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6] | | | HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tensile[1] $\Phi N_{sar}$ lb (kN) | Shear[2] $\Phi V_{sar}$ lb (kN) | Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN) | Tensile[1] $\Phi N_{sar}$ lb (kN) | Shear[2] $\Phi V_{sar}$ lb (kN) | Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN) | Tensile[1] $\Phi N_{sar}$ lb (kN) | Shear[2] $\Phi V_{sar}$ lb (kN) | Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN) | Tensile[1] $\Phi N_{sar}$ lb (kN) | Shear[2] $\Phi V_{sar}$ lb (kN) | Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN) |
| 3/8 | 3,055 (13.6) | 1,720 (7.7) | 1,030 (4.6) | 3,955 (17.6) | 2,225 (9.9) | 2,225 (9.9) | 6,570 (29.2) | 3,695 (16.4) | 3,695 (16.4) | 4,610 (20.5) | 2,570 (11.4) | 2,055 (9.1) |
| 1/2 | 5,595 (24.9) | 3,150 (14.0) | 1,890 (8.4) | 7,240 (32.2) | 4,070 (18.1) | 4,070 (18.1) | 12,035 (53.5) | 6,765 (30.1) | 6,765 (30.1) | 8,445 (37.6) | 4,705 (20.9) | 3,765 (16.7) |
| 5/8 | 8,915 (39.7) | 5,015 (22.3) | 3,010 (13.4) | 11,525 (51.3) | 6,485 (28.8) | 6,485 (28.8) | 19,160 (85.2) | 10,780 (48.0) | 10,780 (48.0) | 13,445 (59.8) | 7,490 (33.3) | 5,990 (26.6) |
| 3/4 | 13,190 (58.7) | 7,420 (33.0) | 4,450 (19.8) | 17,060 (75.9) | 9,600 (42.7) | 9,600 (42.7) | 28,365 (126.2) | 15,955 (71.0) | 15,955 (71.0) | 16,920 (75.3) | 9,425 (41.9) | 7,540 (33.5) |
| 7/8 | 18,210 (81.0) | 10,245 (45.6) | 6,145 (27.3) | 23,550 (104.8) | 13,245 (58.9) | 13,245 (58.9) | 39,150 (174.1) | 22,020 (97.9) | 22,020 (97.9) | 23,350 (103.9) | 13,010 (57.9) | 10,410 (46.3) |
| 1 | 23,890 (106.3) | 13,440 (59.8) | 8,065 (35.9) | 30,890 (137.4) | 17,380 (77.3) | 17,380 (77.3) | 51,360 (228.5) | 28,890 (128.5) | 28,890 (128.5) | 30,635 (136.3) | 17,065 (75.9) | 13,650 (60.7) |
| 1-1/4 | 38,225 (170.0) | 21,500 (95.6) | 12,900 (57.4) | 49,425 (219.9) | 27,800 (123.7) | 27,800 (123.7) | 82,175 (365.5) | 46,220 (205.6) | 46,220 (205.6) | 37,565 (167.1) | 21,130 (94.0) | 16,905 (75.2) |

1 Tensile = $\phi A_{se,N} f_{uta}$ R as noted in CSA A23.3 Eq. D.2.
2 Shear = $\phi$ 0.60 $A_{se,V} f_{uta}$ R as noted in CSA A23.3 Eq. D.31.
3 Seismic Shear = $\alpha_{V,seis} V_{sar}$ : Reduction factor for seismic shear only. See CSA A23.3 Annex D for additional information on seismic applications. Seismic shear for HIT-RE 500 V3
4 HAS-V, HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).
5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.
6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

## Table 75 — Hilti HIT-RE 500-V3 design information with HAS threaded rods in core drilled holes roughened with the TE-YRT Roughening Tool in accordance with CSA A23.3 Annex D[1,8]

| Design parameter | | Symbol | Units | Nominal rod diameter (in.) 5/8 | 3/4 | 7/8 | 1 | 1-1/4 | Ref A23.3-14 |
|---|---|---|---|---|---|---|---|---|---|
| Nominal anchor diameter | | $d_a$ | mm | 15.9 | 19.1 | 22.2 | 25.4 | 31.8 | |
| Effective minimum embedment[2] | | $h_{ef}$ | mm | 79 | 89 | 89 | 102 | 127 | |
| Effective maximum embedment[2] | | $h_{ef}$ | $f$mm | 318 | 286 | 445 | 508 | 635 | |
| Minimum concrete thickness[2] | | $h_{min}$ | mm | $h_{ef} + 2d_o$ | | | | | |
| Critical edge distance | | $c_{ac}$ | – | $2h_{ef}$ | | | | | |
| Minimum edge distance[3] | | $c_{min}$ | mm | 79 | 95 | 111 | 127 | 159 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 79 | 95 | 111 | 127 | 159 | |
| Coeff. for factored concrete breakout resistance, uncracked concrete[4] | | $k_{c,uncr}$ | – | 10 | | | | | D.6.2.2 |
| Coeff. for factored concrete breakout resistance, cracked concrete[4] | | $k_{c,cr}$ | – | 7 | | | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_s$ | – | 0.65 | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | | | | D.5.3(c) |
| Dry and water saturated concrete | | | | | | | | | |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 880 (6.1) | 875 (6.0) | 870 (6.0) | 870 (6.0) | 825 (5.7) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 2,210 (15.2) | 2,130 (14.7) | 2,040 (14.1) | 1,960 (13.5) | 1,790 (12.3) | D.6.5.2 |
| Temp. range B[6] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 610 (4.2) | 605 (4.2) | 605 (4.2) | 600 (4.1) | 570 (3.9) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,530 (10.6) | 1,470 (10.1) | 1,410 (9.7) | 1,350 (9.3) | 1,240 (8.6) | D.6.5.2 |
| Anchor category, dry concrete | | - | - | 1 | 1 | 1 | 1 | 1 | |
| Resistance modification factor | | $R_{dry}$ | - | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | - | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | |

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, table 11 and 12, and converted for use with CSA A23.3 Annex D.
2 See figure 8 of section 3.2.4.3.4.
3 Minimum edge distance may be reduced to 45mm ≤ $c_{ai}$ < 5d provided Tinst is reduced. See ESR-3814 section 4.1.9.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
7 Bond stress values correspond to concrete compressive strength in the range 2,500 psi ≤ $f'_c$ ≤ 8,000 psi.
8 For structures assigned to Seismic Design Categories C, D, E, or F, bond stress values must be multiplied by $\alpha_{N,seis}$.

## Table 76 — Hilti HIT-RE 500 V3 Core Drilled and roughened with TE-YRT Roughening Tool adhesive factored resistance with concrete / bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8,9]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 5/8 | 3-1/8 (79) | 4,620 (20.6) | 5,165 (23.0) | 5,660 (25.2) | 6,535 (29.1) | 9,245 (41.1) | 10,335 (46.0) | 11,320 (50.4) | 13,070 (58.1) |
| | 5-5/8 (143) | 11,160 (49.6) | 12,480 (55.5) | 13,670 (60.8) | 15,785 (70.2) | 22,320 (99.3) | 24,955 (111.0) | 27,335 (121.6) | 31,565 (140.4) |
| | 7-1/2 (191) | 17,185 (76.4) | 19,210 (85.5) | 21,045 (93.6) | 21,160 (94.1) | 34,365 (152.9) | 38,420 (170.9) | 42,090 (187.2) | 42,320 (188.2) |
| | 12-1/2 (318) | 35,265 (156.9) | 35,265 (156.9) | 35,265 (156.9) | 35,265 (156.9) | 70,535 (313.7) | 70,535 (313.7) | 70,535 (313.7) | 70,535 (313.7) |
| 3/4 | 3-1/2 (89) | 5,480 (24.4) | 6,125 (27.2) | 6,710 (29.8) | 7,745 (34.5) | 10,955 (48.7) | 12,250 (54.5) | 13,420 (59.7) | 15,495 (68.9) |
| | 6-3/4 (171) | 14,670 (65.3) | 16,400 (73.0) | 17,970 (79.9) | 20,745 (92.3) | 29,340 (130.5) | 32,805 (145.9) | 35,935 (159.8) | 41,495 (184.6) |
| | 9 (229) | 22,585 (100.5) | 25,255 (112.3) | 27,665 (123.1) | 29,365 (130.6) | 45,175 (200.9) | 50,505 (224.7) | 55,325 (246.1) | 58,735 (261.3) |
| | 11-1/4 (286) | 31,565 (140.4) | 35,290 (157.0) | 36,710 (163.3) | 36,710 (163.3) | 63,135 (280.8) | 70,585 (314.0) | 73,420 (326.6) | 73,420 (326.6) |
| 7/8 | 3-1/2 (89) | 5,480 (24.4) | 6,125 (27.2) | 6,710 (29.8) | 7,745 (34.5) | 10,955 (48.7) | 12,250 (54.5) | 13,420 (59.7) | 15,495 (68.9) |
| | 7-7/8 (200) | 18,485 (82.2) | 20,670 (91.9) | 22,640 (100.7) | 26,145 (116.3) | 36,975 (164.5) | 41,340 (183.9) | 45,285 (201.4) | 52,290 (232.6) |
| | 10-1/2 (267) | 28,465 (126.6) | 31,820 (141.6) | 34,860 (155.1) | 38,285 (170.3) | 56,925 (253.2) | 63,645 (283.1) | 69,720 (310.1) | 76,565 (340.6) |
| | 17-1/2 (445) | 61,240 (272.4) | 63,805 (283.8) | 63,805 (283.8) | 63,805 (283.8) | 122,485 (544.8) | 127,610 (567.6) | 127,610 (567.6) | 127,610 (567.6) |
| 1 | 4 (102) | 6,690 (29.8) | 7,480 (33.3) | 8,195 (36.5) | 9,465 (42.1) | 13,385 (59.5) | 14,965 (66.6) | 16,395 (72.9) | 18,930 (84.2) |
| | 9 (229) | 22,585 (100.5) | 25,255 (112.3) | 27,665 (123.1) | 31,945 (142.1) | 45,175 (200.9) | 50,505 (224.7) | 55,325 (246.1) | 63,885 (284.2) |
| | 12 (305) | 34,775 (154.7) | 38,880 (172.9) | 42,590 (189.5) | 48,040 (213.7) | 69,550 (309.4) | 77,760 (345.9) | 85,180 (378.9) | 96,085 (427.4) |
| | 20 (508) | 74,825 (332.8) | 80,070 (356.2) | 80,070 (356.2) | 80,070 (356.2) | 149,650 (665.7) | 160,140 (712.3) | 160,140 (712.3) | 160,140 (712.3) |
| 1-1/4 | 5 (127) | 9,355 (41.6) | 10,455 (46.5) | 11,455 (51.0) | 13,225 (58.8) | 18,705 (83.2) | 20,915 (93.0) | 22,910 (101.9) | 26,455 (117.7) |
| | 11-1/4 (286) | 31,565 (140.4) | 35,290 (157.0) | 38,660 (172.0) | 44,640 (198.6) | 63,135 (280.8) | 70,585 (314.0) | 77,320 (343.9) | 89,285 (397.1) |
| | 15 (381) | 48,600 (216.2) | 54,335 (241.7) | 59,520 (264.8) | 68,555 (304.9) | 97,200 (432.4) | 108,670 (483.4) | 119,045 (529.5) | 137,110 (609.9) |
| | 25 (635) | 104,570 (465.1) | 114,255 (508.2) | 114,255 (508.2) | 114,255 (508.2) | 209,140 (930.3) | 228,515 (1016.5) | 228,515 (1016.5) | 228,515 (1016.5) |

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 30 - 41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete or water-saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

9 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 77 — Hilti HIT-RE 500 V3 Core Drilled and roughened with TE-YRT Roughening Tool adhesive factored resistance with concrete / bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8,9]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 5/8 | 3-1/8 (79) | 3,235 (14.4) | 3,510 (15.6) | 3,510 (15.6) | 3,510 (15.6) | 6,470 (28.8) | 7,020 (31.2) | 7,020 (31.2) | 7,020 (31.2) |
| | 5-5/8 (143) | 6,320 (28.1) | 6,320 (28.1) | 6,320 (28.1) | 6,320 (28.1) | 12,640 (56.2) | 12,640 (56.2) | 12,640 (56.2) | 12,640 (56.2) |
| | 7-1/2 (191) | 8,425 (37.5) | 8,425 (37.5) | 8,425 (37.5) | 8,425 (37.5) | 16,850 (75.0) | 16,850 (75.0) | 16,850 (75.0) | 16,850 (75.0) |
| | 12-1/2 (318) | 14,045 (62.5) | 14,045 (62.5) | 14,045 (62.5) | 14,045 (62.5) | 28,085 (124.9) | 28,085 (124.9) | 28,085 (124.9) | 28,085 (124.9) |
| 3/4 | 3-1/2 (89) | 3,835 (17.1) | 4,285 (19.1) | 4,690 (20.9) | 4,690 (20.9) | 7,670 (34.1) | 8,575 (38.1) | 9,385 (41.7) | 9,385 (41.7) |
| | 6-3/4 (171) | 9,050 (40.2) | 9,050 (40.2) | 9,050 (40.2) | 9,050 (40.2) | 18,095 (80.5) | 18,095 (80.5) | 18,095 (80.5) | 18,095 (80.5) |
| | 9 (229) | 12,065 (53.7) | 12,065 (53.7) | 12,065 (53.7) | 12,065 (53.7) | 24,130 (107.3) | 24,130 (107.3) | 24,130 (107.3) | 24,130 (107.3) |
| | 11-1/4 (286) | 15,080 (67.1) | 15,080 (67.1) | 15,080 (67.1) | 15,080 (67.1) | 30,160 (134.2) | 30,160 (134.2) | 30,160 (134.2) | 30,160 (134.2) |
| 7/8 | 3-1/2 (89) | 3,835 (17.1) | 4,285 (19.1) | 4,695 (20.9) | 5,425 (24.1) | 7,670 (34.1) | 8,575 (38.1) | 9,390 (41.8) | 10,845 (48.2) |
| | 7-7/8 (200) | 12,245 (54.5) | 12,245 (54.5) | 12,245 (54.5) | 12,245 (54.5) | 24,490 (108.9) | 24,490 (108.9) | 24,490 (108.9) | 24,490 (108.9) |
| | 10-1/2 (267) | 16,325 (72.6) | 16,325 (72.6) | 16,325 (72.6) | 16,325 (72.6) | 32,655 (145.2) | 32,655 (145.2) | 32,655 (145.2) | 32,655 (145.2) |
| | 17-1/2 (445) | 27,210 (121.0) | 27,210 (121.0) | 27,210 (121.0) | 27,210 (121.0) | 54,420 (242.1) | 54,420 (242.1) | 54,420 (242.1) | 54,420 (242.1) |
| 1 | 4 (102) | 4,685 (20.8) | 5,240 (23.3) | 5,740 (25.5) | 6,625 (29.5) | 9,370 (41.7) | 10,475 (46.6) | 11,475 (51.0) | 13,250 (58.9) |
| | 9 (229) | 15,810 (70.3) | 15,995 (71.1) | 15,995 (71.1) | 15,995 (71.1) | 31,620 (140.7) | 31,985 (142.3) | 31,985 (142.3) | 31,985 (142.3) |
| | 12 (305) | 21,325 (94.9) | 21,325 (94.9) | 21,325 (94.9) | 21,325 (94.9) | 42,650 (189.7) | 42,650 (189.7) | 42,650 (189.7) | 42,650 (189.7) |
| | 20 (508) | 35,540 (158.1) | 35,540 (158.1) | 35,540 (158.1) | 35,540 (158.1) | 71,080 (316.2) | 71,080 (316.2) | 71,080 (316.2) | 71,080 (316.2) |
| 1-1/4 | 5 (127) | 6,545 (29.1) | 7,320 (32.6) | 8,020 (35.7) | 9,260 (41.2) | 13,095 (58.2) | 14,640 (65.1) | 16,035 (71.3) | 18,520 (82.4) |
| | 11-1/4 (286) | 22,095 (98.3) | 23,695 (105.4) | 23,695 (105.4) | 23,695 (105.4) | 44,195 (196.6) | 47,395 (210.8) | 47,395 (210.8) | 47,395 (210.8) |
| | 15 (381) | 31,595 (140.5) | 31,595 (140.5) | 31,595 (140.5) | 31,595 (140.5) | 63,190 (281.1) | 63,190 (281.1) | 63,190 (281.1) | 63,190 (281.1) |
| | 25 (635) | 52,660 (234.2) | 52,660 (234.2) | 52,660 (234.2) | 52,660 (234.2) | 105,320 (468.5) | 105,320 (468.5) | 105,320 (468.5) | 105,320 (468.5) |

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 30 - 41 as necessary to the above values. Compare to the steel values in table 29. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete or water-saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.
Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by λa as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by $\alpha_{seis}$ indicated below. See section 3.1.8 for additional information on seismic applications.
5/8-in. diameter $\alpha_{seis}$=0.71
3/4-in. diameter and larger - $\alpha_{seis}$ = 0.75

## HIT-RE 500 V3 adhesive with HIS-(R)N Inserts



### Table 78 — Hilti HIT-RE 500 V3 design information with Hilti HIS-N and HIS-RN internally threaded inserts in hammer drilled holes in accordance with CSA A23.3 Annex D[1,7]

| Design parameter | | Symbol | Units | Nominal bolt/cap screw diameter (in.) | | | | Ref |
|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | A23.3-14 |
| HIS insert outside diameter | | D | mm | 16.5 | 20.5 | 25.4 | 27.6 | |
| Effective embedment[2] | | $h_{ef}$ | mm | 110 | 125 | 170 | 205 | |
| Min. concrete thickness[2] | | $h_{min}$ | mm | 150 | 170 | 230 | 270 | |
| Critical edge distance | | $c_{ac}$ | – | $2h_{ef}$ | | | | |
| Minimum edge distance | | $c_{min}$ | mm | 83 | 102 | 127 | 140 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 83 | 102 | 127 | 140 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete[3] | | $k_{c,uncr}$ | – | 10 | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete[3] | | $k_{c,cr}$ | – | 7 | | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_c$ | – | 0.65 | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | | | D.5.3(c) |
| Dry and water saturated concrete | | | | | | | | |
| Temp. range A[5] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 1,070 (7.4) | 1,070 (7.4) | 1,070 (7.4) | 1,070 (7.4) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,790 (12.3) | 1,790 (12.3) | 1,790 (12.3) | 1,790 (12.3) | D.6.5.2 |
| Temp. range B[5] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 740 (5.1) | 740 (5.1) | 740 (5.1) | 740 (5.1) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,240 (8.6) | 1,240 (8.6) | 1,240 (8.6) | 1,240 (8.6) | D.6.5.2 |
| Anchor category, dry concrete | | – | – | 1 | 1 | 1 | 1 | |
| Resistance modification factor | | $R_{dry}$ | – | 1.00 | 1.00 | 1.00 | 1.00 | |
| Water-filled hole | | | | | | | | |
| Temp. range A[5] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 800 (5.5) | 810 (5.6) | 820 (5.7) | 820 (5.7) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,340 (9.2) | 1,350 (9.3) | 1,370 (9.4) | 1,380 (9.5) | D.6.5.2 |
| Temp. range B[5] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 550 (3.8) | 560 (3.9) | 570 (3.9) | 570 (3.9) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 920 (6.3) | 930 (6.4) | 950 (6.6) | 950 (6.6) | D.6.5.2 |
| Anchor category, water-filled hole | | – | – | 3 | 3 | 3 | 3 | |
| Resistance modification factor | | $R_{wf}$ | – | 0.75 | 0.75 | 0.75 | 0.75 | |
| Underwater applications | | | | | | | | |
| Temp. range A[5] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 710 (4.9) | 720 (5.0) | 750 (5.2) | 750 (5.2) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,190 (8.2) | 1,210 (8.3) | 1,250 (8.6) | 1,260 (8.7) | D.6.5.2 |
| Temp. range B[5] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 490 (3.4) | 500 (3.4) | 510 (3.5) | 520 (3.6) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 820 (5.7) | 840 (5.8) | 860 (5.9) | 870 (6.0) | D.6.5.2 |
| Anchor category, underwater | | – | – | 3 | 3 | 3 | 3 | |
| Resistance modification factor | | $R_{uw}$ | | 0.75 | 0.75 | 0.75 | 0.75 | |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | – | 1.00 | 1.00 | 1.00 | 1.00 | |

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, tables 16 and 17, and converted for use with CSA A23.3 Annex D.

2 See figure 3 of this section.

3 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Bond stress values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of $(f'_c/2{,}500)^{0.25}$ [for SI: $(f'_c/17.2)^{0.25}$]. for uncracked concrete and $(f'c/2{,}500)^{0.15}$ [for SI: $(f'c/17.2)^{0.15}$] for cracked concrete

7 For structures assigned to Seismic Design Categories C, D, E, or F, bond stress values must be multiplied by $\alpha_{N,seis}$.

## Table 79 — Hilti HIT-RE 500 V3 design information with Hilti HIS-N and HIS-RN internally threaded inserts in diamond core drilled holes in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Nominal bolt/cap screw diameter (in.) | | | | Ref |
|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | A23.3-14 |
| HIS insert outside diameter | | D | mm | 16.5 | 20.5 | 25.4 | 27.6 | |
| Effective embedment[2] | | $h_{ef}$ | mm | 110 | 125 | 170 | 205 | |
| Min. concrete thickness[2] | | $h_{min}$ | mm | 150 | 170 | 230 | 270 | |
| Critical edge distance | | $c_{ac}$ | – | $2h_{ef}$ | | | | |
| Minimum edge distance | | $c_{min}$ | mm | 83 | 102 | 127 | 140 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 83 | 102 | 127 | 140 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete[3] | | $k_{c,uncr}$ | – | 10 | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete[3] | | $k_{c,cr}$ | – | 7 | | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_c$ | – | 0.65 | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | | | D.5.3(c) |
| Dry concrete | | | | | | | | |
| Temp. range A[5] | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 1,200 (8.3) | 1,200 (8.3) | 1,200 (8.3) | 1,200 (8.3) | D.6.5.2 |
| Temp. range B[5] | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 830 (5.7) | 830 (5.7) | 830 (5.7) | 830 (5.7) | D.6.5.2 |
| Anchor category, dry concrete | | – | – | 3 | 3 | 3 | 3 | |
| Resistance modification factor | | $R_{dry}$ | – | 0.75 | 0.75 | 0.75 | 0.75 | |
| Water saturated hole | | | | | | | | |
| Temp. range A[5] | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 1,200 (8.3) | 1,200 (8.3) | 1,200 (8.3) | 1,200 (8.3) | D.6.5.2 |
| Temp. range B[5] | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 830 (5.7) | 830 (5.7) | 830 (5.7) | 830 (5.7) | D.6.5.2 |
| Anchor category, water-saturated conc. | | – | – | 3 | 3 | 3 | 3 | |
| Resistance modification factor | | $R_{wf}$ | – | 0.75 | 0.75 | 0.75 | 0.75 | |

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018, tables 16 and 17, and converted for use with CSA A23.3 Annex D.

2 See figure 8 of section 3.2.4.3.6.

3 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Bond stress values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond stress may be increased by a factor of $(f'_c/2{,}500)^{0.25}$ [for SI: $(f'_c/17.2)^{0.25}$] for uncracked concrete.

## Table 80 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8,9,11]

| Thread size | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8-16 UNC | 4-3/8 (110) | 7,540 (33.5) | 8,430 (37.5) | 9,235 (41.1) | 10,660 (47.4) | 15,080 (67.1) | 16,860 (75.0) | 18,470 (82.1) | 21,325 (94.9) |
| 1/2-13 UNC[10] | 5 (125) | 9,135 (40.6) | 10,210 (45.4) | 11,185 (49.8) | 12,915 (57.5) | 18,265 (81.3) | 20,420 (90.8) | 22,370 (99.5) | 25,830 (114.9) |
| 5/8-11 UNC[10] | 6-3/4 (170) | 14,485 (64.4) | 16,195 (72.0) | 17,740 (78.9) | 20,485 (91.1) | 28,970 (128.9) | 32,390 (144.1) | 35,480 (157.8) | 40,970 (182.2) |
| 3/4-10 UNC[10] | 8-1/8 (205) | 19,180 (85.3) | 21,445 (95.4) | 23,490 (104.5) | 27,125 (120.7) | 38,360 (170.6) | 42,890 (190.8) | 46,985 (209.0) | 54,255 (241.3) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 50 - 51 as necessary to the above values. Compare to the steel values in table 49. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
6 Tabular values are for dry concrete or water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.52.
For submerged (under water) applications multiply design strength by 0.46.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. For diamond core drilling, except as indicated in note 10, multiply uncracked concrete tabular values by 0.57.
Diamond core drilling is not permitted for the water-filled or under-water (submerged) applications.
10 Diamond core drilling with Hilti TE-YRT roughening tool is permitted for 1/2-13 UNC, 5/8-11 UNC, and 3/4-10 UNC anchors in dry and water-saturated concrete. See Table 83.
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 81 — Hilti HIT-RE 500 V3 adhesive factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9,11]

| Thread size | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8-16 UNC | 4-3/8 (110) | 5,280 (23.5) | 5,900 (26.2) | 6,465 (28.8) | 6,985 (31.1) | 10,555 (47.0) | 11,800 (52.5) | 12,925 (57.5) | 13,965 (62.1) |
| 1/2-13 UNC[10] | 5 (125) | 6,395 (28.4) | 7,150 (31.8) | 7,830 (34.8) | 9,040 (40.2) | 12,785 (56.9) | 14,295 (63.6) | 15,660 (69.7) | 18,080 (80.4) |
| 5/8-11 UNC[10] | 6-3/4 (170) | 10,140 (45.1) | 11,335 (50.4) | 12,420 (55.2) | 14,340 (63.8) | 20,280 (90.2) | 22,675 (100.9) | 24,835 (110.5) | 28,680 (127.6) |
| 3/4-10 UNC[10] | 8-1/8 (205) | 13,425 (59.7) | 15,010 (66.8) | 16,445 (73.1) | 18,990 (84.5) | 26,855 (119.5) | 30,025 (133.5) | 32,890 (146.3) | 37,975 (168.9) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 50-51 as necessary to the above values. Compare to the steel values in table 49. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130 (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete or water-saturated concrete conditions.
For water-filled drilled holes multiply design strength by 0.52.
For submerged (under water) applications multiply design strength by 0.46.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for holes drilled in concrete with carbide tipped hammer drill bit. Diamond core drilling is not permitted in cracked concrete except as indicated in note 10.
10 Diamond core drilling is permitted in cracked concrete with use of the Hilti TE-YRT roughening tool for 1/2-13 UNC, 5/8-11 UNC, and 3/4-10 UNC anchors in dry and water-saturated concrete. See Table 84.
11 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by $\alpha_{seis}$ = 0.75. See section 3.1.8 for additional information on seismic applications.

## Table 82 — Hilti HIT-RE 500 V3 design information with Hilti HIS-N and HIS-RN internally threaded inserts in core drilled holes roughened with the TE-YRT Roughening Tool in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Nominal bolt/cap screw diameter (in.) | | | Ref |
|---|---|---|---|---|---|---|---|
| | | | | 1/2 | 5/8 | 3/4 | A23.3-14 |
| HIS insert outside diameter | | D | mm | 20.5 | 25.4 | 27.6 | |
| Effective embedment[2] | | $h_{ef}$ | mm | 125 | 170 | 205 | |
| Min. concrete thickness[2] | | $h_{min}$ | mm | 170 | 230 | 270 | |
| Critical edge distance | | $c_{ac}$ | – | $2h_{ef}$ | | | |
| Minimum edge distance | | $c_{min}$ | mm | 102 | 127 | 140 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 102 | 127 | 140 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete[3] | | $k_{c,uncr}$ | – | 10 | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete[3] | | $k_{c,cr}$ | – | 7 | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_c$ | – | 0.65 | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | | D.5.3(c) |
| Dry and water saturated concrete | | | | | | | |
| Temp. range A[5] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 750 (5.2) | 750 (5.2) | 750 (5.2) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,790 (12.3) | 1,790 (12.3) | 1,790 (12.3) | D.6.5.2 |
| Temp. range B[5] | Characteristic bond stress in cracked concrete[6,7] | $\tau_{cr}$ | psi (MPa) | 515 (3.6) | 515 (3.6) | 515 (3.6) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6,7] | $\tau_{uncr}$ | psi (MPa) | 1,240 (8.6) | 1,240 (8.6) | 1,240 (8.6) | D.6.5.2 |
| Anchor category, dry concrete | | - | - | 1 | 1 | 1 | |
| Resistance modification factor | | $R_{dry}$ | - | 1.00 | 1.00 | 1.00 | |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | - | 1.00 | 1.00 | 1.00 | |

1 Design information in this table is taken from ICC-ES ELC-3814, dated April 2018,, table 29, and converted for use with CSA A23.3 Annex D.

2 See figure 8 of section 3.2.4.3.6.

3 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Bond stress values correspond to concrete compressive strength in the range 2,500 psi ≤ $f'_c$ ≤ 8,000 psi.

7 For structures assigned to Seismic Design Categories C, D, E, or F, bond stress values must be multiplied by $\alpha_{N,seis}$.

## Table 83 — Hilti HIT-RE 500-V3 adhesive core drilled and roughened with TE-YRT Roughening Tool factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8]

| Thread size | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/2-13 UNC | 5 (125) | 9,135 (40.6) | 10,210 (45.4) | 11,185 (49.8) | 12,915 (57.5) | 18,265 (81.3) | 20,420 (90.8) | 22,370 (99.5) | 25,830 (114.9) |
| 5/8-11 UNC | 6-3/4 (170) | 14,485 (64.4) | 16,195 (72.0) | 17,740 (78.9) | 20,485 (91.1) | 28,970 (128.9) | 32,390 (144.1) | 35,480 (157.8) | 40,970 (182.2) |
| 3/4-10 UNC | 8-1/8 (205) | 19,180 (85.3) | 21,445 (95.4) | 23,490 (104.5) | 27,125 (120.7) | 38,360 (170.6) | 42,890 (190.8) | 46,985 (209.0) | 54,255 (241.3) |

## Table 84 — Hilti HIT-RE 500 V3 adhesive core drilled and roughened with TE-YRT Roughening Tool factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9]

| Thread size | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/2-13 UNC | 5 (125) | 6,105 (27.2) | 6,105 (27.2) | 6,105 (27.2) | 6,105 (27.2) | 12,215 (54.3) | 12,215 (54.3) | 12,215 (54.3) | 12,215 (54.3) |
| 5/8-11 UNC | 6-3/4 (170) | 10,140 (45.1) | 10,255 (45.6) | 10,255 (45.6) | 10,255 (45.6) | 20,280 (90.2) | 20,505 (91.2) | 20,505 (91.2) | 20,505 (91.2) |
| 3/4-10 UNC | 8-1/8 (205) | 13,425 (59.7) | 13,475 (59.9) | 13,475 (59.9) | 13,475 (59.9) | 26,855 (119.5) | 26,955 (119.9) | 26,955 (119.9) | 26,955 (119.9) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 50 - 51 as necessary to the above values. Compare to the steel values in table 49. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above values by 0.69.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete or water-saturated concrete conditions. Water-filled and submerged (under water) applications are not permitted for this hole preparation method.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values by $\alpha_{seis}$ = 0.75. See section 3.1.8 for additional information on seismic applications.

## Table 85 — Steel factored resistance for steel bolt/cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

| Thread size | ASTM A193 B7 | | | ASTM A193 Grade B8M Stainless Steel | | |
|---|---|---|---|---|---|---|
| | Tensile[4] $N_{sar}$ lb (kN) | Shear[5] $V_{sar}$ lb (kN) | Seismic Shear[6] $V_{sar,eq}$ lb (kN) | Tensile[4] $N_{sar}$ lb (kN) | Shear[5] $V_{sar}$ lb (kN) | Seismic Shear[6] $V_{sar,eq}$ lb (kN) |
| 3/8-16 UNC | 5,765 (25.6) | 3,215 (14.3) | 2,250 (10.0) | 5,070 (22.6) | 2,825 (12.6) | 1,975 (8.8) |
| 1/2-13 UNC | 9,635 (42.9) | 5,880 (26.2) | 4,115 (18.3) | 9,290 (41.3) | 5,175 (23.0) | 3,620 (16.1) |
| 5/8-11 UNC | 16,020 (71.3) | 9,365 (41.7) | 6,555 (29.2) | 14,790 (65.8) | 8,240 (36.7) | 5,770 (25.7) |
| 3/4-10 UNC | 16,280 (72.4) | 13,860 (61.7) | 9,700 (43.1) | 21,895 (97.4) | 12,195 (54.2) | 8,535 (38.0) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Hilti HIS-N and HIS-RN inserts with steel bolts are considered brittle steel elements.
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.
4 Tensile = $A_{se,N}$ $\phi_s$ $f_{uta}$ R as noted in CSA A23.3 Annex D
5 Shear = $A_{se,V}$ $\phi_s$ 0.60 $f_{uta}$ R as noted in CSA A23.3 Annex D. For 3/8-in diameter insert, shear = $A_{se,V}$ $\phi_s$ 0.50 $f_{uta}$ R.
6 Seismic Shear = $\alpha_{V,seis}$ $V_{sar}$ : Reduction factor for seismic shear only. See section 3.1.8 for additional information on seismic applications.

# POST-INSTALLED REBAR DESIGN IN CONCRETE PER ACI 318





### 3.2.4.3.8 Development and splicing of post-installed reinforcement

Calculations for post-installed rebar for typical development lengths may be done according to ACI 318 Chapter 25 (formerly ACI 318-11 Chapter 12) and CSA A23.3 Chapter 12 for adhesive anchors tested and approved in accordance with AC 308. This section contains tables for the data provided in ICC Evaluation Services ESR-3814. Refer to section 3.1.14 and the Hilti North America Post-Installed Reinforcing Bar Guide for the design method.

**Table 86 — Calculated tension development and Class B Splice lengths for Grade 60 bars in walls, slabs, columns, and footings per ACI 318 Chapter 25 for Hilti HIT-RE 500 V3**

| Rebar size | $\frac{c_b + K_{tr}}{d_b}$ | min. edge dist. in.[1] | min. spacing in.[2] | $f'_c$ = 2,500 psi | | $f'_c$ = 3,000 psi | | $f'_c$ = 4,000 psi | | $f'_c$ = 6,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $\ell_d$ in. | Class B splice in. | $\ell_d$ in. | Class B splice in. | $\ell_d$ in. | Class B splice in. | $\ell_d$ in. | Class B splice in. |
| #3 | 2.5 | 2-1/4 | 2 | 12 | 14 | 12 | 13 | 12 | 12 | 12 | 12 |
| #4 | | 2-3/4 | 2-1/2 | 14 | 19 | 13 | 17 | 12 | 15 | 12 | 12 |
| #5 | | 3 | 3-1/4 | 18 | 23 | 16 | 21 | 14 | 18 | 12 | 15 |
| #6 | | 3-3/4 | 3-3/4 | 22 | 28 | 20 | 26 | 17 | 22 | 14 | 18 |
| #7 | | 4-1/2 | 4-1/2 | 32 | 41 | 29 | 37 | 25 | 32 | 20 | 26 |
| #8 | | 5 | 5 | 36 | 47 | 33 | 43 | 28 | 37 | 23 | 30 |
| #9 | | 5-1/4 | 5-3/4 | 41 | 53 | 37 | 48 | 32 | 42 | 26 | 34 |
| #10 | | 5-3/4 | 6-1/2 | 46 | 59 | 42 | 54 | 36 | 47 | 30 | 38 |

1 Edge distances are determined using the minimum cover specified by ESR-3814 with an additional 6% of the development length per suggestions for drilling without an aid per Hilti Post-Installed Reinforcing Bar Guide Section 3.3. Smaller edge distances may be possible, for which development and splice lengths may need to be recalculated. For further information on required cover see ACI 318, Sec. 20.6.1.3.1; see Sec. 2.2 for determination of $c_b$.

2 Spacing values represent those producing $c_b$ =5 $d_b$ rounded up to the nearest 1/4 in. Smaller spacing values may be possible, for which development and splice lengths may need to be recalculated. For further information on required spacing see ACI 318 Sec. 25.2; see Sec. 2.2 for determination of $c_b$.

3 $\psi_t$ = 1.0 See ACI 318, Sec. 25.4.2.4.

4 $\psi_e$ = 1.0 for non-epoxy coated bars. See ACI 318, Sec. 25.4.2.4.

5 $\psi_s$ = 0.8 for #6 bars and smaller bars, 1.0 for #7 and larger bars. See ACI 318, Sec. 25.4.2.4.

6 Values are for normal weight concrete. For sand-lightweight concrete, multiply development and splice lengths by 1.18, for all-lightweight concrete multiply development and splice lengths by 1.33. See ACI 318 Sec. 19.2.4.

7 Development and splice length values are for static design. Seismic design development and splice lengths can be found in ACI 318 18.8.5 for special moment frames and ACI 318 18.10.2.3 for special structural walls. For further information about reinforcement in seismic design, see ACI 318 Ch. 18.

8 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples.

## Table 87 — Suggested embedment, edge distance, and spacing (see figure below) to develop 125% of $f_y$ in Grade 60 bars based on ACI 318 Chapter 17 - SDC A and B only[1,2,3,4,5,6,7]

| Rebar size | $f'_c$ = 2,500 psi | | | | $f'_c$ = 3,000 psi | | | | $f'_c$ = 4,000 psi | | | | $f'_c$ = 6,000 psi | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing $s_{min}$ in. | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing $s_{min}$ in. | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing $s_{min}$ in. | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing $s_{min}$ in. |
| | | Cond. I | Cond. II | | | Cond. I | Cond. II | | | Cond. I | Cond. II | | | Cond. I | Cond. II | |
| #3 | 7 | 17 | 8 | 15 | 6 | 16 | 7 | 14 | 6 | 16 | 7 | 13 | 5 | 15 | 6 | 11 |
| #4 | 9 | 23 | 11 | 22 | 9 | 23 | 11 | 21 | 8 | 22 | 10 | 19 | 7 | 20 | 9 | 17 |
| #5 | 11 | 29 | 15 | 29 | 11 | 28 | 14 | 28 | 10 | 27 | 13 | 25 | 9 | 25 | 11 | 22 |
| #6 | 13 | 35 | 19 | 37 | 13 | 34 | 18 | 35 | 12 | 32 | 16 | 32 | 11 | 30 | 14 | 28 |
| #7 | 16 | 41 | 23 | 45 | 15 | 40 | 22 | 43 | 14 | 38 | 20 | 39 | 13 | 36 | 17 | 34 |
| #8 | 18 | 48 | 27 | 54 | 17 | 46 | 26 | 51 | 16 | 44 | 24 | 47 | 15 | 42 | 21 | 41 |
| #9 | 21 | 56 | 32 | 63 | 20 | 54 | 30 | 60 | 18 | 50 | 27 | 54 | 17 | 47 | 24 | 48 |
| #10 | 25 | 65 | 37 | 74 | 24 | 63 | 35 | 70 | 22 | 58 | 32 | 64 | 19 | 54 | 28 | 56 |

1 For additional information see May-June 2013 issue of the ACI Structural Journal, “Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures” by Charney, Pal and Silva.

2 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14 to develop 125% of nominal bar yield. Bond stresses apply for sustained and non-sustained load conditions. Additional reductions per ACI 318, 17.3.1.2 are not included, however, and as such these embedments are not intended for sustained tension load applications. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the unbolded and bolded tabulated hef values by 0.80 and 0.86, respectively. Reduction factors for non-sustained loading and no bar overstrength may be combined.

3 $c_a$ and s are the minimum edge distance and bar spacing (from bar centerline) associated with the tabulated embedments. Refer to sec. 3.1.14 for applicability of edge distance “Condition I” and “Condition II.”

4 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

5 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814 Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

6 Values are for normal weight concrete. For lightweight concrete contact Hilti.

7 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

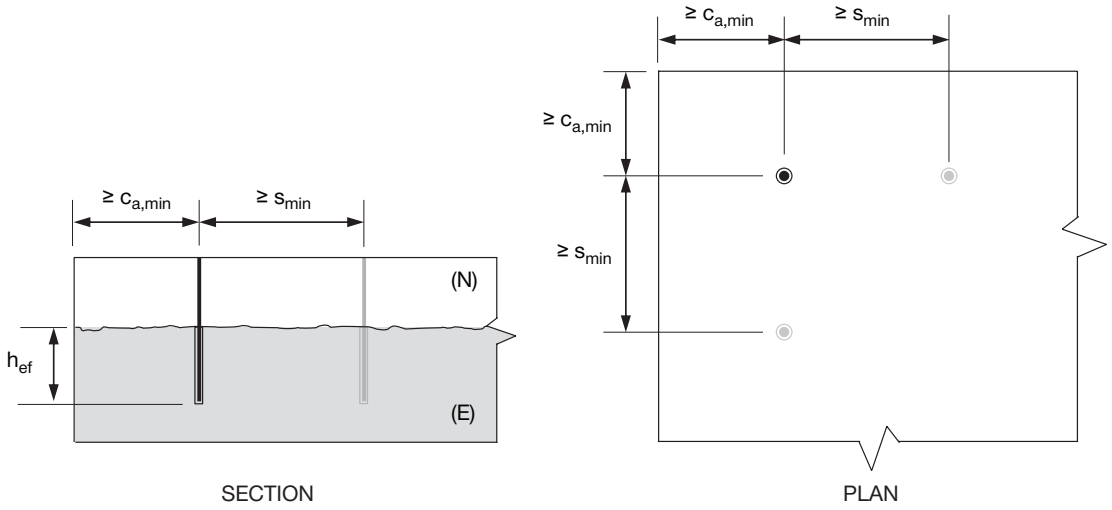



Illustration of Table 87 dimensions

**Table 88 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of $f_y$ in Grade 60 wall/column starter bars in a linear array with bar spacing = 24 inches - SDC A and B only[1,2,3,4,5,6]**

| Rebar size | Linear spacing s in. | $f'_c$ = 2,500 psi | | | $f'_c$ = 3,000 psi | | | $f'_c$ = 4,000 psi | | | $f'_c$ = 6,000 psi | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | |
| | | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II |
| #3 | 24 | 7 | 17 | 8 | 6 | 16 | 7 | 6 | 16 | 7 | 5 | 15 | 6 |
| #4 | | 9 | 23 | 11 | 9 | 23 | 11 | 8 | 22 | 10 | 7 | 20 | 9 |
| #5 | | 13 | 34 | 19 | 11 | 30 | 17 | 10 | 27 | 13 | 9 | 25 | 11 |
| #6 | | 21 | 57 | 32 | 19 | 51 | 28 | 15 | 43 | 23 | 11 | 32 | 17 |
| #7 | | – | – | – | – | – | – | 24 | 66 | 35 | 18 | 52 | 27 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 24 in. Refer to sec. 3.1.14.3 for applicability of edge distance "Condition I" and "Condition II."

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814 Tables 12 and 13 assuming dry concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for detailed explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

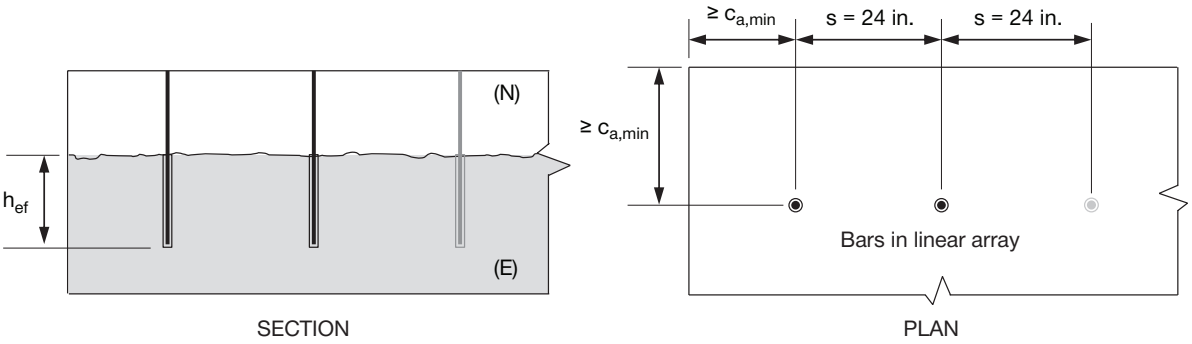



Illustration of Table 88 dimensions

**Table 89 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of fy in Grade 60 wall/column starter bars in a linear array with bar spacing = 18 inches - SDC A and B only[1,2,3,4,5,6]**

| Rebar size | Linear spacing s in. | $f'_c$ = 2,500 psi | | | $f'_c$ = 3,000 psi | | | $f'_c$ = 4,000 psi | | | $f'_c$ = 6,000 psi | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | |
| | | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II |
| #3 | 18 | 7 | 17 | 8 | 6 | 16 | 7 | 6 | 16 | 7 | 5 | 15 | 6 |
| #4 | | 10 | 26 | 14 | 9 | 23 | 13 | 8 | 22 | 10 | 7 | 20 | 9 |
| #5 | | – | – | – | – | – | – | 13 | 36 | 19 | 10 | 28 | 14 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 18 in. Refer to sec. 3.1.14.3 for applicability of edge distance "Condition I" and "Condition II."

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814 Tables 12 and 13 assuming dry concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for detailed explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

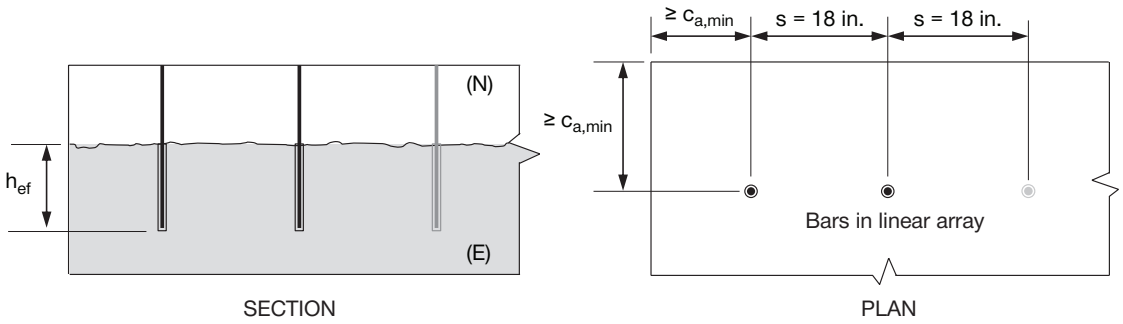



Illustration of Table 89 dimensions

**Table 90 — Suggested embedment and edge distance (see figure below) based on ACI 318 Chapter 17 to develop 125% of $f_y$ in Grade 60 wall/column starter bars in a linear array with bar spacing = 12 inches - SDC A and B only[1,2,3,4,5,6]**

| Rebar size | Linear spacing s in. | $f'_c$ = 2,500 psi | | | $f'_c$ = 3,000 psi | | | $f'_c$ = 4,000 psi | | | $f'_c$ = 6,000 psi | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | | Effective embed. $h_{ef}$ in. | Minimum edge dist $c_{a,min}$ in. | |
| | | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II |
| #3 | 12 | 7 | 17 | 10 | 6 | 16 | 9 | 6 | 16 | 7 | 5 | 15 | 6 |
| #4 | | – | – | – | – | – | – | 11 | 31 | 16 | 8 | 24 | 12 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 12 in. Refer to sec. 3.1.14.3 for applicability of edge distance "Condition I" and "Condition II."

3 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

4 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814 Tables 12 and 13 assuming dry concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

5 Values are for normal weight concrete. For lightweight concrete contact Hilti.

6 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for detailed explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

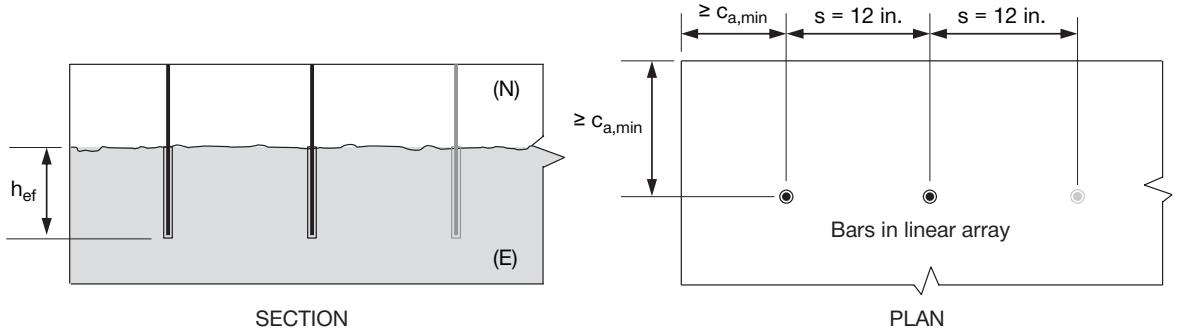



Illustration of Table 90 dimensions

## Table 91 — Calculated tension development and Class B Splice lengths for Canadian 400 MPa bars in walls, slabs, columns, and footings per CSA 23.3-14 for Hilti HIT-RE 500 V3 - non-seismic design only[3,4,5,6,7,8]

| Rebar size | $d_{cs} + K_{tr}$ | min. edge dist. mm[1] | min. spacing mm[2] | $f'_c$ = 20 MPa | | $f'_c$ = 25 MPa | | $f'_c$ = 30 MPa | | $f'_c$ = 40 MPa | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $\ell_d$ mm | Class B splice mm | $\ell_d$ mm | Class B splice mm | $\ell_d$ mm | Class B splice mm | $\ell_d$ mm | Class B splice mm |
| 10M | 2.5 $d_b$ | 60 | 50 | 300 | 380 | 300 | 340 | 300 | 310 | 300 | 300 |
| 15M | | 70 | 75 | 410 | 540 | 370 | 480 | 340 | 440 | 300 | 380 |
| 20M | | 80 | 100 | 510 | 660 | 450 | 490 | 410 | 540 | 360 | 460 |
| 25M | | 120 | 125 | 820 | 1,060 | 730 | 950 | 670 | 870 | 580 | 750 |
| 30M | | 130 | 150 | 960 | 1,250 | 860 | 1,120 | 790 | 1,020 | 680 | 890 |

1 Edge distances are determined using the minimum cover specified by ESR-3184 with an additional 6% of the development length per suggestions for drilling without an aid per Hilti Post-Installed Reinforcing Bar Guide Section 3.3. Smaller edge distances may be possible, for which development and splice lengths may need to be recalculated. For further information on required cover see CSA A23.1-14 Table 17; see Sec. 3.2 for determination of $d_{cs}$.

2 Spacing values represent those producing $d_{cs} = 5d_b$. Smaller spacing values may be possible, for which development and splice lengths may need to be recalculated. For further information on required spacing see CSA A23.1 Sec. 6.6.5.2; see Sec. 3.2 for determination of $d_{cs}$.

3 $k_1$ and $k_2$ as defined by CSA A23.3 12.2.4 (a) and (b), are taken as 1.0 for post-installed reinforcing bars. For additional information see May-June 2013 issue of the ACI Structural Journal, "Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures" by Charney, Pal and Silva.

4 $k_3$ = 0.8 for 20M bars and smaller bars, 1.0 for 25M and larger bars. See CSA A23.3 12.2.4 (d).

5 $K_{tr}$ is assumed to equal zero.

6 Values are for normal weight concrete. For lightweight concrete, multiply development and splice lengths by 1.3.

7 Development and splice length values are for static design. For tension development and splice lengths of bars in joints, see CSA A23.3 21.3.3.5. For further information about reinforcement in seismic design, see CSA A23.3 Ch. 21.

8 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples.

## Table 92 — Suggested embedment, edge distance, and spacing (see figure below) to develop 125% of $f_y$ in Canadian 400 MPa bars based on CSA 23.3-14 Annex D - non-seismic design only[1,2,3,4,5,6,7]

| | $f'_c$ = 20 MPa | | | | $f'_c$ = 25 MPa | | | | $f'_c$ = 30 MPa | | | | $f'_c$ = 40 MPa | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Effective embed. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing | Effective embed. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing | Effective embed. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing | Effective embed. | Minimum edge dist $c_{a,min}$ in. | | Min. spacing |
| Rebar size | $h_{ef}$ mm | Cond. I | Cond. II | $s_{min}$ mm | $h_{ef}$ mm | Cond. I | Cond. II | $s_{min}$ mm | $h_{ef}$ mm | Cond. I | Cond. II | $s_{min}$ mm | $h_{ef}$ mm | Cond. I | Cond. II | $s_{min}$ mm |
| 10M | 180 | 480 | 220 | 440 | 170 | 470 | 200 | 400 | 160 | 450 | 190 | 380 | 150 | 430 | 180 | 350 |
| 15M | 260 | 690 | 350 | 690 | 240 | 670 | 320 | 640 | 230 | 650 | 300 | 600 | 220 | 620 | 280 | 550 |
| 20M | 310 | 850 | 450 | 900 | 300 | 820 | 420 | 840 | 280 | 800 | 400 | 790 | 270 | 760 | 360 | 720 |
| 25M | 420 | 1,140 | 630 | 1,260 | 400 | 1,080 | 590 | 1,170 | 380 | 1,050 | 560 | 1,110 | 350 | 1,000 | 500 | 1,000 |
| 30M | 530 | 1,420 | 790 | 1,580 | 490 | 1,340 | 740 | 1,470 | 460 | 1,280 | 690 | 1,380 | 420 | 1,200 | 630 | 1,260 |

1 For additional information see May-June 2013 issue of the ACI Structural Journal, "Recommended Procedures for Development and Splicing of Post-Installed Bonded Reinforcing Bars in Concrete Structures" by Charney, Pal and Silva.

2 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.3 to develop 125% of nominal bar yield. Bond stresses apply for sustained and non-sustained load conditions. Additional reductions per ACI 318, 17.3.1.2 are not included, however, and as such these embedments are not intended for sustained tension load applications. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the unbolded and bolded tabulated hef values by 0.80 and 0.86, respectively. Reduction factors for non-sustained loading and no bar overstrength may be combined.

3 $c_a$ and s are the minimum edge distance and bar spacing (from bar centerline) associated with the tabulated embedments. Refer to sec. 3.1.14.3 for applicability of edge distance "Condition I" and "Condition II."

4 Applicable for hammer-drilled holes. For rock-drilled and core-drilled holes, contact Hilti.

5 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814 Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

6 Values are for normal weight concrete. For lightweight concrete contact Hilti.

7 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

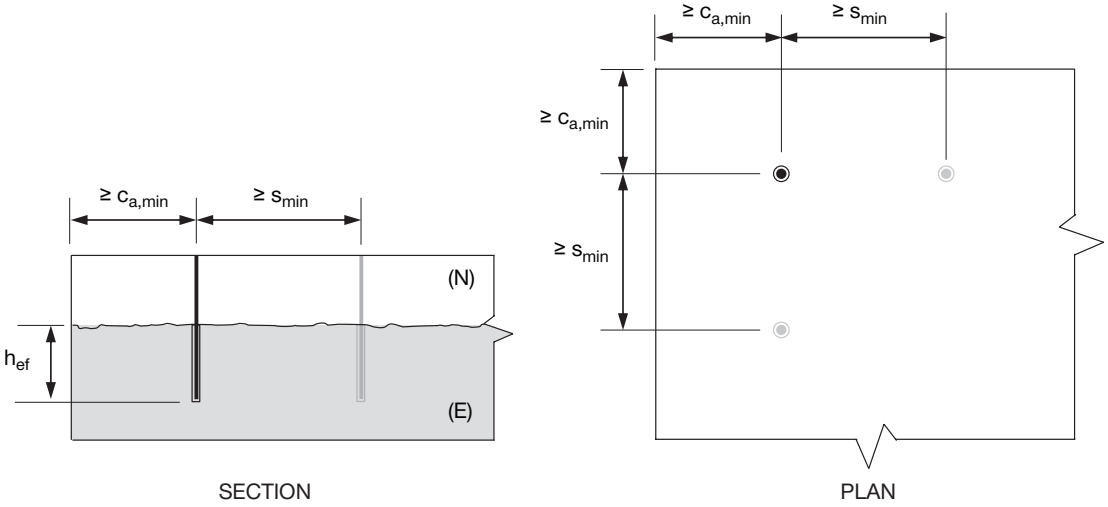



Illustration of Table 91 dimensions

## Table 93 — Suggested embedment and edge distance (see figure below) based on CSA 23.3 Annex D to develop 125% of $f_y$ in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 600 mm - non-seismic only[1,2,3,4,5]

| Rebar size | Linear spacing s mm | $f'_c$ = 20 MPa | | | $f'_c$ = 25 MPa | | | $f'_c$ = 30 MPa | | | $f'_c$ = 40 MPa | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | |
| | | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II |
| 10M | 600 | 180 | 480 | 220 | 170 | 470 | 200 | 160 | 450 | 190 | 150 | 430 | 180 |
| 15M | | 280 | 760 | 420 | 240 | 670 | 350 | 230 | 650 | 300 | 220 | 620 | 280 |
| 20M | | – | – | – | 430 | 1,220 | 650 | 380 | 1,080 | 570 | 310 | 890 | 460 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 600 mm. Refer to sec. 3.1.14.3 for applicability of edge distance "Condition I" and "Condition II."

3 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

4 Values are for normal weight concrete. For lightweight concrete contact Hilti.

5 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

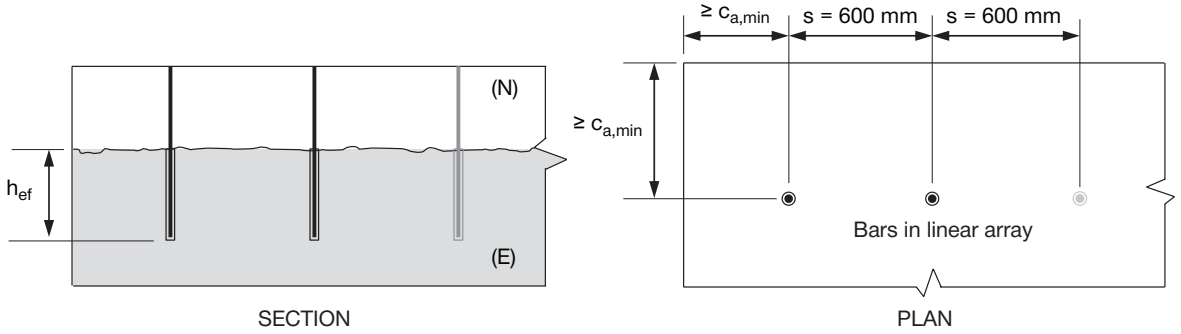



Illustration of Table 93 dimensions

**Table 94 — Suggested embedment and edge distance (see figure below) based on CSA 23.3 Annex D to develop 125% of $f_y$ in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 450 mm - non-seismic only[1,2,3,4,5]**

| Rebar size | Linear spacing s mm | $f'_c$ = 20 MPa | | | $f'_c$ = 25 MPa | | | $f'_c$ = 30 MPa | | | $f'_c$ = 40 MPa | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | | Effective embed. $h_{ef}$ mm | Minimum edge dist $c_{a,min}$ mm | |
| | | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II | | Cond. I | Cond. II |
| 10M | 450 | 180 | 480 | 220 | 170 | 470 | 200 | 160 | 450 | 190 | 150 | 430 | 180 |
| 15M | | 400 | 1,090 | 590 | 340 | 950 | 510 | 300 | 840 | 440 | 240 | 690 | 360 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 450 mm. Refer to sec. 3.1.14.3 for applicability of edge distance "Condition I" and "Condition II."

3 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

4 Values are for normal weight concrete. For lightweight concrete contact Hilti.

5 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

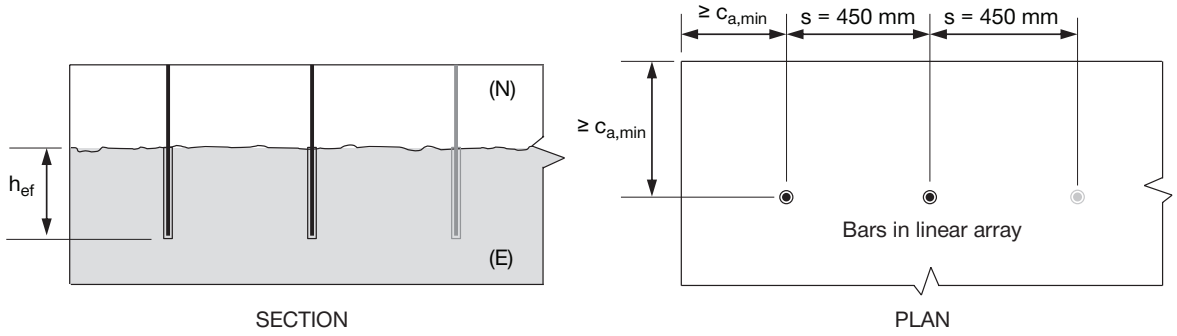



Illustration of Table 94 dimensions

## Table 95 — Suggested embedment and edge distance (see figure below) based on CSA 23.3 Annex D to develop 125% of $f_y$ in Canadian 400 MPa wall/column starter bars in a linear array with bar spacing = 300 mm - non-seismic only[1,2,3,4,5]

| | | $f'_c$ = 20 MPa | | | $f'_c$ = 25 MPa | | | $f'_c$ = 30 MPa | | | $f'_c$ = 40 MPa | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum edge dist $c_{a,min}$ mm | | | Minimum edge dist $c_{a,min}$ mm | | | Minimum edge dist $c_{a,min}$ mm | | | Minimum edge dist $c_{a,min}$ mm | |
| Rebar size | Linear spacing s mm | Effective embed. $h_{ef}$ mm | Cond. I | Cond. II | Effective embed. $h_{ef}$ mm | Cond. I | Cond. II | Effective embed. $h_{ef}$ mm | Cond. I | Cond. II | Effective embed. $h_{ef}$ mm | Cond. I | Cond. II |
| 10M | 300 | 240 | 650 | 350 | 200 | 560 | 300 | 180 | 500 | 260 | 160 | 450 | 210 |

1 $h_{ef}$ is the calculated bar embedment based on uncracked bond and concrete breakout strengths using equations in section 3.1.14.4 to develop 125% of nominal bar yield. Shaded embedment values exceed 20 bar diameters. For non-tabulated rebar sizes, design per development length provisions is recommended. The particular assumptions used for the application of anchor theory to bar development (e.g., bar yield and bond strength values) are a matter of engineering judgment and will in part depend on the specific circumstances of the design. For embedments corresponding to nominal yield (i.e., no overstrength) multiply the tabulated hef values by 0.86.

2 $c_a$ is the minimum edge distance (from bar centerline) associated with the tabulated embedments and s = 300 mm. Refer to sec. 3.1.14.3 for applicability of edge distance "Condition I" and "Condition II."

3 Values determined with bond stresses, k-factors and strength reduction factors taken from ESR-3814, Tables 12 and 13 assuming dry, uncracked concrete conditions where concrete temperatures will not exceed a maximum short-term temperature of 130°F (55°C) and long-term temperature of 110°F (43°C). Bond stresses are for static (non-seismic) loading conditions.

4 Values are for normal weight concrete. For lightweight concrete contact Hilti.

5 Refer to the Hilti North America Post-Installed Reinforcing Bar Guide for further explanation, background information, and design examples. See Hilti Instructions for Use (IFU) for specific installation requirements.

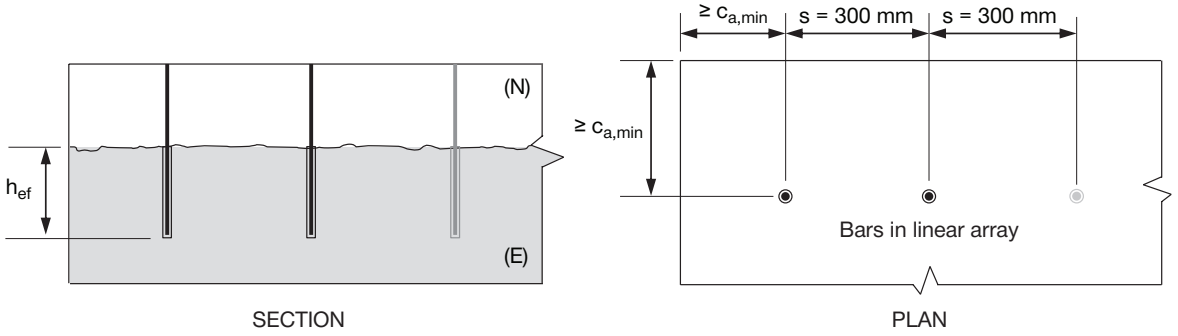



Illustration of Table 95 dimensions

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.



## MATERIAL SPECIFICATIONS

**Figure 9 — Hilti HIT-RE 500 V3 adhesive cure and working time (approx.)**

| T | [°F] | [°C] | $t_{work}$ | $t_{cure, ini}$ | $t_{cure, full}$ |
|---|---|---|---|---|---|
| | 23 | -5 | 2 h | 48 h | 168 h |
| | 32 | 0 | 2 h | 24 h | 36 h |
| | 40 | 4 | 2 h | 16 h | 24 h |
| | 50 | 10 | 1.5 h | 12 h | 16 h |
| | 60 | 16 | 1 h | 8 h | 16 h |
| | 72 | 22 | 25 min | 4 h | 6.5 h |
| | 85 | 29 | 15 min | 2.5 h | 5 h |
| | 95 | 35 | 12 min | 2 h | 4.5 h |
| | 105 | 41 | 10 min | 2 h | 4 h |

≥ +5 °C / 41 °F

= 2x $t_{cure}$

**Table 96 — Resistance of cured Hilti HIT-RE 500 V3 to chemicals**

| Chemicals tested | Content (%) | Resistance |
|---|---|---|
| toluene | 47.5 | |
| iso-octane | 30.4 | |
| heptane | 17.1 | + |
| methanol | 3 | |
| butanol | 2 | |
| toluene | 60 | |
| xylene | 30 | + |
| methylnaphthalene | 10 | |
| diesel | 100 | + |
| petrol | 100 | + |
| methanol | 100 | – |
| dichloromethane | 100 | – |
| mono-chlorobenzene | 100 | ● |
| ethylacetat | 50 | + |
| methylisobutylketone | 50 | |
| salicylic acid-methylester | 50 | + |
| mcetophenon | 50 | |
| acetic acid | 50 | – |
| propionic acid | 50 | |
| sulfuric acid | 100 | – |
| nitric acid | 100 | – |
| hyrdocholoric acid | 36 | – |
| potassium hydroxide | 100 | – |
| sodium hydroxide 20% | 100 | – |
| triethanolamine | 50 | – |
| butylamine | 50 | |
| benzyl alcohol | 100 | |
| ethanol | 100 | |
| ethyl acetate | 100 | – |
| methyl ethly ketone (MEK) | 100 | |
| trichlorethylene | 100 | |
| lutensit TC KLC 50 | 3 | |
| marlophen NP 9,5 | 2 | + |
| water | 95 | |
| tetrahydrofurane | 100 | – |
| demineralized water | 100 | + |
| salt water | saturated | + |
| salt spray testing | – | + |
| $SO_2$ | – | + |
| environment/weather | – | + |
| oil for formwork (forming oil) | 100 | + |
| concrete plasticizer | – | + |
| concrete drilling mud | – | + |
| concrete potash solution | – | + |
| saturated suspension of bore-hole cuttings | – | + |

Key: – non-resistant
+ resistant
● limited resistance

Samples of the HIT-HY 200 A/R V3 adhesive were immersed in the various chemical compounds for up to one year. At the end of the test period, the samples were analyzed. Any samples showing no visible damage and having less than a 25% reduction in bending (flexural) strength were classified as "Resistant." Samples that had slight damage, such as small cracks, chips, etc. or reduction in bending strength of 25% or more were classified as "Limited Resistance" (i.e. exposed for 48 hours or less until chemical is cleaned up). Samples that were heavily damaged or destroyed were classified as "Non-Resistant."

Note: In actual use, the majority of the adhesive is encased in the base material, leaving very little surface area exposed.

## ORDERING INFORMATION




### HIT-RE 500 V3

| Description | Package contents | Qty |
|---|---|---|
| **HIT-RE 500 V3 (11.1 fl oz/330 ml)** | Includes (1) foil pack with (1) mixer and 3/8 filler tube per pack | 1 |
| **HIT-RE 500 V3 Master Carton (11.1 fl oz/330 ml)** | Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack | 25 |
| **HIT-RE 500 V3 Combo (11.1 fl oz/330 ml)** | Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 Manual Dispenser | 25 |
| **HIT-RE 500 V3 Master Carton (16.9 fl oz/500 ml)** | Includes (1) master carton containing (20) foil packs with (1) mixer and 3/8 filler tube per pack | 20 |
| **HIT-RE 500 V3 Combo (16.9 fl oz/500 ml)** | Includes (2) master cartons containing (20) foil packs each with (1) mixer and 3/8 filler tube per pack and (1) HDM 500 Manual Dispenser | 40 |
| **HIT-RE 500 V3 (47.3 fl oz/1400 ml)** | Includes (4) foil packs with (1) mixer and 3/8 filler tube per pack | 4 |
| **HIT-RE 500 V3 Pallet (47.3 fl oz/1400 ml)** | Includes (64) foil packs with (1) mixer and 3/8 filler tube per pack and (1) P800 Pneumatic Dispenser | 64 |
| **HIT-RE 500 V3 TE-CD Starter Package** | Includes foil packs, dispensers, vacuum, hammer drill and various drill bit sizes. Contact Hilti for exact package contents. | 40 |
| **HIT-RE 500 V3 TE-YD Starter Package** | Includes foil packs, dispensers, vacuum, hammer drill and various drill bit sizes. Contact Hilti for exact package contents. | 40 |
| **HIT-RE-M Static Mixer For use with HIT-RE 500 V3 cartridges** | | 1 |



### TE-YRT Roughening Tool

| Order description | Description | Length |
|---|---|---|
| **TE-YRT 7/8" x 15"** | Roughening tool for use with 3/4" diameter threaded rod in core drilled holes | 15" |
| **TE-YRT 1-1/8" x 20** | Roughening tool for use with 1" diameter threaded rod in core drilled holes | 20" |
| **TE-YRT 1-3/8" x 25"** | Roughening tool for use with 1-1/4" diameter threaded rod in core drilled holes | 25" |
| **RTG 7/8"** | Roughening tool gauge for TE-YRT 7/8" | |
| **RTG 1-1/8"** | Roughening tool gauge for TE-YRT 1-1/8" | |
| **RTG 1-3/8"** | Roughening tool gauge for TE-YRT 1-3/8" | |



### TE-CD Hollow Drill Bits

| Order description | Working length |
|---|---|
| **Hollow Drill Bit TE-CD 1/2" x 13"** | 8" |
| **Hollow Drill Bit TE-CD 9/16" x 14"** | 9-1/2" |
| **Hollow Drill Bit TE-CD 5/8" x 14"** | 9-1/2" |
| **Hollow Drill Bit TE-CD 3/4" x 14"** | 9-1/2" |



### TE-YD Hollow Drill Bits

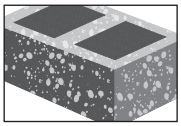
| Order description | Working length |
|---|---|
| **Hollow drill bit TE-YD 5/8" x 24"** | 15-3/4" |
| **Hollow drill bit TE-YD 3/4" x 24"** | 15-3/4" |
| **Hollow drill bit TE-YD 7/8" x 24"** | 15-3/4" |
| **Hollow drill bit TE-YD 1" x 24"** | 15-3/4" |
| **Hollow drill bit TE-YD 1-1/8" x 24"** | 15-3/4" |
| **Hollow drill bit TE-YD 5/8" x 35"** | 26" |
| **Hollow drill bit TE-YD 3/4" x 35"** | 26" |
| **Hollow drill bit TE-YD 7/8" x 35"** | 26" |
| **Hollow drill bit TE-YD 1" x 35"** | 26" |
| **Hollow drill bit TE-YD 1-1/8" x 47"** | 39" |

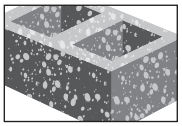
# 3.2.4 HIT-HY 270 HYBRID FOR MASONRY CONSTRUCTION

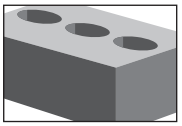
## PRODUCT DESCRIPTION

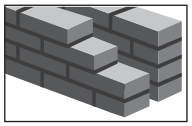
**HIT-HY 270 with Threaded Rod, Rebar, and HIS-N/RN Inserts**

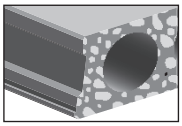
| Anchor System | | Features and Benefits |
|---|---|---|
|  | Hilti HIT-HY 270 Cartridge | • Injectable two-component hybrid adhesive mortar<br>• For use in grouted and ungrouted concrete masonry block walls, solid and hollow brick walls and unreinforced multi-wythe brick walls referred to as unreinforced masonry or URM.<br>• ICC-ES approved for grout-filled and ungrouted concrete masonry and hollow brick<br>• ICC-ES approved for unreinforced masonry (URM)<br>• No hole cleaning requirement when installed with SafeSet™ hollow drill bit technology |
|  | Hilti HAS Threaded Rods | |
|  | Rebar | |
|  | Mesh sleeve HIT-SC | |
|  | Hilti HIS-N/RN | |

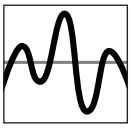

Grout-filled concrete masonry


Ungrouted concrete masonry


Hollow brick


Unreinforced masonry


Hollowcore concrete


Seismic Design categories A-F

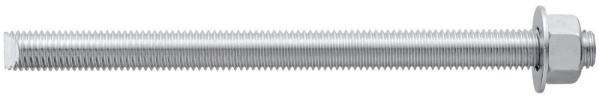


Hollow drill bit

| Approvals/Listings | |
|---|---|
| **ICC-ES (International Code Council)** | ESR-4143 in hollow and grout-filled CMU and hollow brick per ICC-ES AC58<br>ESR-4144 in unreinforced masonry per ICC-ES AC60 |
| **European Technical Approval** | ETA-13/1036 |
| **City of Los Angeles** | 2017 LABC Supplement (within ESR-4143 and ESR-4144) |
| **Florida Building Code** | 2017 FBC Supplement (within ESR-4143) w/ HVHZ |
| **U.S. Green Building Council** | LEED® Credit 4.1-Low Emitting Materials |

## DESIGN DATA IN MASONRY

**HIT-HY 270 adhesive with Hilti HAS threaded rods and deformed reinforcing bars (Rebar)**



Hilti HAS Threaded Rods



Deformed Reinforcing Bars (Rebar)

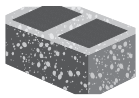
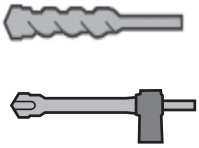
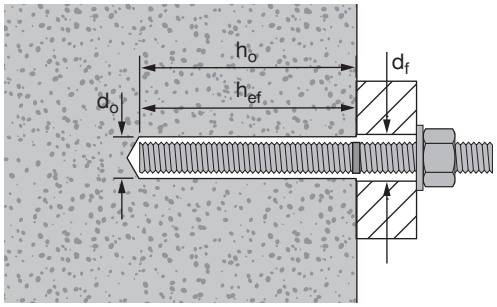
| Permissible Base Materials | | Permissible drilling method | |
|---|---|---|---|
| |  Grout-filled concrete masonry | |  Hammer drilling with carbide tipped drill bit<br>Hilti TE-CD or TE-YD hollow drill bit (for diameters 1/2" - 3/4") |

**Figure 1 — Hilti HIT-HY 270 specifications for HAS threaded rod and reinforcing bars in grout-filled concrete masonry walls**




**Hilti installation specifications for HAS threaded rod in grout-filled concrete masonry walls**

| Setting information | Symbol | Units | Nominal rod diameter (in.) | | | |
|---|---|---|---|---|---|---|
| | | | 3/8 | 1/2 | 5/8 | 3/4 |
| Nominal bit diameter | $d_o$ | in. | 7/16 | 9/16 | 3/4 | 7/8 |
| Nominal / effective embedment | $h_o$ / $h_{ef}$ | in.<br>(mm) | 3-3/8<br>(86) | 4-1/2<br>(114) | 5-5/8<br>(143) | 6-3/4<br>(171) |
| Maximum installation torque | $T_{inst}$ | ft-lb<br>(Nm) | 6<br>(8) | 7.5<br>(10) | 7.5<br>(10) | 10<br>(13.5) |
| Diameter of fixture hole | $d_f$ | in. | 7/16 | 9/16 | 11/16 | 13/16 |

**Hilti installation specifications for reinforcing bars in grout-filled concrete masonry walls**

| Setting information | Symbol | Units | Rebar size | | | |
|---|---|---|---|---|---|---|
| | | | #3 | #4 | #5 | #6 |
| Nominal bit diameter | $d_o$ | in. | 1/2 | 5/8 | 3/4 | 7/8 |
| Nominal / effective embedment | $h_o$ / $h_{ef}$ | in.<br>(mm) | 3-3/8<br>(86) | 4-1/2<br>(114) | 5-5/8<br>(143) | 6-3/4<br>(171) |

## MATERIAL SPECIFICATIONS

**Table 1 — Properties of fully-cured HIT-HY 270 adhesive**

| | | | |
|---|---|---|---|
| Compressive strength | ASTM D695/DIN 53454 | 7,252-10,153 psi | 50-70 MPa |
| Modulus of elasticity (Compression test) | ASTM D790/DIN 53452 | 246,568 psi | 1,700 MPa |
| Water absorption | ASTM D570/DIN 53495 | 3 - 8% | |
| Electrical resistance | VDE/DIN 0303T3 | 4.2 x 10" ohm/in. | 1.065 x $10^{12}$ ohm/cm |

Material specifications for Hilti HAS threaded rods and Hilti HIS-N inserts are listed in section 3.2.8.

**Table 2 — Hilti HIT-HY 270 allowable adhesive bond tension loads for threaded rods and reinforcing bars in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]**

| Nominal anchor diameter | Rebar size | Effective embedment in. (mm)[11] | Tension lb (kN) | Spacing[9] | | | Edge distance[10] | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load reduction factor @ $s_{min}$[12] | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load reduction factor @ $c_{min}$[12] |
| 3/8 | #3 | 3-3/8 (86) | 1,240 (5.5) | 13.5 (343) | 4 (102) | 0.70 | 12 (305) | 4 (102) | 0.80 |
| 1/2 | #4 | 4-1/2 (114) | 2,035 (9.1) | 18 (457) | | 0.70 | 20 (508) | | 0.76 |
| 5/8 | #5 | 5-5/8 (143) | 2,840 (12.6) | 22.5 (572) | | 0.50 | 20 (508) | | 0.71 |
| 3/4 | #6 | 6-3/4 (171) | 3,810 (16.9) | 27 (686) | | 0.50 | 20 (508) | | 0.66 |

**Table 3 — Hilti HIT-HY 270 allowable adhesive bond shear loads for threaded rods and reinforcing bars in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]**

| Nominal anchor diameter | Rebar size | Effective embedment in. (mm)[11] | Shear lb (kN) | Spacing[9] | | | Edge distance[10] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load reduction factor @ $s_{min}$[12] | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load reduction factor @ $c_{min}$[12] | |
| | | | | | | | | | Load perpendicular to edge | Load parallel to edge |
| 3/8 | #3 | 3-3/8 (86) | 850 (3.8) | 13.5 (343) | 4 (102) | 1.00 | 12 (305) | 4 (102) | 0.88 | 1.00 |
| 1/2 | #4 | 4-1/2 (114) | 1,495 (6.7) | 18 (457) | | 1.00 | 12 (305) | | 0.49 | 1.00 |
| 5/8 | #5 | 5-5/8 (143) | 2,615 (11.6) | 22.5 (572) | | 0.50 | 20 (508) | | 0.40 | 0.78 |
| 3/4 | #6 | 6-3/4 (171) | 4,090 (18.2) | 27 (686) | | 0.50 | 20 (508) | | 0.26 | 0.60 |

**The following footnotes apply to both Tables 1 and 2:**

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

2 Anchors may be installed in any location in the face of the masonry wall including cell, web, and mortar joints. Anchors are limited to one per masonry cell. See Figure 2

3 Linear interpolation of load values between minimum spacing ($s_{min}$) and critical spacing ($s_{cr}$) and between minimum edge distance ($c_{min}$) and critical edge distance ($c_{cr}$) is permitted.

4 Concrete masonry thickness must be equal to or greater than 1.5 times the anchor embedment depth. EXCEPTION: the 5/8-inch- and the 3/4-inch diameter anchors (No. 5 and No. 6 bars) may be installed in minimum nominally 8-inch thick concrete masonry.

5 When using the basic load combinations in accordance with IBC Section 1605.3.1, tabulated allowable loads must not be increased for seismic or wind loading. When using the alternative basic load combinations in IBC Section 1605.3.2 that include seismic or wind loads, tabulated allowable loads may be increased by 33-1/3 percent, or the alternative basic load combinations may be reduced by a factor of 0.75.

6 Allowable loads must be the lesser of the adjusted masonry or bond tabulated values and the steel values given in tables 3 and 4.

7 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 13.

8 For combined loading: $(T_{applied} / T_{allowable})^n + (V_{applied} / V_{allowable})^n \leq 1$ where n = 5/3 for 3/8- and 1/2-inch diameters (#3 and #4 rebar) and n = 1 for 5/8- and 3/4-inch diameters (#5 and #6 rebar).

9 The critical spacing, $s_{cr}$, is the anchor spacing where full load values may be used. The minimum spacing, $s_{min}$, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

10 The critical edge distance, $c_{cr}$, is the edge distance where full load values may be used. The minimum edge distance, $c_{min}$, is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to the closest edge.

11 Embedment depth is measured from the outside face of the concrete masonry unit.

12 Load reduction factors are multiplicative: both spacing and edge distance load reduction factors, and spacing and edge distances for all adjacent anchors/ edges less than $s_{cr}/c_{cr}$,must be considered. Load values for anchors installed at less than scr and $c_{cr}$ must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

## Table 4 — Allowable steel strength for Hilti HAS threaded rods [1]

| Nominal anchor diameter in. | ASTM A307 Grade A | | HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr. 36 [2] | | HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55 [2] | | HAS-B-105 and HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr. 105 [2] | | HAS-R Stainless Steel ASTM F593 (3/8-in to 1-in) ASTM A193 (1/4 and 1-1/8-in to 2-in) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tensile lb (kN) | Shear lb (kN) | Tensile lb (kN) | Shear lb (kN) | Tensile lb (kN) | Shear lb (kN) | Tensile lb (kN) | Shear lb (kN) | Tensile lb (kN) | Shear lb (kN) |
| 1/4 | 970 | 500 | - | - | - | - | - | - | 925 | 475 |
| | (4.3) | (2.2) | - | - | - | - | - | - | (4.1) | (2.1) |
| 5/16 | 1,520 | 780 | - | - | - | - | - | - | 1,445 | 745 |
| | (6.8) | (3.5) | - | - | - | - | - | - | (6.4) | (3.3) |
| 3/8 | - | - | 2,115 | 1,090 | 2,730 | 1,410 | 4,555 | 2,345 | 3,645 | 1,875 |
| | - | - | (9.4) | (4.8) | (12.1) | (6.3) | (20.3) | (10.4) | (16.2) | (8.3) |
| 1/2 | - | - | 3,755 | 1,935 | 4,860 | 2,505 | 8,095 | 4,170 | 6,480 | 3,335 |
| | - | - | (16.7) | (8.6) | (21.6) | (11.1) | (36.0) | (18.5) | (28.8) | (14.8) |
| 5/8 | - | - | 5,870 | 3,025 | 7,595 | 3,910 | 12,655 | 6,520 | 10,125 | 5,215 |
| | - | - | (26.1) | (13.5) | (33.8) | (17.4) | (56.3) | (29.0) | (45.0) | (23.2) |
| 3/4 | - | - | 8,455 | 4,355 | 10,935 | 5,635 | 18,225 | 9,390 | 12,390 | 6,385 |
| | - | - | (37.6) | (19.4) | (48.6) | (25.1) | (81.1) | (41.8) | (55.1) | (28.4) |

1 Steel strength as defined in AISC Manual of Steel Construction (ASD):
Tensile = 0.33 x $F_u$ x Nominal Area
Shear = 0.17 x $F_u$ x Nominal Area
2 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

## Table 5 — Hilti HIT-HY 270 allowable tension and shear values for reinforcing bars based on steel strength[1,2,3]

| Rebar size | Tension lb (kN) | Shear lb (kN) |
|---|---|---|
| | ASTM A615, GRADE 60 | ASTM A615, GRADE 60 |
| #3 | 2,905 | 1,495 |
| | (12.9) | (6.7) |
| #4 | 5,280 | 2,720 |
| | (23.5) | (12.1) |
| #5 | 8,185 | 4,215 |
| | (36.4) | (18.7) |
| #6 | 11,615 | 5,985 |
| | (51.7) | (26.6) |

The following footnotes apply to both Tables 3 and 4:
1 Allowable load used in the design must be the lesser of bond values and tabulated steel values.
2 The allowable tension and shear values for threaded rods to resist short term loads, such as wind or seismic, must be calculated in accordance with the appropriate IBC Sections.
3 Allowable steel loads are based on tension and shear stresses equal to 0.33 x $F_u$ and 0.17 x $F_u$ , respectively.

## Figure 2 — Allowable anchor installation locations in the face of grout-filled concrete block

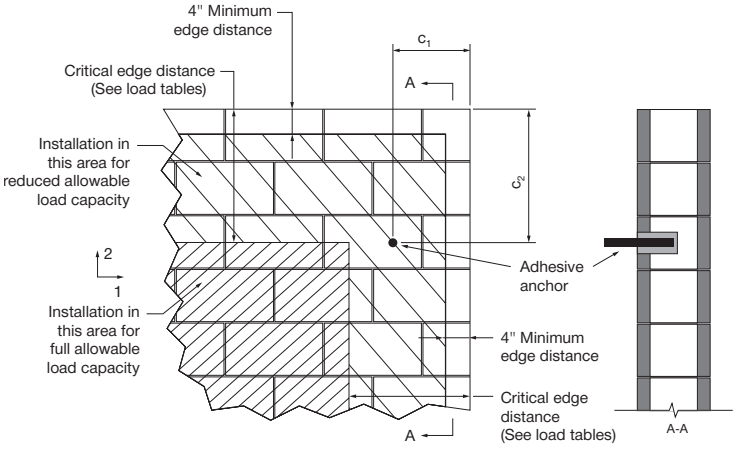


**Table 6 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods and reinforcing bars in the top of grout-filled concrete masonry walls[1,2,4,5,6,7,8]**

| Nominal anchor diameter or rebar size | Effective embedment in. (mm) | Edge distance in. (mm) | End distance in. (mm) | Spacing | | Tension load[9] | | Shear load[9] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | @ $s_{cr}$ lb (kN) | Reduction factor @ $s_{min}$ | Parallel to edge of masonry wall @ $s_{cr}$ lb (kN) | Perpendicular to edge of masonry wall @ $s_{cr}$ lb (kN) | Reduction Factor @ $s_{min}$ |
| 1/2[3] | 4-1/2 (114) | 1-3/4 (44) | 8 (203) | 16 (406) | 3 (76) | 1,165 (5.2) | 0.57 | 815 (3.6) | 345 (1.5) | 0.50 |
| | | 4 (102) | | | | 1,625 (7.2) | 0.50 | 1,445 (6.4) | 505 (2.2) | 0.50 |
| 5/8[3] | 5-5/8 (143) | 1-3/4 (44) | | | | 1,165 (5.2) | 0.58 | 1,190 (5.3) | 385 (1.7) | 0.50 |
| | | 4 (102) | | | | 1,590 (7.1) | 0.50 | 1,825 (8.1) | 655 (2.9) | 0.50 |
| 3/4[3] | 6-3/4 (171) | 2-3/4 (70) | | | | 1,020 (4.5) | 0.74 | 1,405 (6.3) | 425 (1.9) | 0.59 |
| #4[10] | 4-1/2 (114) | 1-3/4 (44) | | 16 (406) | 16 (406) | 865 (3.8) | 1.00 | 635 (2.8) | 245 (1.1) | 1.00 |
| #5[10] | 5-5/8 (143) | | | | | 980 (4.4) | | 755 (3.4) | 295 (1.3) | |

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

2 When using the basic load combinations in accordance with IBC Section 1605.3.1, or the alternative basic load combinations in IBC Section 1605.3.2, tabulated allowable loads must not be increased for seismic or wind loading.

3 One anchor shall be permitted to be installed in each cell.

4 Anchors are not permitted to be installed in a head joint, flange or web of the concrete masonry unit.

5 Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in tables 3 and 4.

6 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 13.

7 For combined loading: $(T_{applied} / T_{allowable})^n + (V_{applied} / V_{allowable})^n \leq 1$ where n = 5/3 for 1/2-inch diameters (#4 rebar) and n = 1 for 5/8-inch diameters (#5 rebar).

8 The tabulated edge distance is measured from the anchor centerline to the edge of the concrete block. See figure 3.

9 Linear interpolation of load values between the two tabulated edge distances is permitted.

10 One anchor shall be permitted to be installed in each concrete block.

**Figure 3 — Edge and end distances for threaded rods and reinforcing bars installed in the top of grout-filled CMU**

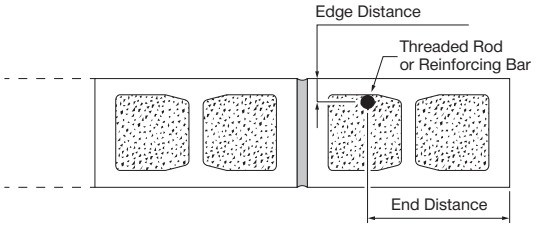


**Table 7 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods and reinforcing bars in the side of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]**

| Nominal anchor diameter or rebar size | Effective embedment in. (mm) | Minimum edge distance in. (mm) | Minimum end distance in. (mm) | Tension lb (kN) | Shear load, lb (kN) | |
|---|---|---|---|---|---|---|
| | | | | | Load parallel to edge of masonry wall | Load perpendicular to edge of masonry wall |
| 1/2 | 4-1/2 (114) | 1-3/4 (44) | 8 (203) | 990 (4.4) | 885 (3.9) | 255 (1.1) |
| 5/8 | 5-5/8 (143) | | | 1,200 (5.3) | 1,220 (5.4) | 330 (1.5) |
| 3/4 | 5-5/8 (143) | 2-3/4 (70) | | 1,200 (5.3) | 1,770 (7.9) | 530 (2.4) |
| #4 | 4-1/2 (114) | 1-3/4 (44.5) | | 1,055 (4.7) | 835 (3.7) | 255 (1.1) |
| #5 | 5-5/8 (143) | | | 1,160 (5.2) | 990 (4.4) | 275 (1.2) |

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

2 When using the basic load combinations in accordance with IBC Section 1605.3.1 or the alternative basic load combinations in IBC Section 1605.3.2. Tabulated allowable loads must not be increased for seismic or wind loading.

3 One anchor shall be permitted to be installed in each concrete block.

4 Anchors are not permitted to be installed in mortar joint of the concrete masonry unit.

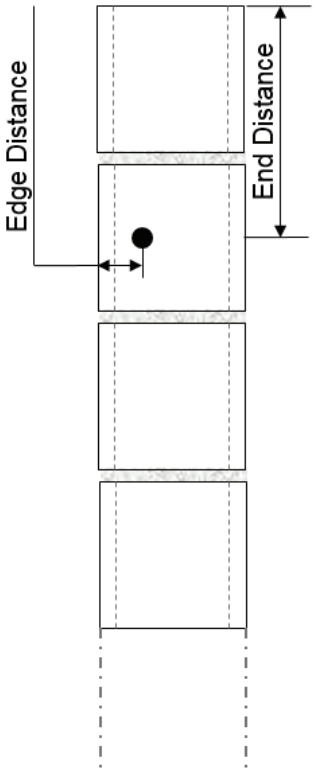
5 Allowable loads must be the lesser of bond tabulated values and the steel values given in tables 3 and 4.

6 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 13.

7 Anchors installed on the side of the wall, shall have minimum of 16" vertical spacing.

8 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$, where n = 5/3 for 1/2-inch diameters (#4 rebar) and n=1 for 5/8-inch diameter or #5 and #6 rebar.

**Figure 4 — Edge and end distances for threaded rods and reinforcing bars installed in the side of grout-filled CMU**



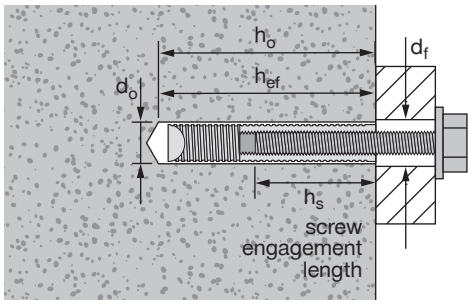
**HIT-HY 270 adhesive with Hilti HIS-N and HIS-RN internally threaded insert**



| Permissible Base Materials | | Permissible drilling method | |
|---|---|---|---|
| | Grout-filled concrete masonry | | Hammer drilling with carbide tipped drill bit<br>Hilti TE-CD or TE-YD hollow drill bit |



**Figure 5 — Hilti HIT-HY 270 specifications for HIS-N and HIS-RN inserts in grout-filled concrete masonry walls**




**Hilti installation specifications for HIS-N and HIS-RN inserts in grout-filled concrete masonry walls**

| Setting information | Symbol | Units | Thread size | |
|---|---|---|---|---|
| | | | 3/8-16 UNC | 1/2-13 UNC |
| Nominal bit diameter | $d_o$ | in. | 11/16 | 7/8 |
| Nominal / effective embedment | $h_o$ / $h_{ef}$ | in.<br>(mm) | 4-3/8<br>(110) | 5<br>(125) |
| Maximum installation torque | $T_{inst}$ | ft-lb<br>(Nm) | 6<br>(8) | 7.5<br>(10) |
| Diameter of fixture hole | $d_f$ | in. | 7/16 | 9/16 |
| Thread engagement length | $h_s$ | in.<br>(mm) | 3/8 to 15/16<br>(10 to 25) | 1/2 to 1-1/4<br>(13 – 32) |

## Table 8 — Hilti HIT-HY 270 allowable adhesive bond tension loads for HIS-N and HIS-RN inserts in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]

| Thread size | Effective embedment in. (mm)[11] | Tension lb (kN) | Spacing[9] | | | Edge distance[10] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load reduction factor @ $s_{min}$[12] | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load reduction factor @ $c_{min}$[12] |
| 3/8-16 UNC | 4-3/8 (110) | 2,075 (9.2) | 17 (432) | 4 (102) | 0.55 | 12 (305) | 4 (102) | 0.82 |
| 1/2-13 UNC | 5 (125) | 2,710 (12.1) | 20 (508) | | 0.55 | 20 (508) | | 0.63 |

## Table 9 — Hilti HIT-HY 270 allowable adhesive bond shear loads for HIS-N and HIS-RN inserts in the face of grout-filled concrete masonry walls[1,2,3,4,5,6,7,8]

| Thread size | Effective embedment in. (mm)[11] | Shear lb (kN) | Spacing[9] | | | Edge distance[10] | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load reduction factor @ $s_{min}$[12] | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load reduction factor | |
| | | | | | | | | Load perpendicular to edge | Load parallel to edge |
| 3/8-16 UNC | 4-3/8 (110) | 1,100 (4.9) | 17.0 (432) | 4 (102) | 0.74 | 12 (305) | 4 (102) | 0.72 | 1.00 |
| 1/2-13 UNC | 5 (125) | 2,065 (9.2) | 20 (508) | | 0.71 | 20 (508) | | 0.40 | 0.87 |

**The following footnotes apply to both Tables 7 and 8:**

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units shall be lightweight, medium-weight or heavy-weight conforming to ASTM C90. Allowable loads are calculated using a safety factor of 5.

2 Anchors may be installed in any location in the face of the masonry wall including cell, web, and mortar joints. Anchors are limited to one per masonry cell. See Figure 2.

3 Linear interpolation of load values between minimum spacing ($s_{min}$) and critical spacing ($s_{cr}$) and between minimum edge distance ($c_{min}$) and critical edge distance ($c_{cr}$) is permitted.

4 Concrete masonry thickness must be equal to or greater than 1.5 times the anchor embedment depth.

5 When using the basic load combinations in accordance with IBC Section 1605.3.1, tabulated allowable loads must not be increased for seismic or wind loading. When using the alternative basic load combinations in IBC Section 1605.3.2 that include seismic or wind loads, tabulated allowable loads may be increased by 33-1/3 percent, or the alternative basic load combinations may be reduced by a factor of 0.75.

6 Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in tables 3 and 4.

7 Tabulated allowable loads shall be adjusted for increased base material temperatures in accordance with figure 13.

8 For combined loading: $(T_{applied} / T_{allowable})^n + (V_{applied} / V_{allowable})^n \leq 1$ where n = 5/3

9 The critical spacing, $s_{cr}$, is the anchor spacing where full load values may be used. The minimum spacing, $s_{min}$, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

10 The critical edge distance, $c_{cr}$, is the edge distance where full load values may be used. The minimum edge distance, $c_{min}$, is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to each edge.

11 Embedment depth is measured from the outside face of the concrete masonry unit.

12 Load reduction factors are multiplicative: both spacing and edge distance load reduction factors, and spacing and edge distances for all adjacent anchors/edges less than $s_{cr}/c_{cr}$, must be considered. Load values for anchors installed at less than $s_{cr}$ and $c_{cr}$ must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

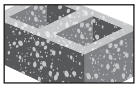
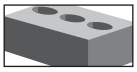
**HIT-HY 270 adhesive with Hilti HAS threaded rods and Hilti HIT-IC Inserts**



Hilti HAS Threaded Rods



Hilti HIT-IC Inserts

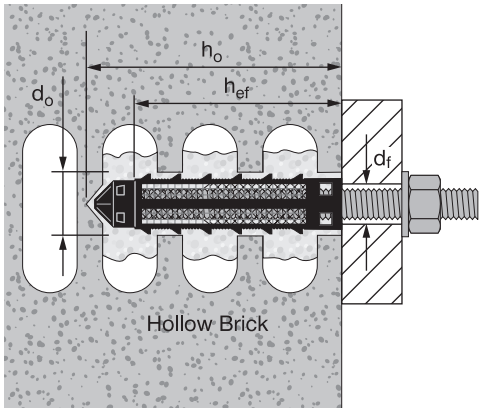
| Permissible Base Materials | | Permissible drilling method | |
|---|---|---|---|
|  Ungrouted Concrete Masonry | |  | Rotary only drilling with carbide tipped drill bit |
|  Brick with Holes | |  | Hilti TE-CD or TE-YD Hollow Drill Bit (for rod diameters 1/4"-3/8") |

3.2.4

**Hilti installation specifications for HAS threaded rod in hollow masonry and brick with holes**

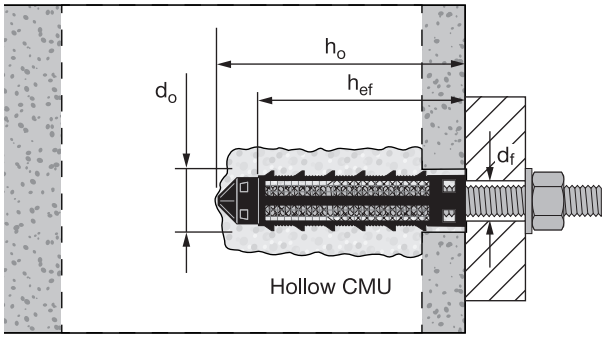
| Setting information | Symbol | Units | Nominal rod diameter (in.) | | | |
|---|---|---|---|---|---|---|
| | | | 1/4 | 5/16 | 3/8 | 1/2 |
| Nominal bit diameter | $d_o$ | in. | 1/2 | 5/8 | 5/8 | 11/16 |
| Screen size, CMU | HIT-SC | - | 12x50 | 16x50 | 16x50 | 18x50 |
| Depth drilled, CMU | $h_o$ | in. (mm) | Through face shell | | | |
| Effective embedment, CMU | $h_{ef}$ | in. (mm) | 2 (50) | 2 (50) | 2 (50) | 2 (50) |
| Screen size, Brick | HIT-SC | - | 12x85 | 16x85 | 16x85 | 18x85 |
| Depth drilled, Brick | $h_o$ | in. (mm) | 3-3/4 (95) | 3-3/4 (95) | 3-3/4 (95) | 3-3/4 (95) |
| Effective embedment, Brick | $h_{ef}$ | in. (mm) | 3-1/8 (79) | 3-1/8 (79) | 3-1/8 (79) | 3-1/8 (79) |
| Maximum installation torque | $T_{inst}$ | ft-lb (Nm) | 2.2 (3) | 2.2 (3) | 3 (4) | 4.5 (6) |
| Diameter of fixture hole | $d_f$ | in. | 9/32 | 3/8 | 7/16 | 9/16 |

**Figure 6 — Hilti HIT-HY 270 specifications for Hilti HAS threaded rod in hollow masonry and brick with holes**




**Hilti installation specifications for #14 screw in hollow masonry and brick with holes**

| Setting information | Symbol | Units | CMU | Brick |
|---|---|---|---|---|
| Nominal bit diameter | $d_o$ | in. | 1/2 | 1/2 |
| Screen size | HIT-S | - | 12/I | 12/I |
| Depth drilled | $h_o$ | in. (mm) | Through face shell | 2 (50) |
| Effective embedment | $h_{ef}$ | in. (mm) | 2 (50) | 2 (50) |
| Diameter of fixture hole | $d_f$ | in. | 9/32 | 9/32 |



## Table 10 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods in the face of hollow concrete masonry units[1,3,7,9,10]

| Nominal anchor diameter in. | Embedment in. (mm)[2] | Tension load lb (kN) | | Critical and minimum edge distance for tension, $c_{cr}$ and $c_{min}$ in (mm) | Shear load at $c_{cr}$ lb (kN) | | Edge distances for shear[6] | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Installation in the cell lb (kN)[4,5,8] | Installation in the bed joint lb (kN)[5,8] | | Installation in the cell lb (kN)[4,5,8] | Installation in the bed joint lb (kN)[5,8] | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load reduction factor @ $c_{min}$ |
| 1/4 | 2 (51) | 220 (1.0) | 300 (1.3) | 4 (102) | 355 (1.6) | 385 (1.7) | 4 (102) | 4 (102) | 1.00 |
| 5/16 | | 390 (1.7) | 300 (1.3) | | 630 (2.8) | 435 (1.9) | 12 (305) | | 0.73 |
| 3/8 | | 390 (1.7) | 300 (1.3) | | 645 (2.9) | 550 (2.4) | 12 (305) | | 0.73 |
| 1/2 | | 390 (1.7) | 330 (1.5) | | 670 (3.0) | 755 (3.4) | 12 (305) | | 0.73 |

## Table 11 — Hilti HIT-HY 270 allowable adhesive bond loads for Hilti HIT-IC inserts in the face of hollow concrete masonry units[1,3,7,9,10]

| Nominal anchor diameter in. | Embedment in. (mm)[2] | Tension load, installation in the cell lb (kN)[4,5,8] | Critical and minimum edge distance for tension, $c_{cr}$ and $c_{min}$ in (mm) | Shear load, installation in the cell lb (kN)[4,5,8] | Edge distances for shear[6] | | |
|---|---|---|---|---|---|---|---|
| | | | | | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load reduction factor @ $c_{min}$ |
| #14 Screw | 2 (51) | 190 (0.8) | 4 (102) | 235 (1.0) | 4 (102) | 4 (102) | 1.00 |
| 5/16-18 UNC | | 415 (1.8) | | 605 (2.7) | 12 (305) | | 0.80 |
| 3/8-16 UNC | | 480 (2.1) | | 620 (2.8) | 12 (305) | | 0.78 |
| 1/2-13 UNC | | 495 (2.2) | | 620 (2.8) | 12 (305) | | 0.75 |

**The following footnotes apply to both Tables 9 and 10:**

1 All values are for anchors installed in hollow concrete masonry with minimum masonry strength of 1500 psi. Concrete masonry units must be light-, medium, normal-weight conforming to ASTM C90. Allowable loads have been calculated using a safety factor of 5.

2 Tabulated embedment depth is limited by the length of the plastic HIT-SC screens.

3 Anchors must be installed in the face of the hollow CMU masonry wall. A maximum of two anchors may be installed in a single cell of the hollow CMU block.

4 Tabulated values are for anchors installed in the cell of the hollow CMU. Installation in other locations of the hollow CMU (mortar joints, flange, or cell web) is not permitted.

5 Two anchors may be spaced as close as 4 inches apart with no reduction in tension or shear capacity. EXCEPTION: Two 3/8-inch diameter HIT-IC inserts and two ½-inch diameter HIT-IC inserts installed in the same cell spaced as close as 4 inches require a 20% reduction in the tension capacity.

6 The critical edge distance, $c_{cr}$, is the edge distance where full load values in the table may be used. The minimum edge distance, $c_{min}$, is the minimum edge distance for which values are available and installation is permitted. Edge distance is measured from the center of the anchor to any edge.

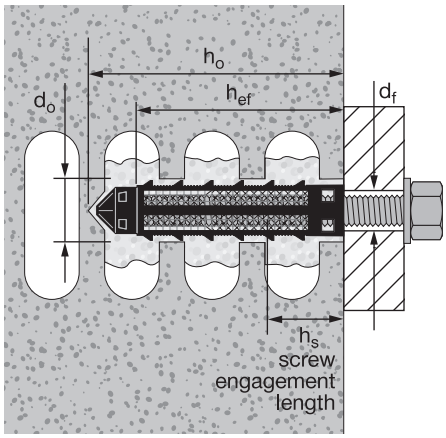
7 Anchors are not recognized for resisting earthquake forces. When using the basic load combinations in accordance with IBC Section 1605.3.1, or the alternative basic load combinations in IBC Section 1605.3.2, tabulated allowable loads must not be increased for wind loading.

8 Allowable loads must be the lesser of the adjusted bond values tabulated above and the steel values given in Table 3.

9 Tabulated allowable bond loads must be adjusted for increased base material temperatures in accordance with Figure 13, as applicable.

10 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

**Figure 7 — Hilti HIT-HY 270 specifications for Hilti HIT-IC in hollow masonry and brick with holes**




**Hilti installation specifications for Hilti HIT-IC in hollow masonry and brick with holes**

| Setting information | Symbol | Units | Nominal rod diameter (in.) | | |
|---|---|---|---|---|---|
| | | | 5/16 | 3/8 | 1/2 |
| Nominal bit diameter | $d_o$ | in. | 5/8 | 7/8 | 7/8 |
| HIT-IC size, CMU | HIT-IC | - | 5/16x2 | 3/8x2 | 1/2x2 |
| Screen size, CMU | HIT-SC | - | 16x50 | 22x50 | 22x50 |
| Nominal embedment, CMU | $h_o$ | in.<br>(mm) | 2-3/8<br>(60) | 2-3/8<br>(60) | 2-3/8<br>(60) |
| Effective embedment, CMU | $h_{ef}$ | in.<br>(mm) | 2<br>(50) | 2<br>(50) | 2<br>(50) |
| Screw engagement length, CMU | $h_s$ | in.<br>(mm) | 3/8 - 1 1/2<br>(9.5 - 38) | 3/8 - 1 1/2<br>(9.5 - 38) | 1/2 - 1 1/2<br>(12.5 - 38) |
| HIT-IC size, Brick | HIT-IC | - | 5/16x3-3/16 | 3/8x3-3/16 | 1/2x3-3/16 |
| Screen size, Brick | HIT-SC | - | 16x85 | 22x85 | 22x85 |
| Nominal embedment, Brick | $h_o$ | in.<br>(mm) | 3-3/4<br>(95) | 3-3/4<br>(95) | 3-3/4<br>(95) |
| Effective embedment, Brick | $h_{ef}$ | in.<br>(mm) | 3-1/8<br>(79) | 3-1/8<br>(79) | 3-1/8<br>(79) |
| Screw engagement length, Brick | $h_s$ | in.<br>(mm) | 3/8 - 3<br>(9.5 - 76) | 3/8 - 3<br>(9.5 - 76) | 1/2 - 3<br>(12.5 - 76) |
| Maximum installation torque | $T_{inst}$ | ft-lb<br>(Nm) | 2.2<br>(3) | 3<br>(4) | 4.5<br>(6) |
| Diameter of fixture hole | $d_f$ | in. | 3/8 | 7/16 | 9/16 |

**Table 12 — Hilti HIT-HY 270 allowable adhesive bond tension loads for threaded rods in the face of hollow brick[1,3,4,8,9,10,11]**

| Nominal anchor diameter in. | Effective embedment in. (mm)[2] | Tension lb (kN) | Spacing[5] | | | Edge distance[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load reduction factor @ $s_{min}$[7] | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load reduction factor @ $c_{min}$[7] |
| 1/4 | 3-1/8 (79) | 530 (2.4) | 8 (203) | 4 (102) | 0.88 | 6 3/8 (162) | 4 (102) | 0.93 |
| 5/16 | | 735 (3.3) | | | 0.82 | | | 0.80 |
| 3/8 | | 905 (4.0) | | | 0.54 | | | 0.83 |
| 1/2 | | 905 (4.0) | | | 0.50 | | | 1.00 |

**Table 13 — Hilti HIT-HY 270 allowable adhesive bond shear loads for threaded rods in the face of hollow brick[1,3,4,8,9,10,11]**

| Nominal anchor diameter in. | Effective embedment in. (mm)[2] | Shear lb (kN) | Spacing[5] | | | Edge distance[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load reduction factor @ $s_{min}$[7] | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load reduction factor @ $c_{min}$[7] |
| 1/4 | 3-1/8 (79) | 370 (1.6) | 8 (203) | 4 (102) | 0.84 | 8 (203) | 4 (102) | 0.86 |
| 5/16 | | 595 (2.6) | | | 0.81 | 8 (203) | | 0.93 |
| 3/8 | | 1,045 (4.6) | | | 0.59 | 12 (305) | | 0.54 |
| 1/2 | | 1,685 (7.5) | | | 0.50 | 12 (305) | | 0.36 |

**The following footnotes apply to both Tables 11 and 12:**

1 All values are for anchors installed in hollow brick masonry with minimum masonry strength of 3000 psi. Hollow brick units must be in conformance with ASTM C652. Allowable loads have been calculated using a safety factor of 5.

2 Tabulated embedment depth is limited by the length of the plastic HIT-SC screens.

3 Anchors must be installed in the face of the hollow brick masonry wall.

4 Tabulated values are for the anchor installed in the center of the hollow brick, mortar joints, flanges, or cell web (all wall face locations permitted).

5 The critical spacing, $s_{cr}$, is the anchor spacing where full load values in the table may be used. The minimum spacing, $s_{min}$, is the minimum anchor spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

6 The critical edge distance, $c_{cr}$, is the edge distance where full load values in the table may be used. The minimum edge distance, $c_{min}$, is the minimum edge distance for which values are available and installation is permitted. Edge distance is measured from the center of the anchor to each edge.

7 Load reduction factors are multiplicative: both spacing and edge distance load reduction factors, and spacing and edge distances for all adjacent anchors/ edges less than $s_{cr}$/$c_{cr}$,must be considered. Load values for anchors installed at less than $s_{cr}$ and $c_{cr}$ must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

8 Anchors are not recognized for resisting earthquake forces. When using the basic load combinations in accordance with IBC Section 1605.3.1, or the alternative basic load combinations in IBC Section 1605.3.2, tabulated allowable loads must not be increased for wind loading.

9 Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in table 3.

10 Tabulated allowable bond loads must be adjusted for increased base material temperatures in accordance with Figure 13, as applicable.

11 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

**Table 14 — Hilti HIT-HY 270 allowable adhesive bond loads for HIT-IC inserts in the face of hollow brick[1,3,4,5,7,8,9,10]**

| Thread size | Effective embedment in. (mm)[2] | Tension lb (kN) | Critical and minimum edge distance for tension, $c_{cr}$ and $c_{min}$ in. (mm) | Shear lb (kN) | Edge distance for shear[6] | | |
|---|---|---|---|---|---|---|---|
| | | | | | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load reduction factor @ $c_{min}$ |
| #14 Screw | 2 (51) | 170 (0.8) | 6 3/8 (162) | 222 (1.0) | 8 (203) | 8 (203) | 1.00 |
| 5/16-18 UNC | 3-1/8 (79) | 880 (3.9) | | 655 (2.9) | 8 (203) | | 1.00 |
| 3/8-16 UNC | | 880 (3.9) | | 1,235 (5.5) | 12 (305) | | 0.66 |
| 1/2-13 UNC | | 990 (4.4) | | 1,895 (8.4) | 12 (305) | | 0.44 |

1 All values are for anchors installed in hollow brick masonry with minimum masonry strength of 3000 psi. Hollow brick units must be in conformance with ASTM C652. Allowable loads have been calculated using a safety factor of 5.

2 Tabulated embedment depth is limited by the length of the plastic HIT-SC screens.

3 Anchors must be installed in the face of the hollow brick masonry wall.

4 Tabulated values are for one anchor installed in the hollow brick, mortar joints, flanges, or cell web (all wall face locations permitted).

5 One anchor is permitted to be installed in each brick. Two anchors installed in adjacent bricks may be spaced as close as 8 inches apart with no load reduction.

6 The critical edge distance, $c_{cr}$, is the edge distance where full load values in the table may be used. The minimum edge distance, $c_{min}$, is the minimum edge distance for which values are available and installation is permitted. Edge distance is measured from the center of the anchor to each edge.

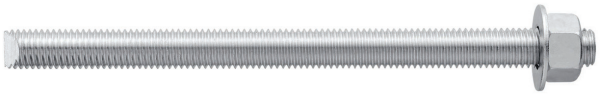
7 Anchors are not recognized for resisting earthquake forces. When using the basic load combinations in accordance with IBC Section 1605.3.1, or the alternative basic load combinations in IBC Section 1605.3.2, tabulated allowable loads must not be increased for wind loading.

8 Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in table 3.

9 Tabulated allowable bond loads must be adjusted for increased base material temperatures in accordance with Figure 13, as applicable.

10 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

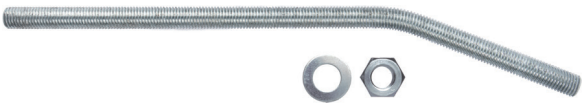
**HIT-HY 270 adhesive with Hilti HAS threaded rods and deformed reinforcing bars (Rebar)**



Hilti HAS Threaded Rods



Deformed Reinforcing Bars (Rebar)



Bent threaded rod 22.5 degrees

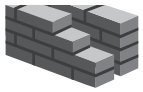
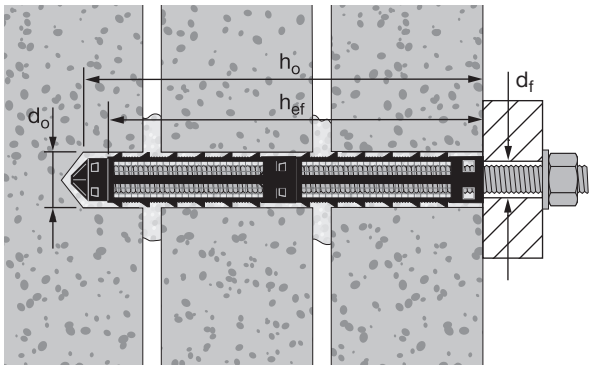
| | | | |
|---|---|---|---|
| Permissible Base Materials |  Unreinforced Multi-wythe Brick (URM) | Permissible drilling method |  Rotary only drilling with carbide tipped drill bit |

**Figure 8 — Hilti HIT-HY 270 specifications for HAS rods in multi-wythe brick wall**




**Hilti installation specifications for HAS rods in multi-wythe brick wall**

| Setting information | Symbol | Units | Nominal rod diameter (in.) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3/8 | | 1/2 | | 5/8 | | 3/4 | |
| Nominal bit diameter | $d_o$ | in. | 5/8 | | 11/16 | | 7/8 | | 1 | |
| Screen size | HIT-SC | - | 2x 16x85 | 3x 16x85 | 2x 18x85 | 3x 18x85 | 2x 22x85 | 3x 22x85 | 26x200 | 26x125 + 26x200 |
| Nominal embedment | $h_o$ | in. | 7-1/8 | 10-3/4 | 7-1/8 | 10-3/4 | 7-1/8 | 10-3/4 | 8-1/4 | 13-1/4 |
| | | (mm) | (181) | (273) | (181) | (273) | (181) | (273) | (210) | (337) |
| Effective embedment | $h_{ef}$ | in. | 6 | 10 | 6 | 10 | 6 | 10 | 8 | 13 |
| | | (mm) | (152) | (254) | (152) | (254) | (152) | (254) | (203) | (330) |
| Maximum installation torque | $T_{inst}$ | ft-lb | 10 | | 30 | | 45 | | 60 | |
| | | (Nm) | (14) | | (41) | | (61) | | (81) | |
| Diameter of fixture hole | $d_f$ | in. | 7/16 | | 9/16 | | 11/16 | | 13/16 | |

**Hilti installation specifications for rebar in multi-wythe brick wall**

| Setting information | Symbol | Units | Nominal rod diameter (in.) | | |
|---|---|---|---|---|---|
| | | | #4 | #5 | #6 |
| Nominal bit diameter | $d_o$ | in. | 1 | 1 | 1 |
| Screen size | HIT-SC | - | 26x200 | 26x200 | 26x200 |
| Nominal embedment | $h_o$ | in. | 8-1/4 | 8-1/4 | 8-1/4 |
| | | (mm) | (210) | (210) | (210) |
| Effective embedment | $h_{ef}$ | in. | 8 | 8 | 8 |
| | | (mm) | (203) | (203) | (203) |

**Figure 9 — Hilti HIT-HY 270 specifications for rebar in multi-wythe brick wall**

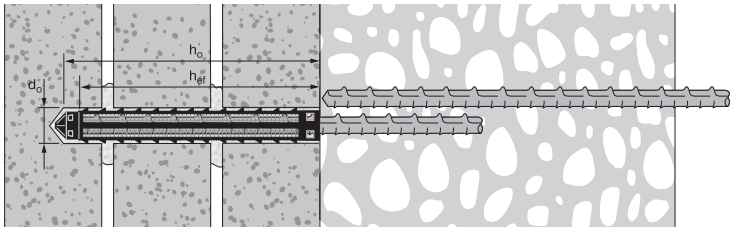



**Table 15 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods in multi-wythe solid brick wall[1,2,3,4,5,6,8,9]**

| Nominal anchor diameter in. | Effective embedment[7] in. (mm) | Tension lb (kN) | Shear lb (kN) | Spacing | | | Edge distance | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load reduction factor@ $s_{min}$ | Critical $c_{cr}$ in. (mm) | Minimum $c_{min}$ in. (mm) | Load reduction factor@ $c_{min}$ |
| 3/8 | 6 (152) | 895 (4.0) | 680 (3.0) | 16 (406) | 8 (203) | 0.50 | 16 (406) | 8 (203) | 0.50 |
| | 10 (254) | 1,325 (5.9) | 795 (3.5) | | | | | | |
| 1/2 | 6 (152) | 895 (4.0) | 1,075 (4.8) | | | | | | |
| | 10 (254) | 1,455 (6.5) | 1,115 (5.0) | | | | | | |
| 5/8 | 6 (152) | 1,025 (4.6) | 1,405 (6.3) | | | | | | |
| | 10 (254) | 1,955 (8.7) | 1,445 (6.4) | | | | | | |
| 3/4 | 8 (203) | 1,575 (7.0) | 1,985 (8.8) | | | | | | |
| | 13 (330) | 2,135 (9.5) | 1,985 (8.8) | | | | | | |

1 All values are based on mortar shear strength of 45 psi or greater. Allowable loads are calculated using a safety factor of 5.

2 Anchors must be installed in the face of the multi-wythe URM wall. The wall must have a minimum thickness of 13 inches made up of 3 wythes of brick.

3 Tabulated values are for maximum one anchor installed in the center of the brick of the multi-wythe URM wall.

4 Edge distance, $c_{min}$, and spacing, $s_{min}$, are the minimum distances for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to each edge. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

5 Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in table 3.

6 Allowable loads shall be adjusted for increased base material temperature in accordance with Figure 13.

7 Tabulated embedment depth is limited by the length of the plastic HIT-SC screens.

8 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

9 Load reduction factors are multiplicative: both spacing and edge distance load reduction factors, and spacing and edge distances for all adjacent anchors/ edges less than $s_{cr}/c_{cr}$, must be considered. Load values for anchors installed at less than $s_{cr}$ and $c_{cr}$ must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

**Table 16 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods in multi-wythe hollow brick wall [1,3,4,5,7,8]**

| Nominal anchor diameter in. | Effective embedment in. (mm)[6] | Tension lb (kN) | Shear lb (kN) | Minimum edge distance $c_{min}$ in. (mm) | Spacing | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Critical $s_{cr}$ in. (mm) | Minimum $s_{min}$ in. (mm) | Load reduction factor in tension @ $s_{min}$ | Load reduction factor in shear @ $s_{min}$ |
| Anchor installed into the face of brick masonry wall[2] | | | | | | | | |
| 3/8 | 6-1/4 (160) | 880 (3.9) | 560 (2.5) | 4 (102) | 16 (406) | 8 (203) | 0.89 | 1.00 |
| | 9-3/4 (248) | 1,540 (6.9) | 895 (4.0) | | | | 0.96 | 0.75 |
| 1/2 | 6-1/4 (160) | 1,430 (6.4) | 655 (2.9) | | | | 0.59 | 0.75 |
| | 9-3/4 (248) | 2,020 (9.0) | 895 (4.0) | | | | 0.89 | 0.78 |
| 5/8 | 6-1/4 (160) | 1,695 (7.5) | 655 (2.9) | | | | 0.50 | 0.71 |
| | 9-3/4 (248) | 2,165 (9.6) | 895 (4.0) | | | | 0.71 | 0.58 |
| 3/4 | 8 (203) | 1,380 (6.1) | 855 (3.8) | | | | 1.00 | 0.67 |
| | 10 (250) | 2,075 (9.2) | 1,070 (4.8) | | | | 0.79 | 0.54 |
| Anchor installed into the top of brick masonry wall | | | | | | | | |
| 3/8 | 3-1/8 (79) | 315 (1.4) | 220 (1.0) | 2.5 (64) | 8 (203) | 8 (203) | 1 | 1 |
| Anchor installed into the side of brick masonry wall | | | | | | | | |
| 3/8 | 3-1/8– (79) | 570 (2.5) | 290 (1.3) | 2.5 (64) | 8 (203) | 8 (203) | 1 | 1 |

1 All values are for anchors installed in brick masonry with minimum masonry strength of 3000 psi. Brick units must be in conformance with ASTM C652. Allowable loads have been calculated using a safety factor of 5.

2 Anchors must be installed in the face of the multi-wythe URM wall. 2-wythe brick walls must have minimum of 6 inches thickness. Anchors with the effective embedment larger than 6-1/4" inches must be installed in the wall with minimum thickness of 13 inches made up of 3-wythe brick walls.

3 Edge distance, $c_{min}$, and spacing, $s_{min}$, are the minimum distances for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to each edge. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

4 Allowable loads must be the lesser of the adjusted bond tabulated values and the steel values given in table 3.

5 Allowable loads shall be adjusted for increased base material temperature in accordance with Figure 13.

6 Tabulated embedment depth is limited by the length of the plastic HIT-SC screens.

7 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

8 Load reduction factors are multiplicative: both spacing and edge distance load reduction factors, and spacing and edge distances for all adjacent anchors/ edges less than $s_{cr}$/ $c_{cr}$ must be considered. Load values for anchors installed at less than $s_{cr}$ and $c_{cr}$must be multiplied by the appropriate load reduction factor based on actual edge distance (c) and spacing (s).

**Figure 10 — Hilti HIT-HY 270 shear anchor or dowel in configuration A**

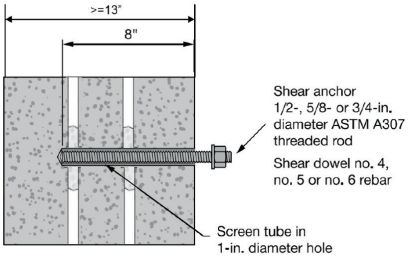



**Figure 11 — Hilti HIT-HY 270 with 22-1/2° combination anchor in configuration B**

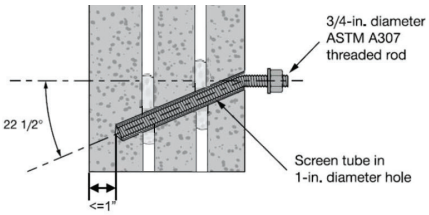



**Table 17 — Hilti HIT-HY 270 allowable adhesive bond seismic loads for threaded rods and reinforcing bars in unreinforced brick masonry[1,2,3]**

| Configuration A – Shear anchor or rebar dowel | | | | |
|---|---|---|---|---|
| Nominal anchor diameter (in.) or rebar size | Embedment in. (mm) | Minimum wall thickness in. (mm) | Tension lb (kN) | Shear lb (kN)[4] |
| 1/2 or # 4 | 8 (203) | 13 (330) | - | 500 (2.2) |
| 5/8 or # 5 | | | - | 750 (3.3 |
| 3/4 or # 6 | | | - | 1,000 (4.4) |
| Configuration B – 22-1/2° combination anchor | | | | |
| Nominal anchor diameter (in.) | Embedment in. (mm) | Minimum wall thickness in. (mm) | Tension lb (kN) | Shear lb (kN)[4] |
| 3/4 | Within 1 inch of opposite wall surface | 13 (330) | 1200 (5.3) | 1,000 (4.4) |

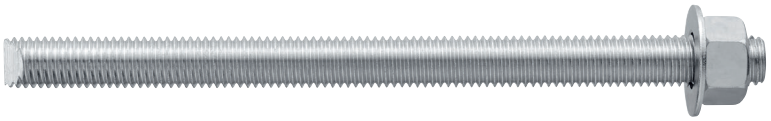
1 Allowable load values are applicable only to anchors where in-place shear tests indicate minimum mortar strength of 50 psi.

2 Allowable loads are computed in accordance with ICC-ES AC60 (2010) and IBC (2009).

3 No increase for short-term loading is permitted, such as loading induced by wind or earthquake.

4 Anchors must be tested in accordance with the requirements of IEBC and UCBC

**HIT-HY 270 adhesive with Hilti HAS threaded rods**



Hilti HAS threaded rod

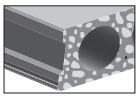
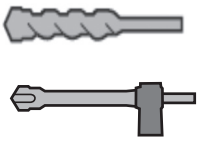
| | | | |
|---|---|---|---|
| Permissible Base Materials |  Hollow core concrete | Permissible drilling method |  Rotary only drilling with carbide tipped drill bit<br>Hilti TE-CD or TE-YD Hollow Drill Bit |

**Table 18 — Hilti HIT-HY 270 allowable adhesive bond loads for threaded rods in hollow core concrete panels[1,4,5,6]**

| Nominal anchor diameter in. | Effective embedment in. (mm)[2] | Minimum concrete thickness in. (mm)[3] | Tension lb (kN) | Shear lb (kN) |
|---|---|---|---|---|
| 3/8 | 2 (50.8) | 1-3/8 (34.9) | 450 (2.0) | 560 (2.5) |

1 All values are for anchor installed in hollow core concrete with minimum compressive strength of 7,000 psi. Due to variations in materials and dimensional configurations, on-site testing is required to determine the actual performance of the anchor. Allowable loads are calculated using a safety factor of 5.

2 Tabulated embedment depth is limited by the plastic HIT-SC 16x50 mm screens. See Figure 12.

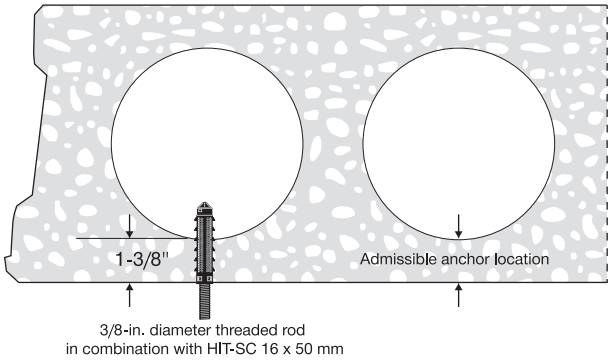
3 The required concrete thickness is the thickness for which values are available and installation is recommended. Anchors shall be installed along the centerline of the hollow core or along the line of minimum thickness. Verify these requirements with the hollow core plank supplier before installation. The required thickness is measured from the inner to the outer side of hollow core panel. See Figure 12.

4 Tabulated allowable loads must be the lesser of the adjusted bond values tabulated and the steel values in table 3.

5 Allowable loads shall be adjusted for increased base material temperature in accordance with Figure 13.

6 For combined loading: $(T_{applied} / T_{allowable}) + (V_{applied} / V_{allowable}) \leq 1$

**Figure 12 — Hilti HIT-HY 270 adhesive installed in hollow core concrete[1,2]**



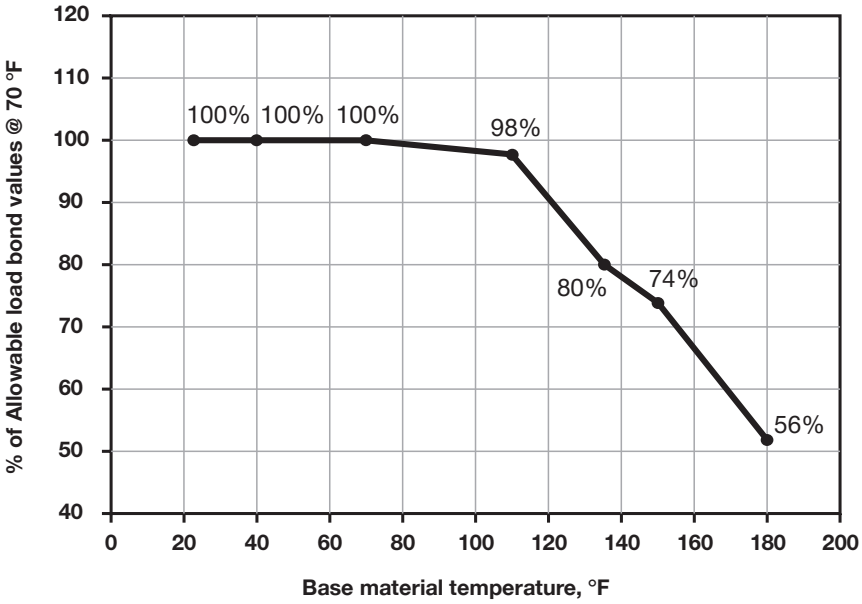

1 Representation of the tested conditions for which allowable adhesive bond loads are applicable. Refer to footnote 3 of corresponding load table above for more information on requirements and restrictions on the admissible anchor installation.

2 Minimum edge distance is 6-inches.
Minimum spacing is:
- 8-inches along the length of each hollow core section.
- One anchor per hollow core section (left and right on page), 6-inches minimum between adjacent hollow core sections.

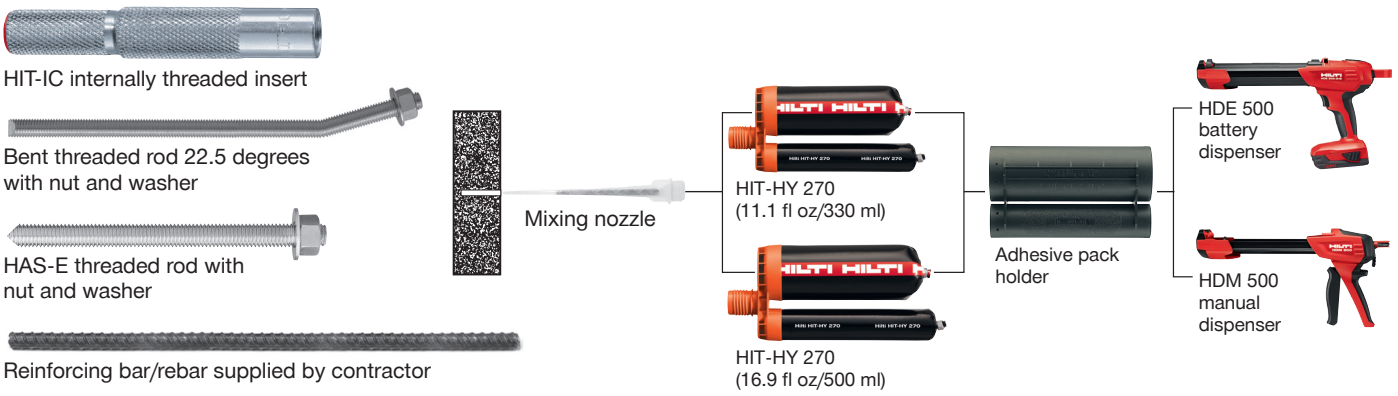
## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

**Figure 13 — Influence of in-service temperature on bond loads**

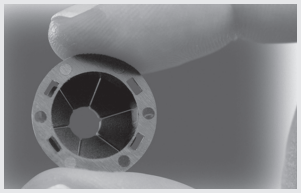


# ORDERING INFORMATION

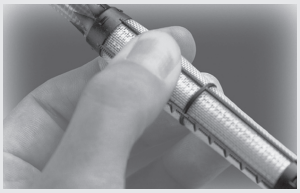



| Description | Package Contents | Qty of Foil Packs |
|---|---|---|
| **HIT-HY 270 (11.1OZ/330ML)** | Includes (1) foil pack with (1) mixer and 3/8-in. filler tuber per pack | 1 |
| **HIT-HY 270 (11.1OZ/330ML) 1 MC** | Includes (1) master carton containing (25) foil packs with (1) mixer and 3/8-in. filler tuber per pack | 25 |
| **HIT-HY 270 (16.9OZ/500ML) 1 MC** | Includes (1) master carton containing (20) foil packs with (1) mixer and 3/8-in. filler tuber per pack | 20 |
| **HIT-HY 270/500ML (2MC)+ HDM 500** | Includes (2) master cartons containing (20) foil packs each with (1) mixer and 3/8-in. filler tuber per pack and (1) HDM 500 manual dispenser | 40 |
| **HIT-HY 270/500ML (2MC)+ HDE 500 KIT** | Includes (2) master cartons containing (20) foil packs each with (1) mixer and 3/8-in. filler tuber per pack and (1) HDM 500 manual dispenser | 40 |
| **HY 270 TE 30-C AVR SAFESET PACK** | Includes TE 30-C AVR, VC 150 6-X, (40) HIT-HY 270 500/1, HDE 500-A22, C 4/36 LI-ION, (1) B 22/2.6 LI-ION, HIT-CB 500, TE-CD BITS: (1) 1/2"-13", (1) 9/16"-14", (1) 5/8"-14", (1) 3/4"-14", & BAG SMALL | 40 |
| **HY 270 TE 6-A22 SAFESET PACK** | Includes TE 6-A22, VC 150 6-X, (40) HIT-HY 270 500/1, HDE 500-A22, C 4/36 LI-ION, (2) B 22/5.2 LI-ION, HIT-CB 500, TE-CD BITS: (1) 1/2"-13", (1) 9/16"-14", (1) 5/8"-14", (1) 3/4"-14", & BAG SMALL | 40 |
| **HY 270 TE 30-A36 SAFESET PACK** | Includes TE 30-A36, VC 150 6-X, (40) HIT-HY 270 500/1, HDE 500-A22, C 4/36-350 LI-ION, (2) B 36/6.0 LI-ION, HIT-CB 500, TE-CD BITS: (1) 1/2"-13", (1) 9/16"-14", (1) 5/8"-14", (1) 3/4"-14", & BAG SMALL | 40 |
| **HIT-RE-M Static Mixer** | For use with HIT-HY 270 cartridges | 1 |

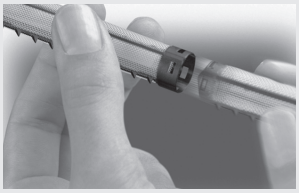
Customize the sleeve to the length of your application. Different embedment depths are created with minimal effort.



**Step 1:** Remove the centering ring of any screen tube within the cell.



**Step 2:** Pierce the tip of the screen tube with the rod intended to be used to check embedment depth.



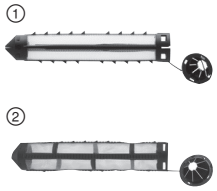
**Step 3:** Combine screen tubes to desired length.

### Brick with holes and hollow concrete block

| Threaded Rod | | | Mesh Sleeve | | Approximate fastenings per foil pack[1] | |
|---|---|---|---|---|---|---|
| Rod Size 5.8 Grade | Embedment, in. | Qty | Nominal Bit Dia., in. | Mesh Sleeve per Fastening | 11.1 fl oz (330 ml) | 16.9 fl oz (500 ml) |
| **Plastic Sleeve (for #14 screw)** | 2 | 20 | 1/2 | (1) HIT S-12/I | 25 | 40 |
| **HAS B 1/4 x 3** | 2 | 20 | 1/2 | (1) SC 12x50 | 25 | 40 |
| **HAS B 1/4 x 4-1/2** | 3-1/8 | 20 | 1/2 | (1) SC 12x85 | 16 | 26 |
| **HAS B 5/16 x 3** | 2 | 20 | 5/8 | (1) SC 16x50 | 16 | 26 |
| **HAS B 5/16 x 4-1/2** | 3-1/8 | 20 | 5/8 | (1) SC 16x85 | 7 | 12 |
| **HAS-E 3/8 x 3** | 2 | 10 | 5/8 | (1) SC 16x50 | 16 | 26 |
| **HAS-E 3/8 x 4-3/8** | 3-1/8 | 10 | 5/8 | (1) SC 16x85 | 7 | 12 |
| **HAS-E 1/2 x 3-1/8** | 2 | 10 | 11/16 | (1) SC 18x50 | 9 | 15 |
| **HAS-E 1/2 x 4-1/2** | 3-1/8 | 10 | 11/16 | (1) SC 18x85 | 4 | 7 |

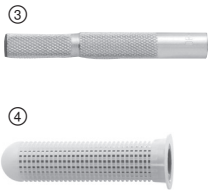
## Composite mesh sleeves for hollow masonry and brick material

| Description | | For use with: | Qty | Actual Dia., in. | Length, in. | Bit Dia. |
|---|---|---|---|---|---|---|
| **Mesh sleeve HIT-SC 12x50** | ① | 1/4 dia. rods | 20 | 0.47 | 1.97 | 1/2 |
| **Mesh sleeve HIT-SC 12x85** | ① | 1/4 dia. rods | 20 | 0.47 | 3.35 | 1/2 |
| **Mesh sleeve HIT-SC 16x50** | ① | 5/16, 3/8 dia. rods and 5/16 HIT-IC rods | 20 | 0.63 | 1.97 | 5/8 |
| **Mesh sleeve HIT-SC 16x85** | ① | 5/16, 3/8 dia. rods and 5/16 HIT-IC rods | 20 | 0.63 | 3.35 | 5/8 |
| **Mesh sleeve HIT-SC 18x50** | ① | 1/2 dia. rods | 20 | 0.71 | 1.97 | 11/16 |
| **Mesh sleeve HIT-SC 18x85** | ① | 1/2 dia. rods | 20 | 0.71 | 3.35 | 11/16 |
| **Mesh sleeve HIT-SC 22x50** | ① | 5/8 dia. rods, 3/8 and 1/2 HIT-IC rods | 20 | 0.87 | 1.97 | 7/8 |
| **Mesh sleeve HIT-SC 22x85** | ① | 5/8 dia. rods, 3/8 and 1/2 HIT-IC rods | 10 | 0.87 | 3.35 | 7/8 |
| **Mesh sleeve HIT-SC 26x125** | ② | 3/4 dia. rods | 20 | 1.02 | 4.92 | 1 |
| **Mesh sleeve HIT-SC 26x200** | ② | 3/4 dia. rods | 20 | 1.02 | 7.87 | 1 |




## Internally threaded inserts for hollow masonry and brick material

| Description | | For use with: | Qty | Bit Dia., in. | Threads per inch |
|---|---|---|---|---|---|
| **Internally Threaded HIT-IC 5/16 x 2** | | In hollow material use with HIT-SC 16 x 50 | 10 | 5/8 | 18 |
| **Internally Threaded HIT-IC 5/16 x 3-3/16** | ③ | In hollow material use with HIT-SC 16 x 85 | 10 | 5/8 | 18 |
| **Internally Threaded HIT-IC 3/8 x 2** | | In hollow material use with HIT-SC 22 x 50 | 10 | 7/8 | 16 |
| **Internally Threaded HIT-IC 3/8 x 3-3/16** | ③ | In hollow material use with HIT-SC 22 x 85 | 10 | 7/8 | 16 |
| **Internally Threaded HIT-IC 1/2 x 2** | | In hollow material use with HIT-SC 22 x 50 | 10 | 7/8 | 13 |
| **Internally Threaded HIT-IC 1/2 3 x 3/16** | ③ | In hollow material use with HIT-SC 22 x 85 | 10 | 7/8 | 13 |
| **HIT Combi-Insert HIT-S - 12/I** | ④ | Plastic sleeve for #14 screw | 20 | 1/2 | - |




## Multi-wythe brick walls

| Threaded Rod | | | Mesh Sleeve | | Approximate fastenings per foil pack[1] | |
|---|---|---|---|---|---|---|
| Rod Size 5.8 Grade | Embedment, in. | Qty | Bit Diameter, in. | Mesh Sleeve per Fastening | 11.1 fl oz (330 ml) | 16.9 fl oz (500 ml) |
| **HAS-E 3/8 x 5-1/8** | 4 | 20 | 5/8 | (2) SC 16x50 | 15 | 24 |
| **HAS-E 3/8 x 8** | 6-3/4 | 10 | 5/8 | (2) SC 16x85 | 9 | 14 |
| **HAS-E 3/8 x 12** | 10 | 10 | 5/8 | (3) SC 16x85 | 5 | 9 |
| **HAS-E 1/2 x 8** | 6-3/4 | 10 | 11/16 | (2) SC 18x85 | 7 | 11 |
| **HAS-E 1/2 x 12** | 10 | 10 | 11/16 | (3) SC 18x85 | 4 | 7 |
| **HAS-E 5/8 x 8** | 6-3/4 | 20 | 7/8 | (2) SC 22x85 | 4 | 7 |
| **HAS-E 5/8 x 12** | 10 | 10 | 7/8 | (3) SC 22x85 | 2 | 4 |
| **HAS-E 3/4 x 10** | 8 | 10 | 1 | (1) SC 26x200 | 2 | 4 |
| **HAS-E 3/4 x 14** | 13 | 10 | 1 | (1) SC 26x200, (1) SC 26x125 | 1 | 2 |
| **HAS-E 3/4 x 17** | 15-3/4 | 10 | 1 | (2) SC 26x200 | 1 | 2 |
| **HAS-E 3/4 x 19** | 18 | 10 | 1 | (2) SC 26x125, (1) SC 26 x 200 | 1 | 2 |
| **HAS-E 3/4 x 25** | 23-1/2 | 10 | 1 | (3) SC 26x200 | 0 | 1 |

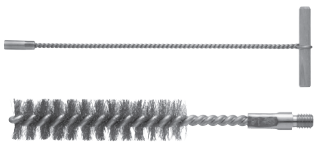
## Internally threaded inserts

| Threaded Rod | | | Mesh Sleeve | | Approximate fastenings per foil pack[1] | |
|---|---|---|---|---|---|---|
| Rod Size 5.8 Grade | Embedment, in. | Qty | Bit Diameter, in. | Mesh Sleeve per Fastening | 11.1 fl oz (330 ml) | 16.9 fl oz (500 ml) |
| **Internally Threaded HIT-IC 5/16 x 2** | 2 | 10 | 5/8 | (1) SC 16x50 | 16 | 26 |
| **Internally Threaded HIT-IC 5/16 x 3-3/16** | 3-1/4 | 10 | 5/8 | (1) SC 16x85 | 7 | 12 |
| **Internally Threaded HIT-IC 3/8 x 2** | 2 | 10 | 7/8 | (1) SC 22x50 | 9 | 15 |
| **Internally Threaded HIT-IC 3/8 x 3-3/16** | 3-1/4 | 10 | 7/8 | (1) SC 22x85 | 4 | 7 |
| **Internally Threaded HIT-IC 1/2 x 2** | 2 | 10 | 7/8 | (1) SC 22x50 | 9 | 15 |
| **Internally Threaded HIT-IC 1/2 3-3/16** | 3-1/4 | 10 | 7/8 | (1) SC 22x85 | 4 | 7 |

1 Assumes use with HDM 500 Manual Dispenser

## Cleaning accessories

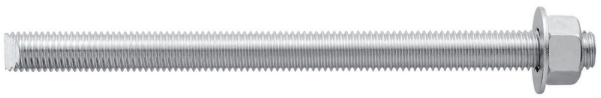
| Hole Diameter | Round Brush Size use with HIT-RBH handle | Qty |
|---|---|---|
| **1/2** | HIT-RB 1/2 | 1 |
| **5/8** | HIT-RB 5/8 | 1 |
| **11/16** | HIT-RB 11/16 | 1 |
| **7/8** | HIT-RB 7/8 | 1 |
| **1** | HIT-RB 1 | 1 |

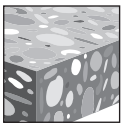


# 3.2.5 HIT-ICE ADHESIVE ANCHORING SYSTEM

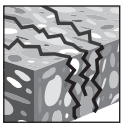
## PRODUCT DESCRIPTION

**HIT-ICE with Threaded Rod, Rebar, and HIS-N Inserts**

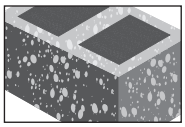
| Mortar Systems | | Features and Benefits |
|---|---|---|
|  | Hilti HIT-ICE Cartridge | • Winter formulation for base material temperatures down to -10°F (-23°C)<br>• Two hole cleaning options including the Hilti SafeSet™ System using the TE-CD or TE-YD Hollow Drill Bit in conjunction with a Hilti Vacuum to remove the dust as you drill.<br>• Small edge distance and anchor spacing allowance<br>• Mixing tube provides proper mixing and accurate dispensing of mixed resin<br>• Contains no styrene and virtually odorless<br>• Cures quickly over a large range of base material temperatures<br>• Excellent weathering resistance and resistance to high temperatures<br>• High load capacities |
|  | Rebar | |
|  | Hilti HAS Threaded Rod | |
|  | Hilti HIS-N | |



Uncracked concrete



Cracked concrete



Grout-filled concrete masonry

SafeSet™ System with Hollow Drill Bit




Profis Anchor design software

| Approvals/Listings | |
|---|---|
| **U.S. Green Building Council** | LEED® Credit 4.1-Low Emitting Materials |

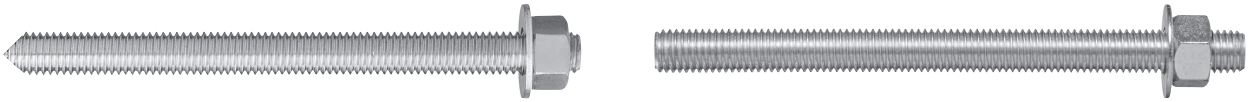
## MATERIAL SPECIFICATIONS

**Table 1 - Material properties of cured HIT-ICE adhesive**

| | | |
|---|---|---|
| Compressive strength | 72 MPa | 10,440 psi |
| Tensile strength | 12 MPa | 1,740 psi |
| Water absorption DIN 53495 | 2.4% | |
| Electrical resistance DIN/VDE 0303T3 | $2x10^{11}$ OHM/cm | $5.1x10^{11}$ OHM/in. |

For material specifications for anchor rods and inserts, please refer to section 3.2.8 of the Hilti North American Tech Guide volume 2: Anchor Fastening Technical Guide, Edition 17.

**Hilti HIT-ICE with HAS Threaded Rod**



Hilti HAS threaded rod

**Figure 1 — Hilti HAS threaded rod installation conditions**

| | | | | | |
|---|---|---|---|---|---|
| Permissible concrete conditions | Uncracked concrete | Dry concrete | Permissible drilling method | Hammer drilling with carbide tipped drill bit | |
| | Cracked concrete | Water saturated concrete | | Hilti TE-CD or TE-YD Hollow Drill Bit | |

**Table 2 — Hilti HAS Rod installation specifications installed with Hilti HIT-ICE adhesive system**

| Setting information | | Symbol | Units | Nominal rod diameter | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 |
| Nominal bit diameter | | $d_o$ | in. | 7/16 | 9/16 | 3/4 | 7/8 | 1 | 1-1/8 | 1-3/8 |
| Effective embedment | minimum | $h_{ef,min}$ | in.<br>(mm) | 2-3/8<br>(60) | 2-3/4<br>(70) | 3-1/8<br>(79) | 3-1/2<br>(89) | 3-1/2<br>(89) | 4<br>(102) | 5<br>(127) |
| | maximum | $h_{ef,max}$ | in.<br>(mm) | 7-1/2<br>(191) | 10<br>(254) | 12-1/2<br>(318) | 15<br>(381) | 17-1/2<br>(445) | 20<br>(508) | 25<br>(635) |
| Minimum diameter of fixture hole | through-set |  | in. | 1/2 | 5/8 | 13/16[1] | 15/16[1] | 1-1/8[1] | 1-1/4[1] | 1-1/2[1] |
| | preset |  | in. | 7/16 | 9/16 | 11/16 | 13/16 | 15/16 | 1-1/8 | 1-3/8 |
| Installation torque | | $T_{inst}$ | ft-lb<br>(Nm) | 15<br>(20) | 30<br>(40) | 60<br>(80) | 100<br>(136) | 125<br>(169) | 150<br>(203) | 200<br>(271) |
| Minimum concrete thickness | | $h_{min}$ | in.<br>(mm) | $h_{ef}$+1-1/4<br>($h_{ef}$+30) | | $h_{ef}$+2*$d_o$ | | | | |
| Minimum edge distance[2] | | $c_{min}$ | in.<br>(mm) | 1-7/8<br>(48) | 2-1/2<br>(64) | 3-1/8<br>(79) | 3-3/4<br>(95) | 4-3/8<br>(111) | 5<br>(127) | 5-5/8<br>(143) |
| Minimum anchor spacing | | $s_{min}$ | in.<br>(mm) | 1-7/8<br>(48) | 2-1/2<br>(64) | 3-1/8<br>(79) | 3-3/4<br>(95) | 4-3/8<br>(111) | 5<br>(127) | 5-5/8<br>(143) |

1 Install using (2) washers. See Figure 3.

2 Edge distance of 1-3/4-inch (44mm) is permitted provided the installation torque is reduced to 0.30 $T_{inst}$ for 5d < s < 16-in. and to 0.5$T_{inst}$ for s >16-in.

**Figure 2 — HAS threaded rods**

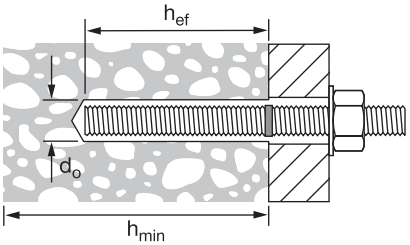



**Figure 3 — Installation with (2) washers**



# DESIGN DATA IN CONCRETE PER ACI 318



### ACI 318 Chapter 17 design

Load Resistance Factored Design of anchors is described in the provisions of ACI 318 Chapter 17 for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Load Resistance Factored Design tables with unfactored characteristic loads that are based on testing in accordance with ACI 355.4. These tables are followed by Hilti Simplified Design Tables. The load values in these tables were developed using the Strength Design parameters developed through testing per ACI 355.4 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to the of the Hilti North American Product Technical Guide, Volume 2: Anchor Fastening Technical Guide.
For additional information or technical assistance, contact Hilti at 800-879-5000 (US) or 800-363-4459 (CA)

**Table 3 — Hilti HIT-ICE design information with HAS threaded rods in holes drilled with a hammer drill and carbide bit (or hollow drill bit) in accordance with ACI 318 Ch. 17[1]**

| Design parameter | | Symbol | Units | Nominal rod diameter (in.) | | | | | | | Ref ACI 318 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 | |
| Nominal anchor diameter | | $d_a$ | in<br>(mm) | 3/8<br>(9.5) | 1/2<br>(12.7) | 5/8<br>(15.9) | 3/4<br>(19.1) | 7/8<br>(22.2) | 1<br>(25.4) | 1-1/4<br>(31.8) | |
| Effective minimum embedment[2] | | $h_{ef,min}$ | in<br>(mm) | 2-3/8<br>(60) | 2-3/4<br>(70) | 3-1/8<br>(79) | 3-1/2<br>(89) | 3-1/2<br>(89) | 4<br>(102) | 5<br>(127) | |
| Effective maximum embedment[2] | | $h_{ef,max}$ | in<br>(mm) | 7-1/2<br>(191) | 10<br>(254) | 12-1/2<br>(318) | 15<br>(381) | 17-1/2<br>(445) | 20<br>(508) | 25<br>(635) | |
| Minimum concrete thickness[2] | | $h_{min}$ | in<br>(mm) | $h_{ef}$ + 1-1/4<br>($h_{ef}$ + 30) | | hef + $2d_0$[8] | | | | | |
| Critical edge distance | | $c_{ac}$ | in<br>(mm) | $c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{1160}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4<br>$\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$<br>($c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4<br>$\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$) | | | | | | | |
| Minimum edge distance[3] | | $c_{min}$ | in<br>(mm) | 1-7/8<br>(48) | 2-1/2<br>(64) | 3-1/8<br>(79) | 3-3/4<br>(95) | 4-3/8<br>(111) | 5<br>(127) | 6-1/4<br>(159) | |
| Minimum anchor spacing | | $s_{min}$ | in<br>(mm) | 1-7/8<br>(48) | 2-1/2<br>(64) | 3-1/8<br>(79) | 3-3/4<br>(95) | 4-3/8<br>(111) | 5<br>(127) | 6-1/4<br>(159) | |
| Effectiveness factor for uncracked concrete[4] | | $k_{c,uncr}$ | - | 24<br>(10) | | | | | | | 17.4.2.2 |
| Effectiveness factor for cracked concrete[4] | | $k_{c,cr}$ | - | 17<br>(7.1) | | | | | | | 17.4.2.2 |
| Strength reduction factor for tension, concrete failure modes[5] | | $\Phi_{c,N}$ | - | 0.65 | | | | | | | 17.3.3 |
| Strength reduction factor for shear, concrete failure modes[5] | | $\Phi_{c,V}$ | - | 0.70 | | | | | | | 17.3.3 |
| Temperature range A[6] | Characteristic bond stress in cracked concrete[7] | $\tau_{k,cr}$ | psi<br>(MPa) | 715<br>(4.9) | 615<br>(4.2) | 520<br>(3.6) | 420<br>(2.9) | 325<br>(2.2) | n/a | n/a | 17.4.5 |
| | Characteristic bond stress in uncracked concrete[7] | $\tau_{k,uncr}$ | psi<br>(MPa) | 1,215<br>(8.4) | 1,200<br>(8.3) | 1,185<br>(8.2) | 1,075<br>(7.4) | 1,060<br>(7.3) | 1,050<br>(7.2) | 1,020<br>(7.0) | 17.4.5 |
| Permissible installation conditions | Strength reduction factor for tension, bond failure modes, dry concrete | - | - | 2 | 1 | 2 | 1 | 1 | 1 | 1 | |
| | | - | - | 0.55 | 0.65 | 0.55 | 0.65 | 0.65 | 0.65 | 0.65 | |
| | Strength reduction factor for tension, bond failure modes, water saturated concrete | - | - | 2 | 1 | 2 | 1 | 1 | 1 | 1 | |
| | | - | - | 0.55 | 0.65 | 0.55 | 0.65 | 0.65 | 0.65 | 0.65 | |

1 Design information in this table is based on testing in accordance with ACI 355.4.
2 See figure 2 and 3 of this section.
3 Minimum edge distance may be reduced to 1-3/4" (44mm) ≤ $c_{min}$ < 5d provided $T_{inst}$ is reduced to 0.30 $T_{inst}$ for 5d < s < 16-in. and to 0.5$T_{inst}$ for s >16-in.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
5 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.
6 Temperature range A: Max. short term temperature = 130°F (54°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
7 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2500 psi (17.2 Mpa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 Mpa) and 8,000 psi (55.2 Mpa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$]
8 $d_0$ = drilled hole diameter

## Table 4 — Hilti HIT-ICE adhesive design strength with concrete / bond failure for threaded rod in uncracked concrete[1,2,3,4,5,6,7,8]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8 | 2-3/8 (60) | 1,870 (8.3) | 1,905 (8.5) | 1,960 (8.7) | 2,040 (9.1) | 2,380 (10.6) | 2,425 (10.8) | 2,495 (11.1) | 2,595 (11.5) |
| | 3-3/8 (86) | 2,655 (11.8) | 2,705 (12.0) | 2,785 (12.4) | 2,900 (12.9) | 6,765 (30.1) | 6,890 (30.6) | 7,090 (31.5) | 7,380 (32.8) |
| | 4-1/2 (114) | 3,545 (15.8) | 3,610 (16.1) | 3,715 (16.5) | 3,865 (17.2) | 9,020 (40.1) | 9,185 (40.9) | 9,450 (42.0) | 9,845 (43.8) |
| | 7-1/2 (191) | 5,905 (26.3) | 6,015 (26.8) | 6,190 (27.5) | 6,445 (28.7) | 15,030 (66.9) | 15,305 (68.1) | 15,755 (70.1) | 16,405 (73.0) |
| 1/2 | 2-3/4 (70) | 3,370 (15.0) | 3,430 (15.3) | 3,530 (15.7) | 3,680 (16.4) | 7,255 (32.3) | 7,390 (32.9) | 7,605 (33.8) | 7,920 (35.2) |
| | 4-1/2 (114) | 5,515 (24.5) | 5,615 (25.0) | 5,780 (25.7) | 6,020 (26.8) | 11,875 (52.8) | 12,095 (53.8) | 12,445 (55.4) | 12,960 (57.6) |
| | 6 (152) | 7,350 (32.7) | 7,485 (33.3) | 7,705 (34.3) | 8,025 (35.7) | 15,835 (70.4) | 16,125 (71.7) | 16,595 (73.8) | 17,280 (76.9) |
| | 10 (254) | 12,250 (54.5) | 12,480 (55.5) | 12,840 (57.1) | 13,375 (59.5) | 26,390 (117.4) | 26,875 (119.5) | 27,660 (123.0) | 28,805 (128.1) |
| 5/8 | 3-1/8 (79) | 4,000 (17.8) | 4,075 (18.1) | 4,190 (18.6) | 4,365 (19.4) | 9,280 (41.3) | 10,165 (45.2) | 10,670 (47.5) | 11,110 (49.4) |
| | 5-5/8 (143) | 7,200 (32.0) | 7,330 (32.6) | 7,545 (33.6) | 7,855 (34.9) | 18,325 (81.5) | 18,660 (83.0) | 19,205 (85.4) | 20,000 (89.0) |
| | 7-1/2 (191) | 9,600 (42.7) | 9,775 (43.5) | 10,060 (44.7) | 10,475 (46.6) | 24,430 (108.7) | 24,880 (110.7) | 25,605 (113.9) | 26,665 (118.6) |
| | 12-1/2 (318) | 15,995 (71.1) | 16,290 (72.5) | 16,765 (74.6) | 17,460 (77.7) | 40,720 (181.1) | 41,465 (184.4) | 42,675 (189.8) | 44,445 (197.7) |
| 3/4 | 3-1/2 (89) | 5,105 (22.7) | 5,595 (24.9) | 6,040 (26.9) | 6,290 (28.0) | 11,000 (48.9) | 12,050 (53.6) | 13,010 (57.9) | 13,545 (60.3) |
| | 6-3/4 (171) | 11,115 (49.4) | 11,320 (50.4) | 11,650 (51.8) | 12,130 (54.0) | 23,935 (106.5) | 24,375 (108.4) | 25,090 (111.6) | 26,125 (116.2) |
| | 9 (229) | 14,820 (65.9) | 15,090 (67.1) | 15,530 (69.1) | 16,175 (71.9) | 31,915 (142.0) | 32,500 (144.6) | 33,450 (148.8) | 34,835 (155.0) |
| | 15 (381) | 24,695 (109.8) | 25,150 (111.9) | 25,885 (115.1) | 26,955 (119.9) | 53,190 (236.6) | 54,170 (241.0) | 55,750 (248.0) | 58,060 (258.3) |
| 7/8 | 3-1/2 (89) | 5,105 (22.7) | 5,595 (24.9) | 6,460 (28.7) | 7,235 (32.2) | 11,000 (48.9) | 12,050 (53.6) | 13,915 (61.9) | 15,585 (69.3) |
| | 7-7/8 (200) | 14,915 (66.3) | 15,190 (67.6) | 15,635 (69.5) | 16,280 (72.4) | 32,125 (142.9) | 32,715 (145.5) | 33,670 (149.8) | 35,065 (156.0) |
| | 10-1/2 (267) | 19,885 (88.5) | 20,255 (90.1) | 20,845 (92.7) | 21,705 (96.5) | 42,835 (190.5) | 43,620 (194.0) | 44,895 (199.7) | 46,750 (208.0) |
| | 17-1/2 (445) | 33,145 (147.4) | 33,755 (150.1) | 34,740 (154.5) | 36,175 (160.9) | 71,390 (317.6) | 72,700 (323.4) | 74,825 (332.8) | 77,920 (346.6) |
| 1 | 4 (102) | 6,240 (27.8) | 6,835 (30.4) | 7,895 (35.1) | 9,360 (41.6) | 13,440 (59.8) | 14,725 (65.5) | 17,000 (75.6) | 20,165 (89.7) |
| | 9 (229) | 19,295 (85.8) | 19,650 (87.4) | 20,225 (90.0) | 21,065 (93.7) | 41,565 (184.9) | 42,330 (188.3) | 43,565 (193.8) | 45,365 (201.8) |
| | 12 (305) | 25,730 (114.5) | 26,205 (116.6) | 26,970 (120.0) | 28,085 (124.9) | 55,420 (246.5) | 56,435 (251.0) | 58,085 (258.4) | 60,490 (269.1) |
| | 20 (508) | 42,885 (190.8) | 43,670 (194.3) | 44,945 (199.9) | 46,805 (208.2) | 92,365 (410.9) | 94,060 (418.4) | 96,810 (430.6) | 100,815 (448.4) |
| 1-1/4 | 5 (127) | 8,720 (38.8) | 9,555 (42.5) | 11,030 (49.1) | 13,510 (60.1) | 18,785 (83.6) | 20,575 (91.5) | 23,760 (105.7) | 29,100 (129.4) |
| | 11-1/4 (286) | 29,290 (130.3) | 29,830 (132.7) | 30,700 (136.6) | 31,970 (142.2) | 63,085 (280.6) | 64,250 (285.8) | 66,125 (294.1) | 68,860 (306.3) |
| | 15 (381) | 39,055 (173.7) | 39,770 (176.9) | 40,935 (182.1) | 42,625 (189.6) | 84,115 (374.2) | 85,665 (381.1) | 88,165 (392.2) | 91,810 (408.4) |
| | 25 (635) | 65,090 (289.5) | 66,285 (294.8) | 68,220 (303.5) | 71,045 (316.0) | 140,195 (623.6) | 142,775 (635.1) | 146,940 (653.6) | 153,020 (680.7) |

1 See section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7 - 18 as necessary to the above values. Compare to the steel values in table 6. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (54°C), max. long term temperature = 110°F (43°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength value by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

**Table 5 — Hilti HIT-ICE adhesive design strength with concrete / bond failure for threaded rod in cracked concrete[1,2,3,4,5,6,7,8]**

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8 | 2-3/8 (60) | 1,100 (4.9) | 1,120 (5.0) | 1,155 (5.1) | 1,200 (5.3) | 1,400 (6.2) | 1,425 (6.3) | 1,470 (6.5) | 1,530 (6.8) |
| | 3-3/8 (86) | 1,565 (7.0) | 1,590 (7.1) | 1,640 (7.3) | 1,705 (7.6) | 3,980 (17.7) | 4,055 (18.0) | 4,170 (18.5) | 4,345 (19.3) |
| | 4-1/2 (114) | 2,085 (9.3) | 2,125 (9.5) | 2,185 (9.7) | 2,275 (10.1) | 5,305 (23.6) | 5,405 (24.0) | 5,560 (24.7) | 5,790 (25.8) |
| | 7-1/2 (191) | 3,475 (15.5) | 3,540 (15.7) | 3,640 (16.2) | 3,795 (16.9) | 8,845 (39.3) | 9,005 (40.1) | 9,270 (41.2) | 9,655 (42.9) |
| 1/2 | 2-3/4 (70) | 1,725 (7.7) | 1,760 (7.8) | 1,810 (8.1) | 1,885 (8.4) | 3,720 (16.5) | 3,790 (16.9) | 3,900 (17.3) | 4,060 (18.1) |
| | 4-1/2 (114) | 2,825 (12.6) | 2,880 (12.8) | 2,960 (13.2) | 3,085 (13.7) | 6,085 (27.1) | 6,200 (27.6) | 6,380 (28.4) | 6,645 (29.6) |
| | 6 (152) | 3,770 (16.8) | 3,835 (17.1) | 3,950 (17.6) | 4,110 (18.3) | 8,115 (36.1) | 8,265 (36.8) | 8,505 (37.8) | 8,855 (39.4) |
| | 10 (254) | 6,280 (27.9) | 6,395 (28.4) | 6,580 (29.3) | 6,855 (30.5) | 13,525 (60.2) | 13,775 (61.3) | 14,175 (63.1) | 14,760 (65.7) |
| 5/8 | 3-1/8 (79) | 1,755 (7.8) | 1,785 (7.9) | 1,840 (8.2) | 1,915 (8.5) | 4,465 (19.9) | 4,550 (20.2) | 4,680 (20.8) | 4,875 (21.7) |
| | 5-5/8 (143) | 3,160 (14.1) | 3,215 (14.3) | 3,310 (14.7) | 3,450 (15.3) | 8,040 (35.8) | 8,190 (36.4) | 8,425 (37.5) | 8,775 (39.0) |
| | 7-1/2 (191) | 4,210 (18.7) | 4,290 (19.1) | 4,415 (19.6) | 4,595 (20.4) | 10,720 (47.7) | 10,920 (48.6) | 11,235 (50.0) | 11,700 (52.0) |
| | 12-1/2 (318) | 7,020 (31.2) | 7,150 (31.8) | 7,355 (32.7) | 7,660 (34.1) | 17,870 (79.5) | 18,195 (80.9) | 18,730 (83.3) | 19,505 (86.8) |
| 3/4 | 3-1/2 (89) | 2,250 (10.0) | 2,295 (10.2) | 2,360 (10.5) | 2,455 (10.9) | 4,850 (21.6) | 4,940 (22.0) | 5,080 (22.6) | 5,295 (23.6) |
| | 6-3/4 (171) | 4,340 (19.3) | 4,420 (19.7) | 4,550 (20.2) | 4,740 (21.1) | 9,350 (41.6) | 9,525 (42.4) | 9,800 (43.6) | 10,205 (45.4) |
| | 9 (229) | 5,790 (25.8) | 5,895 (26.2) | 6,070 (27.0) | 6,320 (28.1) | 12,470 (55.5) | 12,700 (56.5) | 13,070 (58.1) | 13,610 (60.5) |
| | 15 (381) | 9,650 (42.9) | 9,825 (43.7) | 10,115 (45.0) | 10,530 (46.8) | 20,780 (92.4) | 21,165 (94.1) | 21,780 (96.9) | 22,685 (100.9) |
| 7/8 | 3-1/2 (89) | 2,030 (9.0) | 2,070 (9.2) | 2,130 (9.5) | 2,220 (9.9) | 4,380 (19.5) | 4,460 (19.8) | 4,590 (20.4) | 4,780 (21.3) |
| | 7-7/8 (200) | 4,575 (20.4) | 4,655 (20.7) | 4,795 (21.3) | 4,990 (22.2) | 9,850 (43.8) | 10,030 (44.6) | 10,325 (45.9) | 10,750 (47.8) |
| | 10-1/2 (267) | 6,095 (27.1) | 6,210 (27.6) | 6,390 (28.4) | 6,655 (29.6) | 13,135 (58.4) | 13,375 (59.5) | 13,765 (61.2) | 14,335 (63.8) |
| | 17-1/2 (445) | 10,160 (45.2) | 10,350 (46.0) | 10,650 (47.4) | 11,090 (49.3) | 21,890 (97.4) | 22,290 (99.2) | 22,940 (102.0) | 23,890 (106.3) |

1 See section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7-18 as necessary to the above values. Compare to the steel values in table 6. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (54°C), max. long term temperature = 110°F (43°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength value by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic applications are not permitted.

## Table 6 — Steel design strength for Hilti HAS threaded rods for use with ACI 318 Chapter 17

| Nominal anchor diameter in. | HAS-V-36 / HAS-V-36 HDG ASTM F1554 Gr. 36[4,5] | | | HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6] | | | HAS-B-105 and HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4] | | | HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) |
| 3/8 | 3,370 (15.0) | 1,750 (7.8) | 1,050 (4.7) | 4,360 (19.4) | 2,270 (10.1) | 1,590 (7.1) | 7,270 (32.3) | 3,780 (16.8) | 2,645 (11.8) | 5,040 (22.4) | 2,790 (12.4) | 1,955 (8.7) |
| 1/2 | 6,175 (27.5) | 3,210 (14.3) | 1,925 (8.6) | 7,985 (35.5) | 4,150 (18.5) | 2,905 (12.9) | 13,305 (59.2) | 6,920 (30.8) | 4,845 (21.6) | 9,225 (41.0) | 5,110 (22.7) | 3,575 (15.9) |
| 5/8 | 9,835 (43.7) | 5,110 (22.7) | 3,065 (13.6) | 12,715 (56.6) | 6,610 (29.4) | 4,625 (20.6) | 21,190 (94.3) | 11,020 (49.0) | 7,715 (34.3) | 14,690 (65.3) | 8,135 (36.2) | 5,695 (25.3) |
| 3/4 | 14,550 (64.7) | 7,565 (33.7) | 4,540 (20.2) | 18,820 (83.7) | 9,785 (43.5) | 6,850 (30.5) | 31,360 (139.5) | 16,310 (72.6) | 11,415 (50.8) | 18,485 (82.2) | 10,235 (45.5) | 7,165 (31.9) |
| 7/8 | 20,085 (89.3) | 10,445 (46.5) | 6,265 (27.9) | 25,975 (115.5) | 13,505 (60.1) | 9,455 (42.1) | 43,285 (192.5) | 22,510 (100.1) | 15,755 (70.1) | 25,510 (113.5) | 14,125 (62.8) | 9,890 (44.0) |
| 1 | 26,350 (117.2) | 13,700 (60.9) | 8,220 (36.6) | 34,075 (151.6) | 17,720 (78.8) | 12,405 (55.2) | 56,785 (252.6) | 29,530 (131.4) | 20,670 (91.9) | 33,465 (148.9) | 18,535 (82.4) | 12,975 (57.7) |
| 1-1/4 | 42,160 (187.5) | 21,920 (97.5) | 13,150 (58.5) | 54,515 (242.5) | 28,345 (126.1) | 19,840 (88.3) | 90,855 (404.1) | 47,245 (210.2) | 33,070 (147.1) | 41,430 (184.3) | 21,545 (95.8) | 12,925 (57.5) |

1 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 17.4.1.2
2 Shear = $\phi$ 0.60 $A_{se,V} f_{uta}$ as noted in ACI 318 17.5.1.2b.
3 Seismic Shear = $\alpha_{V,seis} \phi V_{sa}$ : Reduction factor for seismic shear only. See ACI 318 for additional information on seismic applications.
4 HAS-V, HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).
5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.
6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V, HAS-E, and HAS-E-B (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

### Table 7 — Load adjustment factors for 3/8-in. diameter threaded rods in uncracked concrete[1,2,3]

| 3/8-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | || To edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.44 | 0.32 | 0.23 | 0.13 | n/a | n/a | n/a | n/a | 0.30 | 0.11 | 0.08 | 0.05 | 0.44 | 0.22 | 0.16 | 0.10 | n/a | n/a | n/a | n/a |
| | 1-7/8 (48) | 0.61 | 0.59 | 0.57 | 0.54 | 0.46 | 0.33 | 0.24 | 0.14 | 0.58 | 0.54 | 0.53 | 0.52 | 0.33 | 0.12 | 0.09 | 0.05 | 0.46 | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | n/a |
| | 2 (51) | 0.62 | 0.60 | 0.57 | 0.54 | 0.48 | 0.34 | 0.25 | 0.14 | 0.59 | 0.54 | 0.54 | 0.53 | 0.36 | 0.13 | 0.10 | 0.06 | 0.48 | 0.27 | 0.20 | 0.12 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.69 | 0.65 | 0.61 | 0.57 | 0.61 | 0.43 | 0.31 | 0.18 | 0.63 | 0.57 | 0.55 | 0.54 | 0.66 | 0.25 | 0.18 | 0.11 | 0.61 | 0.43 | 0.31 | 0.18 | n/a | n/a | n/a | n/a |
| | 3-5/8 (92) | 0.72 | 0.68 | 0.63 | 0.58 | 0.71 | 0.50 | 0.36 | 0.21 | 0.65 | 0.58 | 0.56 | 0.55 | 0.88 | 0.33 | 0.24 | 0.15 | 0.71 | 0.49 | 0.36 | 0.21 | 0.78 | n/a | n/a | n/a |
| | 4 (102) | 0.74 | 0.70 | 0.65 | 0.59 | 0.79 | 0.53 | 0.38 | 0.22 | 0.67 | 0.59 | 0.57 | 0.55 | 1.00 | 0.38 | 0.28 | 0.17 | 0.79 | 0.53 | 0.38 | 0.23 | 0.82 | n/a | n/a | n/a |
| | 4-5/8 (117) | 0.78 | 0.73 | 0.671 | 0.60 | 0.91 | 0.61 | 0.44 | 0.26 | 0.70 | 0.60 | 0.58 | 0.56 | | 0.47 | 0.35 | 0.21 | 0.91 | 0.61 | 0.44 | 0.26 | 0.89 | 0.63 | n/a | n/a |
| | 5 (127) | 0.80 | 0.75 | 0.69 | 0.61 | 0.98 | 0.66 | 0.48 | 0.28 | 0.71 | 0.61 | 0.60 | 0.56 | | 0.53 | 0.40 | 0.24 | 0.98 | 0.66 | 0.48 | 0.28 | 0.92 | 0.66 | n/a | n/a |
| | 5-3/4 (146) | 0.85 | 0.78 | 0.71 | 0.68 | 1.00 | 0.75 | 0.55 | 0.32 | 0.74 | 0.63 | 0.60 | 0.57 | | 0.65 | 0.49 | 0.30 | 1.00 | 0.75 | 0.55 | 0.32 | 0.99 | 0.71 | 0.64 | n/a |
| | 6 (152) | 0.86 | 0.80 | 0.72 | 0.63 | | 0.79 | 0.57 | 0.332 | 0.75 | 0.63 | 0.61 | 0.58 | | 0.69 | 0.52 | 0.31 | | 0.79 | 0.57 | 0.33 | 1.00 | 0.72 | 0.66 | n/a |
| | 7 (178) | 0.93 | 0.85 | 0.76 | 0.66 | | 0.92 | 0.67 | 0.39 | 0.80 | 0.65 | 0.63 | 0.59 | | 0.87 | 0.65 | 0.40 | | 0.92 | 0.67 | 0.39 | | 0.78 | 0.71 | n/a |
| | 8 (203) | 0.99 | 0.90 | 0.80 | 0.68 | | 1.00 | 0.76 | 0.44 | 0.84 | 0.67 | 0.64 | 0.60 | | 1.00 | 0.80 | 0.48 | | 1.00 | 0.76 | 0.44 | | 0.83 | 0.76 | n/a |
| | 8-3/4 (222) | 1.00 | 0.93 | 0.82 | 0.69 | | | 0.84 | 0.48 | 0.87 | 0.69 | 0.66 | 0.61 | | | 0.91 | 0.55 | | | 0.84 | 0.48 | | 0.87 | 0.80 | 0.67 |
| | 9 (229) | | 0.94 | 0.83 | 0.70 | | | 0.86 | 0.50 | 0.88 | 0.70 | 0.66 | 0.62 | | | 0.95 | 0.57 | | | 0.86 | 0.50 | | 0.88 | 0.80 | 0.68 |
| | 10 (254) | | 0.99 | 0.87 | 0.72 | | | 0.96 | 0.55 | 0.92 | 0.72 | 0.68 | 0.63 | | | 1.00 | 0.67 | | | 0.96 | 0.55 | | 0.93 | 0.85 | 0.71 |
| | 11 (279) | | 1.00 | 0.91 | 0.74 | | | 1.00 | 0.61 | 0.97 | 0.74 | 0.70 | 0.64 | | | | 0.77 | | | 1.00 | 0.61 | | 0.98 | 0.89 | 0.75 |
| | 12 (305) | | | 0.94 | 0.77 | | | | 0.66 | 1.00 | 0.76 | 0.72 | 0.65 | | | | 0.88 | | | | 0.66 | | 1.00 | 0.93 | 0.78 |
| | 14 (356) | | | 1.00 | 0.81 | | | | 0.78 | | 0.80 | 0.75 | 0.68 | | | | 1.00 | | | | 0.78 | | | 1.00 | 0.85 |
| | 16 (406) | | | | 0.86 | | | | 0.88 | | 0.85 | 0.79 | 0.70 | | | | | | | | 0.89 | | | | 0.91 |
| | 18 (457) | | | | 0.90 | | | | 1.00 | | 0.89 | 0.82 | 0.73 | | | | | | | | 0.10 | | | | 0.96 |
| | 24 (610) | | | | 1.00 | | | | | | 1.00 | 0.93 | 0.81 | | | | | | | | 1.00 | | | | 1.00 |
| | 30 (762) | | | | | | | | | | | 1.00 | 0.88 | | | | | | | | | | | | |
| | 36 (914) | | | | | | | | | | | | 0.96 | | | | | | | | | | | | |
| | >48 (1219) | | | | | | | | | | | | 1.00 | | | | | | | | | | | | |

### Table 8 — Load adjustment factors for 3/8-in. diameter threaded rods in cracked concrete[1,2,3]

| 3/8-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | || To edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 2-3/8 (60) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.59 | 0.54 | 0.49 | 0.43 | n/a | n/a | n/a | n/a | 0.36 | 0.13 | 0.10 | 0.06 | 0.59 | 0.27 | 0.20 | 0.12 | n/a | n/a | n/a | n/a |
| | 1-7/8 (48) | 0.61 | 0.59 | 0.57 | 0.54 | 0.61 | 0.56 | 0.50 | 0.44 | 0.59 | 0.55 | 0.54 | 0.53 | 0.40 | 0.15 | 0.11 | 0.07 | 0.61 | 0.30 | 0.22 | 0.13 | n/a | n/a | n/a | n/a |
| | 2 (51) | 0.62 | 0.60 | 0.57 | 0.54 | 0.63 | 0.57 | 0.51 | 0.44 | 0.60 | 0.55 | 0.54 | 0.53 | 0.44 | 0.16 | 0.12 | 0.07 | 0.63 | 0.32 | 0.24 | 0.15 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.68 | 0.65 | 0.61 | 0.57 | 0.79 | 0.70 | 0.60 | 0.49 | 0.64 | 0.57 | 0.56 | 0.54 | 0.81 | 0.30 | 0.22 | 0.13 | 0.79 | 0.59 | 0.45 | 0.27 | n/a | n/a | n/a | n/a |
| | 3-5/8 (92) | 0.72 | 0.68 | 0.63 | 0.58 | 0.91 | 0.79 | 0.66 | 0.53 | 0.67 | 0.59 | 0.57 | 0.55 | 1.00 | 0.40 | 0.30 | 0.18 | 0.91 | 0.79 | 0.59 | 0.36 | 0.84 | n/a | n/a | n/a |
| | 4 (102) | 0.74 | 0.70 | 0.65 | 0.59 | 0.98 | 0.84 | 0.70 | 0.55 | 0.69 | 0.60 | 0.58 | 0.56 | | 0.46 | 0.34 | 0.21 | 0.98 | 0.84 | 0.69 | 0.41 | 0.88 | n/a | n/a | n/a |
| | 4-5/8 (117) | 0.78 | 0.73 | 0.67 | 0.60 | 1.00 | 0.93 | 0.76 | 0.58 | 0.72 | 0.61 | 0.59 | 0.57 | | 0.57 | 0.43 | 0.26 | 1.00 | 0.93 | 0.76 | 0.51 | 0.94 | 0.68 | n/a | n/a |
| | 5 (127) | 0.804 | 0.75 | 0.69 | 0.61 | | 0.99 | 0.80 | 0.60 | 0.74 | 0.62 | 0.61 | 0.57 | | 0.64 | 0.48 | 0.29 | | 0.99 | 0.80 | 0.58 | 0.98 | 0.70 | n/a | n/a |
| | 5-3/4 (146) | 0.85 | 0.78 | 0.71 | 0.63 | | 1.00 | 0.89 | 0.65 | 0.78 | 0.64 | 0.62 | 0.58 | | 0.79 | 0.59 | 0.36 | | 1.00 | 0.89 | 0.65 | 1.00 | 0.75 | 0.69 | n/a |
| | 6 (152) | 0.86 | 0.80 | 0.72 | 0.63 | | | 0.91 | 0.66 | 0.79 | 0.65 | 0.62 | 0.59 | | 0.84 | 0.63 | 0.38 | | | 0.91 | 0.66 | | 0.77 | 0.70 | n/a |
| | 7 (178) | 0.93 | 0.85 | 0.76 | 0.66 | | | 1.00 | 0.72 | 0.84 | 0.67 | 0.64 | 0.60 | | 1.00 | 0.79 | 0.48 | | | 1.00 | 0.72 | | 0.83 | 0.76 | n/a |
| | 8 (203) | 0.99 | 0.90 | 0.80 | 0.68 | | | | 0.78 | 0.89 | 0.70 | 0.66 | 0.62 | | | 0.97 | 0.58 | | | | 0.78 | | 0.89 | 0.81 | n/a |
| | 8-3/4 (222) | 1.00 | 0.93 | 0.82 | 0.69 | | | | 0.83 | 0.92 | 0.72 | 0.68 | 0.63 | | | 1.00 | 0.67 | | | | 0.83 | | 0.93 | 0.85 | 0.71 |
| | 9 (229) | | 0.94 | 0.83 | 0.70 | | | | 0.85 | 0.93 | 0.72 | 0.68 | 0.63 | | | | 0.70 | | | | 0.85 | | 0.94 | 0.86 | 0.72 |
| | 10 (254) | | 0.99 | 0.87 | 0.72 | | | | 0.91 | 0.98 | 0.75 | 0.70 | 0.65 | | | | 0.81 | | | | 0.91 | | 0.99 | 0.90 | 0.76 |
| | 11 (279) | | 1.00 | 0.91 | 0.74 | | | | 0.98 | 1.00 | 0.77 | 0.73 | 0.66 | | | | 0.92 | | | | 0.98 | | 1.00 | 0.95 | 0.80 |
| | 12 (305) | | | 0.94 | 0.76 | | | | 1.00 | | 0.80 | 0.75 | 0.67 | | | | 1.00 | | | | 1.00 | | | 0.99 | 0.84 |
| | 14 (356) | | | 1.00 | 0.81 | | | | | | 0.85 | 0.79 | 0.70 | | | | | | | | | | | 1.000 | 0.90 |
| | 16 (406) | | | | 0.86 | | | | | | 0.90 | 0.83 | 0.73 | | | | | | | | | | | | 0.96 |
| | 18 (457) | | | | 0.90 | | | | | | 0.95 | 0.87 | 0.76 | | | | | | | | | | | | 1.00 |
| | 24 (610) | | | | 1.00 | | | | | | 1.00 | 0.99 | 0.85 | | | | | | | | | | | | |
| | 30 (762) | | | | | | | | | | | 1.00 | 0.94 | | | | | | | | | | | | |
| | 36 (914) | | | | | | | | | | | | 1.00 | | | | | | | | | | | | |
| | >48 (1219) | | | | | | | | | | | | | | | | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$ is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 9 — Load adjustment factors for 1/2-in. diameter threaded rods in uncracked concrete[1,2,3]

| 1/2-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.404 | 0.275 | 0.20 | 0.12 | n/a | n/a | n/a | n/a | 0.11 | 0.07 | 0.05 | 0.03 | 0.22 | 0.14 | 0.11 | 0.06 | n/a | n/a | n/a | n/a |
| | 2-1/2 (64) | 0.62 | 0.59 | 0.57 | 0.54 | 0.49 | 0.32 | 0.24 | 0.14 | 0.55 | 0.54 | 0.53 | 0.52 | 0.19 | 0.12 | 0.09 | 0.06 | 0.37 | 0.25 | 0.18 | 0.11 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.64 | 0.61 | 0.58 | 0.55 | 0.54 | 0.35 | 0.26 | 0.15 | 0.57 | 0.55 | 0.54 | 0.53 | 0.24 | 0.16 | 0.12 | 0.07 | 0.49 | 0.32 | 0.24 | 0.15 | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.68 | 0.65 | 0.61 | 0.57 | 0.67 | 0.42 | 0.31 | 0.18 | 0.59 | 0.57 | 0.55 | 0.54 | 0.38 | 0.25 | 0.19 | 0.11 | 0.67 | 0.42 | 0.31 | 0.18 | 0.59 | n/a | n/a | n/a |
| | 5 (127) | 0.73 | 0.69 | 0.64 | 0.58 | 0.83 | 0.49 | 0.36 | 0.21 | 0.61 | 0.58 | 0.57 | 0.55 | 0.53 | 0.35 | 0.26 | 0.16 | 0.83 | 0.49 | 0.36 | 0.21 | 0.66 | n/a | n/a | n/a |
| | 5-3/4 (146) | 0.76 | 0.71 | 0.66 | 0.60 | 0.96 | 0.55 | 0.41 | 0.24 | 0.63 | 0.59 | 0.58 | 0.56 | 0.65 | 0.43 | 0.32 | 0.19 | 0.96 | 0.55 | 0.41 | 0.24 | 0.71 | 0.62 | n/a | n/a |
| | 6 (152) | 0.78 | 0.72 | 0.67 | 0.60 | 1.00 | 0.58 | 0.42 | 0.25 | 0.63 | 0.60 | 0.58 | 0.56 | 0.69 | 0.46 | 0.34 | 0.21 | 1.00 | 0.58 | 0.42 | 0.25 | 0.72 | 0.63 | n/a | n/a |
| | 7 (178) | 0.82 | 0.76 | 0.69 | 0.62 | | 0.67 | 0.49 | 0.29 | 0.65 | 0.62 | 0.60 | 0.57 | 0.87 | 0.57 | 0.43 | 0.26 | | 0.67 | 0.49 | 0.29 | 0.78 | 0.68 | n/a | n/a |
| | 7-1/4 (184) | 0.83 | 0.77 | 0.70 | 0.62 | | 0.70 | 0.5 | 0.30 | 0.66 | 0.62 | 0.60 | 0.57 | 0.92 | 0.60 | 0.45 | 0.27 | | 0.69 | 0.51 | 0.30 | 0.79 | 0.69 | 0.63 | n/a |
| | 8 (203) | 0.87 | 0.80 | 0.72 | 0.63 | | 0.77 | 0.56 | 0.33 | 0.67 | 0.63 | 0.61 | 0.58 | 1.00 | 0.70 | 0.53 | 0.32 | | 0.77 | 0.56 | 0.33 | 0.83 | 0.73 | 0.66 | n/a |
| | 9 (229) | 0.91 | 0.83 | 0.75 | 0.65 | | 0.86 | 0.63 | 0.37 | 0.70 | 0.65 | 0.62 | 0.59 | | 0.84 | 0.63 | 0.38 | | 0.86 | 0.63 | 0.37 | 0.88 | 0.77 | 0.70 | n/a |
| | 10 (254) | 0.96 | 0.87 | 0.78 | 0.67 | | 0.96 | 0.70 | 0.41 | 0.72 | 0.66 | 0.64 | 0.60 | | 0.98 | 0.73 | 0.44 | | 0.96 | 0.70 | 0.41 | 0.93 | 0.81 | 0.74 | n/a |
| | 11-1/4 (286) | 1.00 | 0.92 | 0.81 | 0.69 | | 1.00 | 0.79 | 0.46 | 0.74 | 0.69 | 0.65 | 0.61 | | 1.00 | 0.88 | 0.53 | | 1.00 | 0.79 | 0.46 | 0.99 | 0.86 | 0.78 | 0.66 |
| | 12 (305) | | 0.94 | 0.83 | 0.70 | | | 0.85 | 0.49 | 0.76 | 0.70 | 0.66 | 0.62 | | | 0.97 | 0.58 | | | 0.85 | 0.49 | 1.00 | 0.89 | 0.81 | 0.69 |
| | 14 (356) | | 1.00 | 0.89 | 0.73 | | | 0.99 | 0.58 | 0.80 | 0.73 | 0.69 | 0.64 | | | 1.00 | 0.73 | | | 0.99 | 0.58 | | 0.96 | 0.87 | 0.74 |
| | 16 (406) | | | 0.94 | 0.77 | | | 1.00 | 0.66 | 0.85 | 0.76 | 0.72 | 0.65 | | | | 0.89 | | | 1.00 | 0.66 | | 1.00 | 0.93 | 0.79 |
| | 18 (457) | | | 1.00 | 0.80 | | | | 0.74 | 0.89 | 0.80 | 0.74 | 0.67 | | | | 1.00 | | | | 0.74 | | | 0.99 | 0.83 |
| | 20 (508) | | | | 0.83 | | | | 0.82 | 0.93 | 0.83 | 0.77 | 0.69 | | | | | | | | 0.82 | | | 1.00 | 0.88 |
| | 22 (559) | | | | 0.87 | | | | 0.91 | 0.98 | 0.86 | 0.80 | 0.71 | | | | | | | | 0.91 | | | | 0.92 |
| | 24 (610) | | | | 0.90 | | | | 0.99 | 1.00 | 0.89 | 0.83 | 0.73 | | | | | | | | 0.99 | | | | 0.96 |
| | 30 (762) | | | | 1.00 | | | | 1.00 | | 0.99 | 0.91 | 0.79 | | | | | | | | 1.00 | | | | 1.00 |
| | 36 (914) | | | | | | | | | | 1.00 | 0.99 | 0.85 | | | | | | | | | | | | |
| | >48 (1219) | | | | | | | | | | | 1.00 | 0.96 | | | | | | | | | | | | |

## Table 10 — Load adjustment factors for 1/2-in. diameter threaded rods in cracked concrete[1,2,3]

| 1/2-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) | 2-3/4 (70) | 4-1/2 (114) | 6 (152) | 10 (254) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.526 | 0.49 | 0.45 | 0.41 | n/a | n/a | n/a | n/a | 0.15 | 0.10 | 0.08 | 0.05 | 0.30 | 0.20 | 0.15 | 0.09 | n/a | n/a | n/a | n/a |
| | 2-1/2 (64) | 0.62 | 0.59 | 0.57 | 0.54 | 0.61 | 0.56 | 0.50 | 0.44 | 0.57 | 0.55 | 0.54 | 0.53 | 0.26 | 0.17 | 0.13 | 0.08 | 0.52 | 0.34 | 0.26 | 0.15 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.64 | 0.61 | 0.58 | 0.55 | 0.67 | 0.60 | 0.53 | 0.46 | 0.58 | 0.56 | 0.55 | 0.54 | 0.34 | 0.22 | 0.17 | 0.10 | 0.67 | 0.45 | 0.34 | 0.20 | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.68 | 0.65 | 0.61 | 0.57 | 0.80 | 0.70 | 0.60 | 0.49 | 0.61 | 0.58 | 0.57 | 0.549 | 0.52 | 0.35 | 0.26 | 0.16 | 0.80 | 0.69 | 0.52 | 0.31 | 0.66 | n/a | n/a | n/a |
| | 5 (127) | 0.73 | 0.69 | 0.64 | 0.58 | 0.93 | 0.80 | 0.67 | 0.53 | 0.64 | 0.60 | 0.59 | 0.56 | 0.73 | 0.48 | 0.36 | 0.22 | 0.93 | 0.80 | 0.67 | 0.43 | 0.736 | n/a | n/a | n/a |
| | 5-3/4 (146) | 0.76 | 0.71 | 0.66 | 0.60 | 1.00 | 0.89 | 0.73 | 0.56 | 0.66 | 0.62 | 0.60 | 0.57 | 0.90 | 0.60 | 0.45 | 0.27 | 1.00 | 0.89 | 0.73 | 0.54 | 0.79 | 0.69 | n/a | n/a |
| | 6 (152) | 0.78 | 0.72 | 0.67 | 0.60 | | 0.91 | 0.75 | 0.57 | 0.66 | 0.62 | 0.60 | 0.57 | 0.96 | 0.63 | 0.48 | 0.29 | | 0.91 | 0.75 | 0.57 | 0.81 | 0.70 | n/a | n/a |
| | 7 (178) | 0.82 | 0.76 | 0.69 | 0.62 | | 1.00 | 0.83 | 0.62 | 0.69 | 0.64 | 0.62 | 0.58 | 1.00 | 0.80 | 0.60 | 0.36 | | 1.00 | 0.83 | 0.62 | 0.87 | 0.76 | n/a | n/a |
| | 7-1/4 (184) | 0.83 | 0.77 | 0.70 | 0.62 | | | 0.85 | 0.63 | 0.70 | 0.65 | 0.62 | 0.59 | | 0.84 | 0.63 | 0.38 | | | 0.85 | 0.63 | 0.89 | 0.77 | 0.70 | n/a |
| | 8 (203) | 0.87 | 0.80 | 0.72 | 0.63 | | | 0.91 | 0.66 | 0.72 | 0.66 | 0.64 | 0.60 | | 0.98 | 0.73 | 0.44 | | | 0.91 | 0.66 | 0.93 | 0.81 | 0.74 | n/a |
| | 9 (229) | 0.91 | 0.83 | 0.75 | 0.65 | | | 1.00 | 0.70 | 0.74 | 0.69 | 0.65 | 0.61 | | 1.00 | 0.87 | 0.52 | | | 1.00 | 0.70 | 0.99 | 0.86 | 0.78 | n/a |
| | 10 (254) | 0.96 | 0.87 | 0.78 | 0.67 | | | | 0.75 | 0.77 | 0.71 | 0.67 | 0.62 | | | 1.00 | 0.61 | | | | 0.75 | 1.00 | 0.91 | 0.82 | n/a |
| | 11-1/4 (286) | 1.00 | 0.92 | 0.81 | 0.69 | | | | 0.81 | 0.81 | 0.73 | 0.69 | 0.64 | | | | 0.73 | | | | 0.81 | | 0.96 | 0.87 | 0.74 |
| | 12 (305) | | 0.94 | 0.83 | 0.70 | | | | 0.85 | 0.83 | 0.75 | 0.70 | 0.64 | | | | 0.81 | | | | 0.85 | | 0.99 | 0.90 | 0.76 |
| | 14 (356) | | 1.00 | 0.89 | 0.73 | | | | 0.95 | 0.88 | 0.79 | 0.74 | 0.67 | | | | 1.00 | | | | 0.95 | | 1.00 | 0.97 | 0.82 |
| | 16 (406) | | | 0.94 | 0.77 | | | | 1.00 | 0.93 | 0.83 | 0.77 | 0.69 | | | | | | | | 1.00 | | | 1.00 | 0.88 |
| | 18 (457) | | | 1.00 | 0.80 | | | | | 0.99 | 0.87 | 0.81 | 0.72 | | | | | | | | | | | | 0.93 |
| | 20 (508) | | | | 0.83 | | | | | 1.00 | 0.91 | 0.84 | 0.74 | | | | | | | | | | | | 0.98 |
| | 22 (559) | | | | 0.87 | | | | | | 0.95 | 0.87 | 0.77 | | | | | | | | | | | | 1.00 |
| | 24 (610) | | | | 0.90 | | | | | | 0.99 | 0.91 | 0.79 | | | | | | | | | | | | |
| | 30 (762) | | | | 1.00 | | | | | | 1.00 | 1.00 | 0.86 | | | | | | | | | | | | |
| | 36 (914) | | | | | | | | | | | | 0.93 | | | | | | | | | | | | |
| | >48 (1219) | | | | | | | | | | | | 1.00 | | | | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

### Table 11 — Load adjustment factors for 5/8-in. diameter threaded rods in uncracked concrete[1,2,3]

| 5/8-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | || To edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.39 | 0.26 | 0.19 | 0.11 | n/a | n/a | n/a | n/a | 0.09 | 0.05 | 0.04 | 0.02 | 0.187 | 0.10 | 0.08 | 0.05 | n/a | n/a | n/a | n/a |
| 3-1/8 | (79) | 0.62 | 0.60 | 0.57 | 0.54 | 0.52 | 0.32 | 0.23 | 0.14 | 0.56 | 0.54 | 0.53 | 0.52 | 0.22 | 0.12 | 0.09 | 0.06 | 0.45 | 0.25 | 0.19 | 0.11 | n/a | n/a | n/a | n/a |
| 4 | (102) | 0.65 | 0.62 | 0.59 | 0.55 | 0.62 | 0.36 | 0.27 | 0.16 | 0.58 | 0.55 | 0.54 | 0.53 | 0.32 | 0.18 | 0.14 | 0.08 | 0.62 | 0.36 | 0.27 | 0.16 | n/a | n/a | n/a | n/a |
| 4-5/8 | (117) | 0.67 | 0.64 | 0.60 | 0.56 | 0.69 | 0.40 | 0.29 | 0.17 | 0.59 | 0.56 | 0.55 | 0.54 | 0.40 | 0.22 | 0.17 | 0.10 | 0.69 | 0.40 | 0.29 | 0.17 | 0.60 | n/a | n/a | n/a |
| 5 | (127) | 0.68 | 0.648 | 0.61 | 0.57 | 0.74 | 0.42 | 0.31 | 0.18 | 0.60 | 0.57 | 0.56 | 0.54 | 0.45 | 0.25 | 0.19 | 0.11 | 0.74 | 0.42 | 0.31 | 0.18 | 0.63 | n/a | n/a | n/a |
| 6 | (152) | 0.72 | 0.68 | 0.63 | 0.58 | 0.891 | 0.47 | 0.35 | 0.20 | 0.62 | 0.58 | 0.57 | 0.55 | 0.59 | 0.33 | 0.25 | 0.15 | 0.89 | 0.47 | 0.35 | 0.20 | 0.69 | n/a | n/a | n/a |
| 7 | (178) | 0.76 | 0.71 | 0.66 | 0.59 | 1.00 | 0.54 | 0.40 | 0.23 | 0.64 | 0.59 | 0.58 | 0.55 | 0.75 | 0.42 | 0.31 | 0.19 | 1.00 | 0.54 | 0.40 | 0.23 | 0.74 | n/a | n/a | n/a |
| 7-1/8 | (181) | 0.76 | 0.71 | 0.66 | 0.60 | | 0.55 | 0.40 | 0.24 | 0.64 | 0.59 | 0.58 | 0.56 | 0.77 | 0.43 | 0.32 | 0.19 | | 0.55 | 0.40 | 0.24 | 0.75 | 0.62 | n/a | n/a |
| 8 | (203) | 0.80 | 0.74 | 0.68 | 0.61 | | 0.62 | 0.45 | 0.27 | 0.66 | 0.61 | 0.59 | 0.56 | 0.91 | 0.51 | 0.38 | 0.23 | | 0.62 | 0.45 | 0.27 | 0.79 | 0.65 | n/a | n/a |
| 9 | (229) | 0.83 | 0.77 | 0.70 | 0.62 | | 0.69 | 0.51 | 0.30 | 0.68 | 0.62 | 0.60 | 0.57 | 1.00 | 0.61 | 0.45 | 0.27 | | 0.69 | 0.51 | 0.30 | 0.84 | 0.69 | 0.63 | n/a |
| 10 | (254) | 0.87 | 0.80 | 0.72 | 0.63 | | 0.77 | 0.57 | 0.33 | 0.70 | 0.63 | 0.61 | 0.58 | | 0.71 | 0.53 | 0.32 | | 0.77 | 0.57 | 0.33 | 0.89 | 0.73 | 0.6 | n/a |
| 11 | (279) | 0.91 | 0.83 | 0.74 | 0.65 | | 0.85 | 0.62 | 0.36 | 0.72 | 0.65 | 0.62 | 0.59 | | 0.82 | 0.61 | 0.37 | | 0.85 | 0.62 | 0.36 | 0.93 | 0.76 | 0.694 | n/a |
| 12 | (305) | 0.94 | 0.86 | 0.77 | 0.66 | | 0.92 | 0.68 | 0.40 | 0.74 | 0.66 | 0.63 | 0.59 | | 0.93 | 0.70 | 0.42 | | 0.92 | 0.68 | 0.40 | 0.97 | 0.80 | 0.73 | n/a |
| 14 | (356) | 1.00 | 0.92 | 0.81 | 0.69 | | 1.00 | 0.79 | 0.46 | 0.77 | 0.69 | 0.65 | 0.61 | | 1.00 | 0.88 | 0.53 | | 1.00 | 0.79 | 0.46 | 1.00 | 0.86 | 0.78 | 0.66 |
| 16 | (406) | | 0.97 | 0.86 | 0.71 | | | 0.90 | 0.53 | 0.81 | 0.71 | 0.68 | 0.63 | | | 1.00 | 0.65 | | | 0.90 | 0.53 | | 0.92 | 0.84 | 0.71 |
| 18 | (457) | | 1.00 | 0.90 | 0.74 | | | 1.00 | 0.60 | 0.85 | 0.74 | 0.70 | 0.64 | | | | 0.77 | | | 1.00 | 0.60 | | 0.98 | 0.89 | 0.75 |
| 20 | (508) | | | 0.94 | 0.77 | | | | 0.66 | 0.89 | 0.77 | 0.72 | 0.66 | | | | 0.90 | | | | 0.66 | | 1.00 | 0.94 | 0.79 |
| 22 | (559) | | | 0.99 | 0.79 | | | | 0.73 | 0.93 | 0.80 | 0.74 | 0.67 | | | | 1.00 | | | | 0.73 | | | 0.98 | 0.83 |
| 24 | (610) | | | 1.00 | 0.82 | | | | 0.79 | 0.97 | 0.82 | 0.76 | 0.69 | | | | | | | | 0.79 | | | 1.00 | 0.86 |
| 26 | (660) | | | | 0.85 | | | | 0.86 | 1.00 | 0.85 | 0.79 | 0.70 | | | | | | | | 0.86 | | | | 0.90 |
| 28 | (711) | | | | 0.87 | | | | 0.93 | | 0.87 | 0.81 | 0.72 | | | | | | | | 0.93 | | | | 0.93 |
| 30 | (762) | | | | 0.90 | | | | 0.99 | | 0.90 | 0.83 | 0.73 | | | | | | | | 0.99 | | | | 0.97 |
| 36 | (914) | | | | 0.98 | | | | 1.00 | | 0.98 | 0.89 | 0.78 | | | | | | | | 1.00 | | | | 1.00 |
| > 48 | (1219) | | | | 1.00 | | | | | | 1.00 | 1.00 | 0.87 | | | | | | | | | | | | |

Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm)

### Table 12 — Load adjustment factors for 5/8-in. diameter threaded rods in cracked concrete[1,2,3]

| 5/8-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | || To edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) | 3-1/8 (79) | 5-5/8 (143) | 7-1/2 (191) | 12-1/2 (318) |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.49 | 0.46 | 0.43 | 0.40 | n/a | n/a | n/a | n/a | 0.14 | 0.09 | 0.06 | 0.04 | 0.28 | 0.17 | 0.13 | 0.08 | n/a | n/a | n/a | n/a |
| 3-1/8 | (79) | 0.62 | 0.59 | 0.57 | 0.54 | 0.61 | 0.56 | 0.50 | 0.44 | 0.58 | 0.56 | 0.55 | 0.53 | 0.33 | 0.20 | 0.15 | 0.09 | 0.61 | 0.40 | 0.30 | 0.18 | n/a | n/a | n/a | n/a |
| 4 | (102) | 0.65 | 0.62 | 0.59 | 0.55 | 0.70 | 0.62 | 0.55 | 0.46 | 0.602 | 0.57 | 0.56 | 0.54 | 0.48 | 0.29 | 0.22 | 0.13 | 0.70 | 0.58 | 0.44 | 0.26 | n/a | n/a | n/a | n/a |
| 4-5/8 | (117) | 0.67 | 0.64 | 0.60 | 0.56 | 0.76 | 0.67 | 0.58 | 0.48 | 0.62 | 0.59 | 0.57 | 0.55 | 0.60 | 0.36 | 0.27 | 0.16 | 0.76 | 0.67 | 0.55 | 0.33 | 0.69 | n/a | n/a | n/a |
| 5 | (127) | 0.68 | 0.65 | 0.61 | 0.57 | 0.80 | 0.70 | 0.60 | 0.49 | 0.63 | 0.59 | 0.58 | 0.55 | 0.67 | 0.41 | 0.31 | 0.18 | 0.80 | 0.70 | 0.60 | 0.37 | 0.71 | n/a | n/a | n/a |
| 6 | (152) | 0.72 | 0.68 | 0.63 | 0.58 | 0.91 | 0.78 | 0.66 | 0.53 | 0.65 | 0.61 | 0.59 | 0.57 | 0.88 | 0.54 | 0.40 | 0.24 | 0.91 | 0.78 | 0.66 | 0.48 | 0.78 | n/a | n/a | n/a |
| 7 | (178) | 0.76 | 0.71 | 0.66 | 0.59 | 1.00 | 0.87 | 0.72 | 0.56 | 0.68 | 0.63 | 0.61 | 0.58 | 1.00 | 0.68 | 0.51 | 0.30 | 1.00 | 0.87 | 0.72 | 0.56 | 0.85 | n/a | n/a | n/a |
| 7-1/8 | (181) | 0.76 | 0.71 | 0.66 | 0.60 | | 0.88 | 0.73 | 0.56 | 0.68 | 0.63 | 0.61 | 0.58 | | 0.69 | 0.52 | 0.31 | | 0.88 | 0.73 | 0.56 | 0.85 | 0.72 | n/a | n/a |
| 8 | (203) | 0.80 | 0.74 | 0.68 | 0.61 | | 0.96 | 0.78 | 0.60 | 0.70 | 0.65 | 0.62 | 0.59 | | 0.83 | 0.62 | 0.37 | | 0.96 | 0.78 | 0.59 | 0.90 | 0.77 | n/a | n/a |
| 9 | (229) | 0.83 | 0.77 | 0.70 | 0.62 | | 1.00 | 0.85 | 0.63 | 0.73 | 0.67 | 0.64 | 0.60 | | 0.99 | 0.74 | 0.44 | | 1.00 | 0.85 | 0.63 | 0.96 | 0.81 | 0.74 | n/a |
| 10 | (254) | 0.87 | 0.80 | 0.72 | 0.63 | | | 0.91 | 0.66 | 0.76 | 0.68 | 0.65 | 0.61 | | 1.00 | 0.87 | 0.52 | | | 0.91 | 0.66 | 1.00 | 0.86 | 0.78 | n/a |
| 11 | (279) | 0.91 | 0.83 | 0.74 | 0.65 | | | 0.98 | 0.70 | 0.78 | 0.70 | 0.67 | 0.62 | | | 1.00 | 0.60 | | | 0.98 | 0.70 | | 0.90 | 0.82 | n/a |
| 12 | (305) | 0.94 | 0.86 | 0.77 | 0.66 | | | 1.00 | 0.73 | 0.81 | 0.72 | 0.68 | 0.63 | | | | 0.68 | | | 1.00 | 0.73 | | 0.94 | 0.85 | n/a |
| 14 | (356) | 1.00 | 0.92 | 0.81 | 0.69 | | | | 0.81 | 0.86 | 0.76 | 0.71 | 0.65 | | | | 0.86 | | | | 0.81 | | 1.00 | 0.92 | 0.78 |
| 16 | (406) | | 0.97 | 0.86 | 0.71 | | | | 0.89 | 0.91 | 0.79 | 0.74 | 0.67 | | | | 1.00 | | | | 0.89 | | | 0.98 | 0.83 |
| 18 | (457) | | 1.00 | 0.90 | 0.74 | | | | 0.97 | 0.96 | 0.83 | 0.77 | 0.69 | | | | | | | | 0.97 | | | 1.00 | 0.88 |
| 20 | (508) | | | 0.94 | 0.77 | | | | 1.00 | 1.00 | 0.87 | 0.80 | 0.72 | | | | | | | | 1.00 | | | | 0.93 |
| 22 | (559) | | | 0.99 | 0.79 | | | | | | 0.90 | 0.83 | 0.74 | | | | | | | | | | | | 0.97 |
| 24 | (610) | | | 1.00 | 0.82 | | | | | | 0.94 | 0.86 | 0.76 | | | | | | | | | | | | 1.00 |
| 26 | (660) | | | | 0.85 | | | | | | 0.98 | 0.89 | 0.78 | | | | | | | | | | | | |
| 28 | (711) | | | | 0.87 | | | | | | 1.00 | 0.92 | 0.80 | | | | | | | | | | | | |
| 30 | (762) | | | | 0.90 | | | | | | | 0.95 | 0.82 | | | | | | | | | | | | |
| 36 | (914) | | | | 0.98 | | | | | | | 1.00 | 0.89 | | | | | | | | | | | | |
| > 48 | (1219) | | | | 1.00 | | | | | | | | 1.00 | | | | | | | | | | | | |

Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm)

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 13 — Load adjustment factors for 3/4-in. diameter threaded rods in uncracked concrete[1,2,3]

| 3/4-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | || To edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.39 | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | n/a | 0.09 | 0.04 | 0.03 | 0.02 | 0.17 | 0.09 | 0.06 | 0.04 | n/a | n/a | n/a | n/a |
| 3-3/4 | (95) | 0.62 | 0.59 | 0.57 | 0.54 | 0.57 | 0.32 | 0.24 | 0.14 | 0.57 | 0.54 | 0.54 | 0.53 | 0.27 | 0.13 | 0.10 | 0.06 | 0.53 | 0.27 | 0.20 | 0.12 | n/a | n/a | n/a | n/a |
| 4 | (102) | 0.63 | 0.60 | 0.57 | 0.54 | 0.60 | 0.33 | 0.25 | 0.14 | 0.57 | 0.55 | 0.54 | 0.53 | 0.29 | 0.15 | 0.11 | 0.07 | 0.59 | 0.30 | 0.22 | 0.13 | n/a | n/a | n/a | n/a |
| 5 | (127) | 0.66 | 0.62 | 0.59 | 0.56 | 0.70 | 0.38 | 0.28 | 0.16 | 0.59 | 0.56 | 0.55 | 0.53 | 0.41 | 0.21 | 0.15 | 0.09 | 0.70 | 0.38 | 0.28 | 0.16 | n/a | n/a | n/a | n/a |
| 5-1/4 | (133) | 0.67 | 0.63 | 0.60 | 0.56 | 0.73 | 0.39 | 0.29 | 0.17 | 0.60 | 0.56 | 0.55 | 0.54 | 0.44 | 0.22 | 0.17 | 0.10 | 0.73 | 0.39 | 0.29 | 0.17 | 0.62 | n/a | n/a | n/a |
| 6 | (152) | 0.69 | 0.65 | 0.61 | 0.57 | 0.83 | 0.43 | 0.31 | 0.18 | 0.61 | 0.57 | 0.56 | 0.54 | 0.54 | 0.27 | 0.20 | 0.12 | 0.83 | 0.41 | 0.31 | 0.18 | 0.67 | n/a | n/a | n/a |
| 7 | (178) | 0.73 | 0.67 | 0.63 | 0.58 | 0.92 | 0.48 | 0.35 | 0.21 | 0.63 | 0.58 | 0.57 | 0.55 | 0.68 | 0.34 | 0.26 | 0.15 | 0.92 | 0.48 | 0.35 | 0.21 | 0.72 | n/a | n/a | n/a |
| 8 | (203) | 0.76 | 0.70 | 0.65 | 0.59 | 1.00 | 0.53 | 0.39 | 0.23 | 0.65 | 0.59 | 0.58 | 0.56 | 0.83 | 0.42 | 0.31 | 0.19 | 1.00 | 0.53 | 0.39 | 0.23 | 0.77 | n/a | n/a | n/a |
| 8-1/2 | (216) | 0.77 | 0.71 | 0.66 | 0.59 | | 0.57 | 0.42 | 0.24 | 0.66 | 0.60 | 0.58 | 0.56 | 0.91 | 0.46 | 0.34 | 0.21 | | 0.57 | 0.42 | 0.24 | 0.79 | 0.63 | n/a | n/a |
| 9 | (229) | 0.79 | 0.72 | 0.67 | 0.60 | | 0.60 | 0.44 | 0.26 | 0.67 | 0.61 | 0.59 | 0.56 | 0.99 | 0.50 | 0.37 | 0.22 | | 0.60 | 0.44 | 0.26 | 0.81 | 0.65 | n/a | n/a |
| 10 | (254) | 0.82 | 0.75 | 0.69 | 0.61 | | 0.67 | 0.49 | 0.27 | 0.68 | 0.62 | 0.60 | 0.57 | 1.00 | 0.58 | 0.44 | 0.26 | | 0.67 | 0.49 | 0.29 | 0.86 | 0.68 | n/a | n/a |
| 10-3/4 | (273) | 0.85 | 0.77 | 0.70 | 0.62 | | 0.72 | 0.53 | 0.31 | 0.70 | 0.63 | 0.60 | 0.57 | | 0.65 | 0.49 | 0.29 | | 0.72 | 0.53 | 0.31 | 0.89 | 0.71 | 0.64 | n/a |
| 12 | (305) | 0.89 | 0.80 | 0.72 | 0.63 | | 0.80 | 0.59 | 0.34 | 0.72 | 0.64 | 0.62 | 0.58 | | 0.77 | 0.57 | 0.35 | | 0.80 | 0.59 | 0.34 | 0.94 | 0.75 | 0.68 | n/a |
| 14 | (356) | 0.95 | 0.85 | 0.76 | 0.66 | | 0.93 | 0.69 | 0.40 | 0.76 | 0.66 | 0.63 | 0.60 | | 0.97 | 0.72 | 0.43 | | 0.931 | 0.68 | 0.40 | 1.00 | 0.81 | 0.73 | n/a |
| 16 | (406) | 1.00 | 0.90 | 0.80 | 0.68 | | 1.00 | 0.79 | 0.46 | 0.80 | 0.69 | 0.65 | 0.61 | | 1.00 | 0.89 | 0.53 | | 1.00 | 0.78 | 0.46 | | 0.86 | 0.78 | n/a |
| 16-3/4 | (425) | | 0.91 | 0.81 | 0.69 | | | 0.82 | 0.48 | 0.81 | 0.70 | 0.66 | 0.61 | | | 0.95 | 0.57 | | | 0.82 | 0.48 | | 0.88 | 0.80 | 0.68 |
| 18 | (457) | | 0.94 | 0.83 | 0.70 | | | 0.88 | 0.52 | 0.83 | 0.71 | 0.67 | 0.62 | | | 1.00 | 0.63 | | | 0.88 | 0.52 | | 0.92 | 0.83 | 0.70 |
| 20 | (508) | | 0.99 | 0.87 | 0.72 | | | 0.98 | 0.57 | 0.87 | 0.73 | 0.69 | 0.64 | | | | 0.74 | | | 0.98 | 0.57 | | 0.96 | 0.88 | 0.74 |
| 22 | (559) | | 1.00 | 0.91 | 0.74 | | | 1.00 | 0.63 | 0.91 | 0.76 | 0.71 | 0.65 | | | | 0.86 | | | 1.00 | 0.63 | | 1.00 | 0.92 | 0.78 |
| 24 | (610) | | | 0.94 | 0.77 | | | | 0.69 | 0.94 | 0.78 | 0.73 | 0.66 | | | | 0.98 | | | | 0.69 | | | 0.96 | 0.81 |
| 26 | (660) | | | 0.98 | 0.79 | | | | 0.74 | 0.98 | 0.80 | 0.75 | 0.68 | | | | 1.00 | | | | 0.74 | | | 1.00 | 0.84 |
| 28 | (711) | | | 1.00 | 0.81 | | | | 0.80 | 1.00 | 0.83 | 0.77 | 0.69 | | | | | | | | 0.80 | | | | 0.87 |
| 30 | (762) | | | | 0.83 | | | | 0.86 | | 0.85 | 0.79 | 0.71 | | | | | | | | 0.86 | | | | 0.91 |
| 36 | (914) | | | | 0.90 | | | | 1.00 | | 0.92 | 0.85 | 0.75 | | | | | | | | 1.00 | | | | 0.99 |
| > 48 | (1219) | | | | 1.00 | | | | | | 1.00 | 0.96 | 0.83 | | | | | | | | | | | | 1.00 |

## Table 14 — Load adjustment factors for 3/4-in. diameter threaded rods in cracked concrete[1,2,3]

| 3/4-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | || To edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) | 3-1/2 (89) | 6-3/4 (171) | 9 (229) | 15 (381) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | n/a | 0.47 | 0.44 | 0.42 | 0.39 | n/a | n/a | n/a | n/a | 0.14 | 0.08 | 0.06 | 0.04 | 0.28 | 0.16 | 0.12 | 0.07 | n/a | n/a | n/a | n/a |
| 3-3/4 | (95) | 0.62 | 0.59 | 0.57 | 0.54 | 0.63 | 0.56 | 0.50 | 0.44 | 0.60 | 0.57 | 0.55 | 0.54 | 0.43 | 0.25 | 0.18 | 0.11 | 0.63 | 0.49 | 0.37 | 0.22 | n/a | n/a | n/a | n/a |
| 4 | (102) | 0.63 | 0.60 | 0.57 | 0.54 | 0.65 | 0.57 | 0.51 | 0.44 | 0.60 | 0.57 | 0.56 | 0.54 | 0.48 | 0.27 | 0.20 | 0.12 | 0.65 | 0.56 | 0.40 | 0.24 | n/a | n/a | n/a | n/a |
| 5 | (127) | 0.66 | 0.62 | 0.59 | 0.56 | 0.74 | 0.63 | 0.56 | 0.47 | 0.63 | 0.59 | 0.57 | 0.55 | 0.67 | 0.38 | 0.28 | 0.17 | 0.74 | 0.63 | 0.56 | 0.34 | n/a | n/a | n/a | n/a |
| 5-1/4 | (133) | 0.67 | 0.63 | 0.60 | 0.56 | 0.76 | 0.65 | 0.57 | 0.48 | 0.63 | 0.59 | 0.58 | 0.55 | 0.72 | 0.41 | 0.30 | 0.18 | 0.76 | 0.65 | 0.57 | 0.37 | 0.73 | n/a | n/a | n/a |
| 6 | (152) | 0.70 | 0.65 | 0.61 | 0.57 | 0.83 | 0.70 | 0.60 | 0.49 | 0.65 | 0.60 | 0.59 | 0.56 | 0.88 | 0.50 | 0.37 | 0.22 | 0.83 | 0.70 | 0.61 | 0.45 | 0.78 | n/a | n/a | n/a |
| 7 | (178) | 0.73 | 0.67 | 0.63 | 0.58 | 0.92 | 0.77 | 0.65 | 0.52 | 0.68 | 0.62 | 0.60 | 0.57 | 1.00 | 0.62 | 0.47 | 0.28 | 0.92 | 0.77 | 0.65 | 0.52 | 0.84 | n/a | n/a | n/a |
| 8 | (203) | 0.76 | 0.70 | 0.65 | 0.59 | 1.00 | 0.84 | 0.70 | 0.55 | 0.70 | 0.64 | 0.62 | 0.58 | | 0.76 | 0.57 | 0.34 | 1.00 | 0.84 | 0.70 | 0.55 | 0.90 | n/a | n/a | n/a |
| 8-1/2 | (216) | 0.78 | 0.71 | 0.66 | 0.59 | | 0.88 | 0.72 | 0.56 | 0.72 | 0.65 | 0.62 | 0.59 | | 0.84 | 0.63 | 0.38 | | 0.88 | 0.72 | 0.56 | 0.93 | 0.77 | n/a | n/a |
| 9 | (229) | 0.80 | 0.72 | 0.67 | 0.60 | | 0.91 | 0.75 | 0.57 | 0.73 | 0.66 | 0.63 | 0.59 | | 0.91 | 0.68 | 0.41 | | 0.91 | 0.75 | 0.57 | 0.96 | 0.79 | n/a | n/a |
| 10 | (254) | 0.82 | 0.75 | 0.69 | 0.61 | | 0.99 | 0.80 | 0.60 | 0.75 | 0.67 | 0.64 | 0.60 | | 1.00 | 0.80 | 0.48 | | 0.99 | 0.80 | 0.60 | 1.00 | 0.83 | n/a | n/a |
| 10-3/4 | (273) | 0.85 | 0.77 | 0.70 | 0.62 | | 1.00 | 0.84 | 0.62 | 0.77 | 0.69 | 0.65 | 0.61 | | | 0.90 | 0.53 | | 1.00 | 0.84 | 0.62 | | 0.87 | 0.79 | n/a |
| 12 | (305) | 0.89 | 0.80 | 0.72 | 0.63 | | | 0.91 | 0.66 | 0.81 | 0.71 | 0.67 | 0.62 | | | 1.00 | 0.63 | | | 0.91 | 0.66 | | 0.91 | 0.83 | n/a |
| 14 | (356) | 0.95 | 0.85 | 0.76 | 0.66 | | | 1.00 | 0.72 | 0.86 | 0.74 | 0.70 | 0.64 | | | | 0.79 | | | 1.00 | 0.72 | | 0.99 | 0.90 | n/a |
| 16 | (406) | 1.00 | 0.90 | 0.80 | 0.68 | | | | 0.78 | 0.91 | 0.78 | 0.73 | 0.66 | | | | 0.97 | | | | 0.78 | | 1.00 | 0.96 | n/a |
| 16-3/4 | (425) | | 0.91 | 0.81 | 0.69 | | | | 0.81 | 0.93 | 0.79 | 0.74 | 0.67 | | | | 1.00 | | | | 0.81 | | | 0.98 | 0.83 |
| 18 | (457) | | 0.94 | 0.83 | 0.70 | | | | 0.85 | 0.96 | 0.81 | 0.76 | 0.68 | | | | | | | | 0.85 | | | 1.00 | 0.86 |
| 20 | (508) | | 0.99 | 0.87 | 0.72 | | | | 0.91 | 1.00 | 0.85 | 0.79 | 0.70 | | | | | | | | 0.91 | | | | 0.90 |
| 22 | (559) | | 1.00 | 0.91 | 0.74 | | | | 0.98 | | 0.88 | 0.82 | 0.73 | | | | | | | | 0.98 | | | | 0.95 |
| 24 | (610) | | | 0.94 | 0.77 | | | | 1.00 | | 0.92 | 0.84 | 0.75 | | | | | | | | 1.00 | | | | 0.99 |
| 26 | (660) | | | 0.98 | 0.79 | | | | | | 0.95 | 0.87 | 0.77 | | | | | | | | | | | | 1.00 |
| 28 | (711) | | | 1.00 | 0.81 | | | | | | 0.99 | 0.90 | 0.79 | | | | | | | | | | | | |
| 30 | (762) | | | | 0.83 | | | | | | 1.00 | 0.93 | 0.81 | | | | | | | | | | | | |
| 36 | (914) | | | | 0.90 | | | | | | | 1.00 | 0.87 | | | | | | | | | | | | |
| > 48 | (1219) | | | | 1.00 | | | | | | | | 0.99 | | | | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 15 — Load adjustment factors for 7/8-in. diameter threaded rods in uncracked concrete[1,2,3]

| 7/8-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.40 | 0.23 | 0.17 | 0.10 | n/a | n/a | n/a | n/a | 0.09 | 0.03 | 0.02 | 0.01 | 0.18 | 0.06 | 0.05 | 0.03 | n/a | n/a | n/a | n/a |
| | 4-3/8 (111) | 0.62 | 0.59 | 0.57 | 0.54 | 0.63 | 0.33 | 0.24 | 0.14 | 0.58 | 0.54 | 0.54 | 0.53 | 0.35 | 0.13 | 0.09 | 0.06 | 0.63 | 0.25 | 0.19 | 0.11 | n/a | n/a | n/a | n/a |
| | 5 (127) | 0.64 | 0.61 | 0.58 | 0.55 | 0.68 | 0.35 | 0.26 | 0.15 | 0.60 | 0.55 | 0.54 | 0.53 | 0.43 | 0.15 | 0.12 | 0.07 | 0.68 | 0.31 | 0.23 | 0.14 | n/a | n/a | n/a | n/a |
| | 5-1/2 (140) | 0.65 | 0.62 | 0.59 | 0.55 | 0.71 | 0.37 | 0.27 | 0.16 | 0.60 | 0.55 | 0.54 | 0.53 | 0.50 | 0.18 | 0.13 | 0.08 | 0.71 | 0.35 | 0.27 | 0.16 | 0.65 | n/a | n/a | n/a |
| | 6 (152) | 0.67 | 0.63 | 0.60 | 0.56 | 0.75 | 0.39 | 0.28 | 0.17 | 0.61 | 0.56 | 0.55 | 0.54 | 0.57 | 0.20 | 0.15 | 0.09 | 0.75 | 0.39 | 0.28 | 0.17 | 0.68 | n/a | n/a | n/a |
| | 7 (178) | 0.70 | 0.65 | 0.61 | 0.57 | 0.83 | 0.43 | 0.31 | 0.18 | 0.63 | 0.57 | 0.56 | 0.54 | 0.71 | 0.25 | 0.19 | 0.11 | 0.83 | 0.43 | 0.31 | 0.18 | 0.73 | n/a | n/a | n/a |
| | 8 (203) | 0.72 | 0.67 | 0.63 | 0.58 | 0.92 | 0.47 | 0.35 | 0.20 | 0.65 | 0.58 | 0.56 | 0.55 | 0.87 | 0.31 | 0.23 | 0.14 | 0.92 | 0.47 | 0.35 | 0.20 | 0.78 | n/a | n/a | n/a |
| | 9 (229) | 0.75 | 0.69 | 0.64 | 0.59 | 1.00 | 0.52 | 0.38 | 0.22 | 0.67 | 0.59 | 0.57 | 0.55 | 1.00 | 0.37 | 0.28 | 0.17 | 1.00 | 0.52 | 0.38 | 0.22 | 0.83 | n/a | n/a | n/a |
| | 9-7/8 (251) | 0.78 | 0.71 | 0.66 | 0.59 | | 0.57 | 0.42 | 0.24 | 0.69 | 0.59 | 0.58 | 0.56 | | 0.43 | 0.32 | 0.19 | | 0.57 | 0.42 | 0.24 | 0.87 | 0.61 | n/a | n/a |
| | 10 (254) | 0.78 | 0.71 | 0.66 | 0.60 | | 0.57 | 0.42 | 0.25 | 0.69 | 0.60 | 0.58 | 0.56 | | 0.43 | 0.33 | 0.20 | | 0.57 | 0.42 | 0.25 | 0.87 | 0.62 | n/a | n/a |
| | 11 (279) | 0.81 | 0.73 | 0.68 | 0.61 | | 0.63 | 0.46 | 0.27 | 0.71 | 0.61 | 0.59 | 0.56 | | 0.50 | 0.38 | 0.23 | | 0.63 | 0.46 | 0.27 | 0.91 | 0.65 | n/a | n/a |
| | 12 (305) | 0.84 | 0.75 | 0.69 | 0.62 | | 0.69 | 0.51 | 0.30 | 0.73 | 0.62 | 0.60 | 0.57 | | 0.57 | 0.43 | 0.26 | | 0.69 | 0.51 | 0.30 | 0.96 | 0.68 | n/a | n/a |
| | 12-1/2 (318) | 0.85 | 0.77 | 0.70 | 0.62 | | 0.72 | 0.53 | 0.31 | 0.74 | 0.62 | 0.60 | 0.57 | | 0.61 | 0.46 | 0.27 | | 0.72 | 0.53 | 0.31 | 0.98 | 0.69 | 0.63 | n/a |
| | 14 (356) | 0.89 | 0.80 | 0.72 | 0.63 | | 0.80 | 0.59 | 0.35 | 0.77 | 0.63 | 0.61 | 0.58 | | 0.72 | 0.54 | 0.32 | | 0.80 | 0.59 | 0.35 | 1.00 | 0.73 | 0.67 | n/a |
| | 16 (406) | 0.95 | 0.84 | 0.75 | 0.65 | | 0.92 | 0.67 | 0.40 | 0.80 | 0.65 | 0.63 | 0.59 | | 0.88 | 0.66 | 0.40 | | 0.92 | 0.67 | 0.40 | | 0.78 | 0.71 | n/a |
| | 18 (457) | 1.00 | 0.88 | 0.79 | 0.67 | | 1.00 | 0.76 | 0.44 | 0.84 | 0.67 | 0.64 | 0.60 | | 1.00 | 0.79 | 0.47 | | 1.00 | 0.76 | 0.44 | | 0.83 | 0.75 | n/a |
| | 19-1/2 (495) | | 0.91 | 0.81 | 0.69 | | | 0.82 | 0.48 | 0.87 | 0.69 | 0.65 | 0.61 | | | 0.89 | 0.53 | | | 0.82 | 0.48 | | 0.86 | 0.78 | 0.66 |
| | 20 (508) | | 0.92 | 0.82 | 0.69 | | | 0.84 | 0.49 | 0.88 | 0.69 | 0.66 | 0.61 | | | 0.92 | 0.55 | | | 0.84 | 0.49 | | 0.87 | 0.79 | 0.67 |
| | 22 (559) | | 0.97 | 0.85 | 0.71 | | | 0.93 | 0.54 | 0.92 | 0.71 | 0.67 | 0.63 | | | 1.00 | 0.64 | | | 0.93 | 0.54 | | 0.92 | 0.83 | 0.70 |
| | 24 (610) | | 1.00 | 0.88 | 0.73 | | | 1.00 | 0.59 | 0.96 | 0.73 | 0.69 | 0.64 | | | | 0.73 | | | 1.00 | 0.59 | | 0.96 | 0.87 | 0.73 |
| | 26 (660) | | | 0.91 | 0.75 | | | | 0.64 | 0.99 | 0.75 | 0.71 | 0.65 | | | | 0.82 | | | | 0.64 | | 1.00 | 0.91 | 0.76 |
| | 28 (711) | | | 0.94 | 0.77 | | | | 0.69 | 1.00 | 0.77 | 0.72 | 0.66 | | | | 0.92 | | | | 0.69 | | | 0.94 | 0.79 |
| | 30 (762) | | | 0.98 | 0.79 | | | | 0.74 | | 0.79 | 0.74 | 0.67 | | | | 1.00 | | | | 0.74 | | | 0.97 | 0.82 |
| | 36 (914) | | | 1.00 | 0.84 | | | | 0.89 | | 0.84 | 0.78 | 0.70 | | | | | | | | 0.89 | | | 1.00 | 0.90 |
| | > 48 (1219) | | | | 0.96 | | | | 1.00 | | 0.96 | 0.88 | 0.77 | | | | | | | | 1.00 | | | | 1.00 |

## Table 16 — Load adjustment factors for 7/8-in. diameter threaded rods in cracked concrete[1,2,3]

| 7/8-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear: ∥ To edge $f_{RV}$ | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 3-1/2 (89) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.46 | 0.43 | 0.41 | 0.38 | n/a | n/a | n/a | n/a | 0.16 | 0.07 | 0.06 | 0.03 | 0.32 | 0.15 | 0.11 | 0.07 | n/a | n/a | n/a | n/a |
| | 4-3/8 (111) | 0.62 | 0.59 | 0.57 | 0.54 | 0.63 | 0.56 | 0.50 | 0.44 | 0.62 | 0.57 | 0.56 | 0.54 | 0.63 | 0.29 | 0.22 | 0.13 | 0.63 | 0.56 | 0.44 | 0.26 | n/a | n/a | n/a | n/a |
| | 5 (127) | 0.64 | 0.61 | 0.58 | 0.55 | 0.68 | 0.59 | 0.52 | 0.45 | 0.64 | 0.58 | 0.57 | 0.55 | 0.77 | 0.36 | 0.27 | 0.16 | 0.68 | 0.59 | 0.52 | 0.32 | n/a | n/a | n/a | n/a |
| | 5-1/2 (140) | 0.65 | 0.62 | 0.59 | 0.55 | 0.71 | 0.62 | 0.54 | 0.46 | 0.65 | 0.59 | 0.58 | 0.55 | 0.89 | 0.41 | 0.31 | 0.19 | 0.71 | 0.62 | 0.54 | 0.37 | 0.79 | n/a | n/a | n/a |
| | 6 (152) | 0.67 | 0.63 | 0.60 | 0.56 | 0.75 | 0.64 | 0.56 | 0.47 | 0.67 | 0.60 | 0.58 | 0.56 | 1.00 | 0.47 | 0.35 | 0.21 | 0.75 | 0.64 | 0.56 | 0.42 | 0.82 | n/a | n/a | n/a |
| | 7 (178) | 0.70 | 0.648 | 0.61 | 0.57 | 0.83 | 0.70 | 0.60 | 0.49 | 0.70 | 0.62 | 0.60 | 0.57 | | 0.59 | 0.44 | 0.27 | 0.83 | 0.70 | 0.60 | 0.49 | 0.89 | n/a | n/a | n/a |
| | 8 (203) | 0.72 | 0.67 | 0.63 | 0.58 | 0.92 | 0.76 | 0.64 | 0.52 | 0.72 | 0.63 | 0.61 | 0.58 | | 0.72 | 0.54 | 0.33 | 0.92 | 0.76 | 0.64 | 0.52 | 0.95 | n/a | n/a | n/a |
| | 9 (229) | 0.75 | 0.69 | 0.64 | 0.59 | 1.00 | 0.82 | 0.69 | 0.54 | 0.75 | 0.65 | 0.63 | 0.59 | | 0.86 | 0.65 | 0.39 | 1.00 | 0.82 | 0.69 | 0.54 | 1.00 | n/a | n/a | n/a |
| | 9-7/8 (251) | 0.78 | 0.71 | 0.66 | 0.59 | | 0.88 | 0.72 | 0.56 | 0.78 | 0.67 | 0.64 | 0.60 | | 0.99 | 0.74 | 0.45 | | 0.87 | 0.72 | 0.56 | | 0.81 | n/a | n/a |
| | 10 (254) | 0.78 | 0.71 | 0.66 | 0.60 | | 0.88 | 0.73 | 0.56 | 0.78 | 0.67 | 0.64 | 0.60 | | 1.00 | 0.76 | 0.46 | | 0.88 | 0.73 | 0.56 | | 0.82 | n/a | n/a |
| | 11 (279) | 0.81 | 0.73 | 0.68 | 0.61 | | 0.95 | 0.77 | 0.59 | 0.81 | 0.69 | 0.65 | 0.61 | | | 0.88 | 0.53 | | 0.95 | 0.77 | 0.59 | | 0.86 | n/a | n/a |
| | 12 (305) | 0.84 | 0.75 | 0.69 | 0.61 | | 1.00 | 0.82 | 0.61 | 0.84 | 0.70 | 0.67 | 0.62 | | | 1.00 | 0.60 | | 1.00 | 0.82 | 0.61 | | 0.90 | n/a | n/a |
| | 12-1/2 (318) | 0.85 | 0.77 | 0.70 | 0.62 | | | 0.84 | 0.62 | 0.85 | 0.71 | 0.67 | 0.62 | | | | 0.64 | | | 0.84 | 0.62 | | 0.92 | 0.83 | n/a |
| | 14 (356) | 0.90 | 0.80 | 0.72 | 0.63 | | | 0.92 | 0.66 | 0.89 | 0.74 | 0.69 | 0.64 | | | | 0.75 | | | 0.91 | 0.66 | | 0.97 | 0.88 | n/a |
| | 16 (406) | 0.95 | 0.84 | 0.75 | 0.65 | | | 1.00 | 0.71 | 0.95 | 0.77 | 0.72 | 0.66 | | | | 0.92 | | | 1.00 | 0.71 | | 1.00 | 0.94 | n/a |
| | 18 (457) | 1.00 | 0.88 | 0.79 | 0.67 | | | | 0.76 | 1.00 | 0.80 | 0.75 | 0.68 | | | | 1.00 | | | | 0.76 | | | 1.00 | n/a |
| | 19-1/2 (495) | | 0.91 | 0.81 | 0.69 | | | | 0.80 | | 0.83 | 0.77 | 0.69 | | | | | | | | 0.80 | | | | 0.88 |
| | 20 (508) | | 0.92 | 0.82 | 0.69 | | | | 0.82 | | 0.84 | 0.78 | 0.70 | | | | | | | | 0.82 | | | | 0.89 |
| | 22 (559) | | 0.97 | 0.85 | 0.71 | | | | 0.87 | | 0.87 | 0.81 | 0.72 | | | | | | | | 0.87 | | | | 0.93 |
| | 24 (610) | | 1.00 | 0.88 | 0.73 | | | | 0.93 | | 0.90 | 0.83 | 0.74 | | | | | | | | 0.93 | | | | 0.97 |
| | 26 (660) | | | 0.91 | 0.75 | | | | 0.99 | | 0.94 | 0.86 | 0.76 | | | | | | | | 0.99 | | | | 1.00 |
| | 28 (711) | | | 0.94 | 0.77 | | | | 1.00 | | 0.97 | 0.89 | 0.78 | | | | | | | | 1.00 | | | | |
| | 30 (762) | | | 0.98 | 0.79 | | | | | | 1.00 | 0.92 | 0.80 | | | | | | | | | | | | |
| | 36 (914) | | | 1.00 | 0.85 | | | | | | | 1.00 | 0.86 | | | | | | | | | | | | |
| | > 48 (1219) | | | | 0.96 | | | | | | | | 0.97 | | | | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 17 — Load adjustment factors for 1-in. diameter threaded rods in uncracked concrete[1,2,3]

| 1-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) | 4 (102) | 9 (229) | 12 (305) | 20 (508) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.38 | 0.23 | 0.17 | 0.10 | n/a | n/a | n/a | n/a | 0.08 | 0.03 | 0.02 | 0.01 | 0.15 | 0.05 | 0.04 | 0.02 | n/a | n/a | n/a | n/a |
| | 5 (127) | 0.62 | 0.59 | 0.57 | 0.542 | 0.63 | 0.32 | 0.24 | 0.14 | 0.59 | 0.54 | 0.53 | 0.52 | 0.37 | 0.12 | 0.09 | 0.05 | 0.63 | 0.24 | 0.18 | 0.12 | n/a | n/a | n/a | n/a |
| | 6 (152) | 0.65 | 0.61 | 0.58 | 0.550 | 0.70 | 0.36 | 0.26 | 0.15 | 0.60 | 0.55 | 0.54 | 0.53 | 0.48 | 0.16 | 0.12 | 0.07 | 0.70 | 0.31 | 0.23 | 0.14 | n/a | n/a | n/a | n/a |
| | 6-1/4 (159) | 0.65 | 0.62 | 0.59 | 0.552 | 0.71 | 0.37 | 0.27 | 0.16 | 0.61 | 0.55 | 0.54 | 0.53 | 0.51 | 0.17 | 0.12 | 0.08 | 0.71 | 0.33 | 0.25 | 0.15 | 0.65 | n/a | n/a | n/a |
| | 7 (178) | 0.67 | 0.63 | 0.60 | 0.558 | 0.76 | 0.39 | 0.29 | 0.17 | 0.62 | 0.56 | 0.55 | 0.53 | 0.61 | 0.20 | 0.15 | 0.09 | 0.76 | 0.39 | 0.29 | 0.17 | 0.69 | n/a | n/a | n/a |
| | 8 (203) | 0.70 | 0.65 | 0.61 | 0.567 | 0.83 | 0.43 | 0.31 | 0.18 | 0.64 | 0.56 | 0.55 | 0.54 | 0.74 | 0.24 | 0.18 | 0.11 | 0.84 | 0.43 | 0.31 | 0.19 | 0.74 | n/a | n/a | n/a |
| | 9 (229) | 0.72 | 0.67 | 0.63 | 0.575 | 0.91 | 0.47 | 0.34 | 0.20 | 0.65 | 0.57 | 0.56 | 0.54 | 0.89 | 0.29 | 0.22 | 0.13 | 0.91 | 0.47 | 0.34 | 0.20 | 0.78 | n/a | n/a | n/a |
| | 10 (254) | 0.75 | 0.69 | 0.64 | 0.583 | 0.98 | 0.50 | 0.37 | 0.22 | 0.67 | 0.58 | 0.57 | 0.55 | 1.00 | 0.34 | 0.25 | 0.15 | 0.98 | 0.50 | 0.37 | 0.22 | 0.83 | n/a | n/a | n/a |
| | 11 (279) | 0.77 | 0.70 | 0.65 | 0.592 | 1.00 | 0.55 | 0.41 | 0.24 | 0.69 | 0.59 | 0.57 | 0.55 | | 0.39 | 0.29 | 0.17 | 1.00 | 0.55 | 0.41 | 0.24 | 0.87 | n/a | n/a | n/a |
| | 11-1/4 (286) | 0.78 | 0.71 | 0.66 | 0.594 | | 0.57 | 0.42 | 0.24 | 0.70 | 0.59 | 0.58 | 0.55 | | 0.40 | 0.30 | 0.18 | | 0.57 | 0.42 | 0.24 | 0.88 | 0.60 | n/a | n/a |
| | 12 (305) | 0.80 | 0.72 | 0.67 | 0.600 | | 0.60 | 0.44 | 0.26 | 0.71 | 0.60 | 0.58 | 0.56 | | 0.44 | 0.33 | 0.20 | | 0.60 | 0.44 | 0.26 | 0.91 | 0.62 | n/a | n/a |
| | 13 (330) | 0.82 | 0.74 | 0.68 | 0.608 | | 0.65 | 0.48 | 0.28 | 0.72 | 0.61 | 0.59 | 0.56 | | 0.50 | 0.37 | 0.22 | | 0.65 | 0.48 | 0.28 | 0.94 | 0.65 | n/a | n/a |
| | 14 (356) | 0.84 | 0.76 | 0.69 | 0.617 | | 0.70 | 0.52 | 0.30 | 0.74 | 0.61 | 0.59 | 0.57 | | 0.56 | 0.42 | 0.25 | | 0.70 | 0.52 | 0.30 | 0.98 | 0.67 | n/a | n/a |
| | 14-1/4 (362) | 0.85 | 0.76 | 0.70 | 0.619 | | 0.72 | 0.53 | 0.31 | 0.74 | 0.62 | 0.60 | 0.57 | | 0.57 | 0.43 | 0.26 | | 0.72 | 0.53 | 0.31 | 0.99 | 0.68 | 0.62 | n/a |
| | 16 (406) | 0.90 | 0.80 | 0.72 | 0.633 | | 0.80 | 0.59 | 0.35 | 0.77 | 0.63 | 0.61 | 0.58 | | 0.68 | 0.51 | 0.31 | | 0.80 | 0.59 | 0.35 | 1.00 | 0.72 | 0.65 | n/a |
| | 18 (457) | 0.94 | 0.83 | 0.75 | 0.650 | | 0.90 | 0.66 | 0.39 | 0.81 | 0.65 | 0.62 | 0.59 | | 0.81 | 0.61 | 0.35 | | 0.90 | 0.664 | 0.40 | | 0.76 | 0.70 | n/a |
| | 20 (508) | 0.99 | 0.87 | 0.78 | 0.667 | | 1.00 | 0.74 | 0.43 | 0.84 | 0.66 | 0.63 | 0.60 | | 0.95 | 0.71 | 0.43 | | 1.00 | 0.74 | 0.43 | | 0.80 | 0.73 | n/a |
| | 22 (559) | 1.00 | 0.91 | 0.81 | 0.683 | | | 0.81 | 0.48 | 0.88 | 0.68 | 0.65 | 0.60 | | 1.00 | 0.82 | 0.49 | | | 0.81 | 0.48 | | 0.84 | 0.77 | n/a |
| | 22-1/4 (565) | | 0.91 | 0.81 | 0.685 | | | 0.82 | 0.48 | 0.88 | 0.68 | 0.65 | 0.61 | | | 0.84 | 0.50 | | | 0.82 | 0.48 | | 0.85 | 0.77 | 0.65 |
| | 24 (610) | | 0.94 | 0.83 | 0.700 | | | 0.89 | 0.52 | 0.91 | 0.69 | 0.66 | 0.61 | | | 0.94 | 0.56 | | | 0.89 | 0.52 | | 0.88 | 0.80 | 0.67 |
| | 26 (660) | | 0.98 | 0.86 | 0.717 | | | 0.96 | 0.56 | 0.94 | 0.71 | 0.67 | 0.62 | | | 1.00 | 0.63 | | | 0.96 | 0.56 | | 0.92 | 0.83 | 0.70 |
| | 28 (711) | | 1.00 | 0.89 | 0.733 | | | 1.00 | 0.61 | 0.98 | 0.73 | 0.69 | 0.63 | | | | 0.71 | | | 1.00 | 0.61 | | 0.95 | 0.86 | 0.73 |
| | 30 (762) | | | 0.92 | 0.750 | | | | 0.65 | 1.00 | 0.74 | 0.70 | 0.64 | | | | 0.79 | | | | 0.65 | | 0.98 | 0.89 | 0.75 |
| | 36 (914) | | | 1.00 | 0.800 | | | | 0.78 | | 0.79 | 0.74 | 0.67 | | | | 1.00 | | | | 0.78 | | 1.00 | 0.98 | 0.83 |
| | > 48 (1219) | | | | 0.900 | | | | 1.00 | | 0.87 | 0.82 | 0.73 | | | | | | | | 1.00 | | | 1.00 | 0.95 |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 18 — Load adjustment factors for 1-1/4-in. diameter threaded rods in uncracked concrete[1,2,3]

| 1-1/4-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ‖ To and away from edge $f_{RV}$ | | | | | | | |
| Embedment $h_{ef}$ | in. (mm) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 15 (381) | 25 (635) | 5 (127) | 11-1/4 (286) | 11-1/4 (286) | 25 (635) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 (44) | n/a | n/a | n/a | n/a | 0.37 | 0.22 | 0.16 | 0.09 | n/a | n/a | n/a | n/a | 0.05 | 0.02 | 0.01 | 0.01 | 0.11 | 0.03 | 0.02 | 0.02 | n/a | n/a | n/a | n/a |
| | 6-1/4 (159) | 0.62 | 0.59 | 0.57 | 0.542 | 0.64 | 0.32 | 0.24 | 0.14 | 0.59 | 0.54 | 0.53 | 0.52 | 0.37 | 0.11 | 0.08 | 0.05 | 0.64 | 0.22 | 0.16 | 0.10 | n/a | n/a | n/a | n/a |
| | 7 (178) | 0.64 | 0.60 | 0.58 | 0.547 | 0.68 | 0.34 | 0.25 | 0.15 | 0.60 | 0.54 | 0.54 | 0.53 | 0.44 | 0.13 | 0.10 | 0.06 | 0.68 | 0.26 | 0.19 | 0.12 | n/a | n/a | n/a | n/a |
| | 8 (203) | 0.66 | 0.62 | 0.59 | 0.553 | 0.73 | 0.37 | 0.27 | 0.16 | 0.61 | 0.55 | 0.54 | 0.53 | 0.53 | 0.16 | 0.12 | 0.07 | 0.73 | 0.32 | 0.24 | 0.15 | 0.66 | n/a | n/a | n/a |
| | 9 (229) | 0.68 | 0.63 | 0.60 | 0.560 | 0.79 | 0.40 | 0.29 | 0.17 | 0.62 | 0.56 | 0.55 | 0.53 | 0.63 | 0.19 | 0.14 | 0.09 | 0.79 | 0.38 | 0.28 | 0.17 | 0.70 | n/a | n/a | n/a |
| | 10 (254) | 0.70 | 0.65 | 0.61 | 0.567 | 0.84 | 0.43 | 0.32 | 0.19 | 0.64 | 0.561 | 0.55 | 0.54 | 0.74 | 0.22 | 0.17 | 0.10 | 0.84 | 0.43 | 0.32 | 0.19 | 0.74 | n/a | n/a | n/a |
| | 11 (279) | 0.72 | 0.66 | 0.62 | 0.573 | 0.90 | 0.46 | 0.34 | 0.20 | 0.65 | 0.57 | 0.56 | 0.54 | 0.86 | 0.26 | 0.19 | 0.12 | 0.90 | 0.46 | 0.34 | 0.20 | 0.78 | n/a | n/a | n/a |
| | 12 (305) | 0.74 | 0.68 | 0.63 | 0.580 | 0.96 | 0.49 | 0.36 | 0.21 | 0.66 | 0.57 | 0.56 | 0.54 | 0.98 | 0.29 | 0.22 | 0.13 | 0.96 | 0.49 | 0.36 | 0.21 | 0.81 | n/a | n/a | n/a |
| | 13 (330) | 0.76 | 0.69 | 0.64 | 0.587 | 1.00 | 0.53 | 0.39 | 0.23 | 0.68 | 0.58 | 0.57 | 0.55 | 1.00 | 0.33 | 0.25 | 0.15 | 1.00 | 0.53 | 0.39 | 0.23 | 0.84 | n/a | n/a | n/a |
| | 14 (356) | 0.78 | 0.71 | 0.66 | 0.593 | | 0.57 | 0.42 | 0.25 | 0.70 | 0.59 | 0.57 | 0.55 | | 0.37 | 0.28 | 0.17 | | 0.57 | 0.42 | 0.25 | 0.88 | 0.58 | n/a | n/a |
| | 14-1/4 (362) | 0.78 | 0.71 | 0.66 | 0.595 | | 0.58 | 0.43 | 0.25 | 0.70 | 0.59 | 0.57 | 0.55 | | 0.38 | 0.28 | 0.17 | | 0.58 | 0.43 | 0.25 | 0.88 | 0.58 | n/a | n/a |
| | 15 (381) | 0.80 | 0.72 | 0.67 | 0.600 | | 0.61 | 0.45 | 0.26 | 0.71 | 0.59 | 0.58 | 0.55 | | 0.41 | 0.31 | 0.18 | | 0.61 | 0.45 | 0.26 | 0.91 | 0.61 | n/a | n/a |
| | 16 (406) | 0.82 | 0.74 | 0.68 | 0.607 | | 0.65 | 0.48 | 0.28 | 0.72 | 0.60 | 0.58 | 0.56 | | 0.45 | 0.34 | 0.20 | | 0.65 | 0.48 | 0.28 | 0.94 | 0.62 | n/a | n/a |
| | 17 (432) | 0.84 | 0.75 | 0.69 | 0.613 | | 0.69 | 0.51 | 0.30 | 0.73 | 0.60 | 0.59 | 0.56 | | 0.49 | 0.37 | 0.22 | | 0.69 | 0.51 | 0.30 | 0.96 | 0.64 | n/a | n/a |
| | 18 (457) | 0.86 | 0.77 | 0.70 | 0.620 | | 0.73 | 0.54 | 0.32 | 0.75 | 0.61 | 0.59 | 0.56 | | 0.53 | 0.40 | 0.24 | | 0.73 | 0.54 | 0.32 | 0.99 | 0.66 | 0.60 | n/a |
| | 20 (508) | 0.90 | 0.80 | 0.72 | 0.633 | | 0.81 | 0.60 | 0.35 | 0.77 | 0.62 | 0.60 | 0.57 | | 0.63 | 0.47 | 0.28 | | 0.81 | 0.60 | 0.35 | 1.00 | 0.70 | 0.63 | n/a |
| | 22 (559) | 0.94 | 0.83 | 0.74 | 0.647 | | 0.89 | 0.66 | 0.39 | 0.80 | 0.63 | 0.61 | 0.58 | | 0.72 | 0.54 | 0.33 | | 0.89 | 0.66 | 0.39 | | 0.73 | 0.67 | n/a |
| | 24 (610) | 0.98 | 0.86 | 0.77 | 0.660 | | 0.97 | 0.72 | 0.42 | 0.83 | 0.65 | 0.62 | 0.58 | | 0.82 | 0.62 | 0.37 | | 0.97 | 0.72 | 0.42 | | 0.77 | 0.70 | n/a |
| | 26 (660) | 1.00 | 0.89 | 0.79 | 0.673 | | 1.00 | 0.78 | 0.46 | 0.86 | 0.66 | 0.63 | 0.59 | | 0.93 | 0.70 | 0.42 | | 1.00 | 0.78 | 0.46 | | 0.80 | 0.72 | n/a |
| | 28 (711) | | 0.92 | 0.81 | 0.687 | | | 0.84 | 0.49 | 0.88 | 0.67 | 0.64 | 0.60 | | 1.00 | 0.78 | 0.47 | | | 0.84 | 0.49 | | 0.81 | 0.75 | 0.63 |
| | 30 (762) | | 0.94 | 0.83 | 0.700 | | | 0.90 | 0.53 | 0.91 | 0.68 | 0.65 | 0.61 | | | 0.86 | 0.52 | | | 0.90 | 0.53 | | 0.86 | 0.78 | 0.66 |
| | 36 (914) | | 1.00 | 0.90 | 0.740 | | | 1.00 | 0.63 | 0.99 | 0.72 | 0.68 | 0.63 | | | 1.00 | 0.68 | | | 1.00 | 0.63 | | 0.94 | 0.85 | 0.72 |
| | > 48 (1219) | | | 1.00 | 0.820 | | | | 0.84 | 1.00 | 0.79 | 0.74 | 0.67 | | | | 1.00 | | | | 0.84 | | 1.00 | 0.98 | 0.83 |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

**Hilti HIT-ICE adhesive with deformed reinforcing bars (rebar)**



**Figure 4 — Rebar installation conditions**

| | | | | | |
|---|---|---|---|---|---|
| Permissible concrete conditions |  Uncracked concrete |  Dry concrete | Permissible drilling method |  Hammer drilling with carbide tipped drill bit | |
| | |  Water-saturated concrete | |  Hilti TE-CD or TE-YD Hollow Drill Bit | |

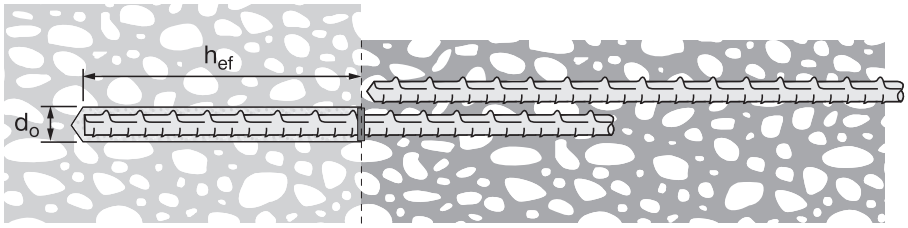
3.2.5

**Table 19 — Rebar installation specifications with Hilti HIT-ICE adhesive system**

| Setting information | | Symbol | Units | Rebar size | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 | #11 |
| Nominal bit diameter | | $d_o$ | in. | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/8 | 1-3/8 | 1-1/2 | 1-3/4 |
| Effective embedment | minimum | $h_{ef,min}$ | in. | 2-3/8 | 2-3/8 | 3 | 3 | 3-3/8 | 4 | 4-1/2 | 5 | 5-1/2 |
| | | | (mm) | (60) | (60) | (76) | (76) | (85) | (102) | (114) | (127) | (140) |
| | maximum | $h_{ef,max}$ | in. | 7-1/2 | 10 | 12-1/2 | 15 | 17-1/2 | 20 | 22-1/2 | 25 | 27-1/2 |
| | | | (mm) | (191) | (254) | (318) | (381) | (445) | (508) | (572) | (635) | (699) |
| Minimum concrete thickness | | $h_{min}$ | in. | $h_{ef}$ + 1-1/4 | | ($h_{ef}$ + 2$d_o$) | | | | | | |
| | | | (mm) | ($h_{ef}$ + 30) | | | | | | | | |
| Minimum edge distance[1] | | $c_{min}$ | in. | 1-7/8 | 2-1/2 | 3-1/8 | 3-3/4 | 4-3/8 | 5 | 5-5/8 | 6-1/4 | 7 |
| | | | (mm) | (48) | (64) | (79) | (95) | (111) | (127) | (143) | (159) | (178) |
| Minimum anchor spacing | | $s_{min}$ | in. | 1-7/8 | 2-1/2 | 3-1/8 | 3-3/4 | 4-3/8 | 5 | 5-5/8 | 6-1/4 | 7 |
| | | | (mm) | (48) | (64) | (79) | (95) | (111) | (127) | (143) | (159) | (178) |

1 Edge distance of 1-3/4-inch (44mm) is permitted provided the rebar remains un-torqued.

**Figure 5 — Rebar installed with HIT-ICE adhesive**



## Table 20 — Hilti HIT-ICE design information with Rebar holes drilled with a hammer drill and carbide bit (or hollow drill bit) in accordance with ACI 318 Ch. 17[1]

| Design parameter | | Symbol | Units | Nominal rod diameter (in.) | | | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 | #11 | ACI 318 |
| Nominal anchor diameter | | $d_a$ | in<br>(mm) | 3/8<br>(9.5) | 1/2<br>(12.7) | 5/8<br>(15.9) | 3/4<br>(19.1) | 7/8<br>(22.2) | 1.00<br>(25.4) | 1-1/8<br>(28.6) | 1-1/4<br>(31.8) | 1-3/8<br>(34.9) | |
| Effective minimum embedment[2] | | $h_{ef,min}$ | in<br>(mm) | 2-3/8<br>(60) | 2-3/4<br>(70) | 3-1/8<br>(79) | 3-1/2<br>(89) | 3-1/2<br>(89) | 4<br>(102) | 4-1/2<br>(114) | 5<br>(127) | 5-1/2<br>(114) | |
| Effective maximum embedment[2] | | $h_{ef,max}$ | in<br>(mm) | 7-1/2<br>(191) | 10<br>(254) | 12-1/2<br>(318) | 15<br>(381) | 17-1/2<br>(445) | 20<br>(508) | 22-1/2<br>(572) | 25<br>(635) | 27-1/2<br>(699) | |
| Minimum concrete thickness[2] | | $h_{min}$ | in<br>(mm) | $h_{ef}$ + 1-1/4<br>($h_{ef}$ + 30) | | hef + $2d_0$[8] | | | | | | | |
| Critical edge distance | | | in<br>(mm) | - | $c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{1160}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4<br>$\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$<br>$\left(c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4<br>$\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}\right)$ | | | | | | | | |
| Minimum edge distance | | $c_{min}$ | in<br>(mm) | 1-7/8<br>(48) | 2-1/2<br>(64) | 3-1/8<br>(79) | 3-3/4<br>(95) | 4-3/8<br>(111) | 5<br>(127) | 5-5/8<br>(143) | 6-1/4<br>(159) | 7<br>(178) | |
| Minimum anchor spacing | | $s_{min}$ | in<br>(mm) | 1-7/8<br>(48) | 2-1/2<br>(64) | 3-1/8<br>(79) | 3-3/4<br>(95) | 4-3/8<br>(111) | 5<br>(127) | 5-5/8<br>(143) | 6-1/4<br>(159) | 7<br>(178) | |
| Effectiveness factor for uncracked concrete[4] | | $k_{c,uncr}$ | - | 24<br>(10) | | | | | | | | | 17.4.2.2 |
| Effectiveness factor for cracked concrete[4] | | $k_{c,cr}$ | - | 17<br>(7.1) | | | | | | | | | 17.4.2.2 |
| Strength reduction factor for tension, concrete failure modes[5] | | $\Phi_{c,N}$ | - | 0.65 | | | | | | | | | 17.3.3 |
| Strength reduction factor for shear, concrete failure modes[5] | | $\Phi_{c,V}$ | - | 0.70 | | | | | | | | | 17.3.3 |
| Temperature range A[6] | Characteristic bond stress in cracked concrete[7] | $\tau_{k,cr}$ | psi<br>MPa | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 17.4.5 |
| | Characteristic bond stress in uncracked concrete[7] | $\tau_{k,uncr}$ | psi<br>(MPa) | 1,015<br>(7.0) | 1,005<br>(6.9) | 990<br>(6.8) | 975<br>(6.7) | 965<br>(6.7) | 950<br>(6.6) | 935<br>(6.4) | 920<br>(6.3) | 905<br>(6.2) | 17.4.5 |
| Permissible installation conditions | Strength reduction factor for tension, bond failure modes, dry concrete | | Anchor category | - | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | |
| | | $\Phi_{b,dry}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | |
| | Strength reduction factor for tension, bond failure modes, water saturated concrete | | Anchor category | - | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | |
| | | $\Phi_{b,ws}$ | - | 0.65 | 0.65 | 0.65 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | |

1 Design information in this table is based on testing in accordance with ACI 355.4.
2 See figure 4 of this section.
3 Minimum edge distance may be reduced to 1-3/4" (44mm) provided the rebar remains untorqued.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
5 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.
6 Temperature range A: Max. short term temperature = 130°F (54°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
7 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2500 psi (17.2 Mpa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 Mpa) and 8,000 psi (55.2 Mpa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].
8 $d_0$ = drilled hole diameter

## Table 21 — Hilti HIT-ICE adhesive design strength with concrete / bond failure for US rebar in uncracked concrete[1,2,3,4,5,6,7,8]

| Rebar size | Effective embedment in. (mm) | Tension — $\phi N_n$ | | | | Shear — $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| #3 | 3-3/8 (86) | 2,625 (11.7) | 2,670 (11.9) | 2,750 (12.2) | 2,865 (12.7) | 5,650 (25.1) | 5,755 (25.6) | 5,920 (26.3) | 6,165 (27.4) |
| | 4-1/2 (114) | 3,500 (15.6) | 3,560 (15.8) | 3,665 (16.3) | 3,820 (17.0) | 7,535 (33.5) | 7,670 (34.1) | 7,895 (35.1) | 8,225 (36.6) |
| | 7-1/2 (191) | 5,830 (25.9) | 5,935 (26.4) | 6,110 (27.2) | 6,365 (28.3) | 12,555 (55.8) | 12,785 (56.9) | 13,160 (58.5) | 13,705 (61.0) |
| #4 | 4-1/2 (114) | 4,620 (20.6) | 4,705 (20.9) | 4,840 (21.5) | 5,040 (22.4) | 9,945 (44.2) | 10,130 (45.1) | 10,425 (46.4) | 10,855 (48.3) |
| | 6 (152) | 6,155 (27.4) | 6,270 (27.9) | 6,455 (28.7) | 6,720 (29.9) | 13,260 (59.0) | 13,505 (60.1) | 13,900 (61.8) | 14,475 (64.4) |
| | 10 (254) | 10,260 (45.6) | 10,450 (46.5) | 10,755 (47.8) | 11,200 (49.8) | 22,100 (98.3) | 22,510 (100.1) | 23,165 (103.0) | 24,125 (107.3) |
| #5 | 5-5/8 (143) | 7,105 (31.6) | 7,240 (32.2) | 7,450 (33.1) | 7,760 (34.5) | 15,310 (68.1) | 15,590 (69.3) | 16,045 (71.4) | 16,710 (74.3) |
| | 7-1/2 (191) | 9,475 (42.1) | 9,650 (42.9) | 9,930 (44.2) | 10,345 (46.0) | 20,410 (90.8) | 20,785 (92.5) | 21,395 (95.2) | 22,280 (99.1) |
| | 12-1/2 (318) | 15,795 (70.3) | 16,085 (71.5) | 16,555 (73.6) | 17,240 (76.7) | 34,020 (151.3) | 34,645 (154.1) | 35,655 (158.6) | 37,130 (165.2) |
| #6 | 6-3/4 (171) | 8,530 (37.9) | 8,685 (38.6) | 8,940 (39.8) | 9,310 (41.4) | 21,710 (96.6) | 22,110 (98.3) | 22,755 (101.2) | 23,695 (105.4) |
| | 9 (229) | 11,370 (50.6) | 11,580 (51.5) | 11,920 (53.0) | 12,410 (55.2) | 28,945 (128.8) | 29,480 (131.1) | 30,340 (135.0) | 31,595 (140.5) |
| | 15 (381) | 18,955 (84.3) | 19,300 (85.9) | 19,865 (88.4) | 20,685 (92.0) | 48,245 (214.6) | 49,130 (218.5) | 50,565 (224.9) | 52,655 (234.2) |
| #7 | 7-7/8 (200) | 11,490 (51.1) | 11,700 (52.0) | 12,040 (53.6) | 12,540 (55.8) | 29,245 (130.1) | 29,785 (132.5) | 30,655 (136.4) | 31,920 (142.0) |
| | 10-1/2 (267) | 15,320 (68.1) | 15,600 (69.4) | 16,055 (71.4) | 16,720 (74.4) | 38,995 (173.5) | 39,710 (176.6) | 40,870 (181.8) | 42,560 (189.3) |
| | 17-1/2 (445) | 25,530 (113.6) | 26,000 (115.7) | 26,760 (119.0) | 27,870 (124.0) | 64,990 (289.1) | 66,185 (294.4) | 68,120 (303.0) | 70,935 (315.5) |
| #8 | 9 (229) | 14,775 (65.7) | 15,045 (66.9) | 15,485 (68.9) | 16,125 (71.7) | 37,605 (167.3) | 38,295 (170.3) | 39,415 (175.3) | 41,045 (182.6) |
| | 12 (305) | 19,700 (87.6) | 20,060 (89.2) | 20,645 (91.8) | 21,500 (95.6) | 50,140 (223.0) | 51,060 (227.1) | 52,555 (233.8) | 54,725 (243.4) |
| | 20 (508) | 32,830 (146.0) | 33,435 (148.7) | 34,410 (153.1) | 35,835 (159.4) | 83,565 (371.7) | 85,105 (378.6) | 87,590 (389.6) | 91,210 (405.7) |
| #9 | 10-1/8 (257) | 18,400 (81.8) | 18,740 (83.4) | 19,290 (85.8) | 20,085 (89.3) | 46,840 (208.4) | 47,705 (212.2) | 49,095 (218.4) | 51,130 (227.4) |
| | 13-1/2 (343) | 24,535 (109.1) | 24,990 (111.2) | 25,715 (114.4) | 26,780 (119.1) | 62,455 (277.8) | 63,605 (282.9) | 65,460 (291.2) | 68,170 (303.2) |
| | 22-1/2 (572) | 40,895 (181.9) | 41,645 (185.2) | 42,860 (190.6) | 44,635 (198.5) | 104,095 (463.0) | 106,010 (471.6) | 109,105 (485.3) | 113,620 (505.4) |
| #10 | 11-1/4 (286) | 22,355 (99.4) | 22,765 (101.3) | 23,430 (104.2) | 24,400 (108.5) | 56,900 (253.1) | 57,950 (257.8) | 59,640 (265.3) | 62,110 (276.3) |
| | 15 (381) | 29,805 (132.6) | 30,355 (135.0) | 31,240 (139.0) | 32,535 (144.7) | 75,870 (337.5) | 77,265 (343.7) | 79,520 (353.7) | 82,810 (368.4) |
| | 25 (635) | 49,675 (221.0) | 50,590 (225.0) | 52,065 (231.6) | 54,220 (241.2) | 126,450 (562.5) | 128,775 (572.8) | 132,535 (589.5) | 138,020 (613.9) |

1 See section 3.1.8 for explanation on development of load values.
2 See section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 23-30 as necessary to the above values. Compare to the steel values in table 22. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete, multiply design strength (factored resistance) by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

**Table 22 — Steel design strength for US rebar[1,2]**

| Rebar size | ASTM A615 Grade 40 [4] | | ASTM A615 Grade 60 [4] | | ASTM A706 Grade 60 [4] | |
|---|---|---|---|---|---|---|
| | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) |
| #3 | 4,290 (19.1) | 2,375 (10.6) | 5,720 (25.4) | 3,170 (14.1) | 6,600 (29.4) | 3,430 (15.3) |
| #4 | 7,800 (34.7) | 4,320 (19.2) | 10,400 (46.3) | 5,760 (25.6) | 12,000 (53.4) | 6,240 (27.8) |
| #5 | 12,090 (53.8) | 6,695 (29.8) | 16,120 (71.7) | 8,930 (39.7) | 18,600 (82.7) | 9,670 (43.0) |
| #6 | 17,160 (76.3) | 9,505 (42.3) | 22,880 (101.8) | 12,670 (56.4) | 26,400 (117.4) | 13,730 (61.1) |
| #7 | 23,400 (104.1) | 12,960 (57.6) | 31,200 (138.8) | 17,280 (76.9) | 36,000 (160.1) | 18,720 (83.3) |
| #8 | 30,810 (137.0) | 17,065 (75.9) | 41,080 (182.7) | 22,750 (101.2) | 47,400 (210.8) | 24,650 (109.6) |
| #9 | 39,000 (173.5) | 21,600 (96.1) | 52,000 (231.3) | 28,800 (128.1) | 60,000 (266.9) | 31,200 (138.8) |
| #10 | 49,530 (220.3) | 27,430 (122.0) | 66,040 (293.8) | 36,575 (162.7) | 76,200 (339.0) | 39,625 (176.3) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 ASTM A706 Grade 60 rebar are considered ductile steel elements. ASTM A615 Grade 40 and 60 rebar are considered brittle steel elements.
3 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
4 Shear = $\phi$ 0.60 $A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

### Table 23 — Load adjustment factors for #3 rebar in uncracked concrete[1,2,3]

| #3 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) | 3-3/8 (86) | 4-1/2 (114) | 7-1/2 (191) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.33 | 0.24 | 0.14 | n/a | n/a | n/a | 0.13 | 0.10 | 0.06 | 0.26 | 0.20 | 0.12 | n/a | n/a | n/a |
| | 1-7/8 | (48) | 0.59 | 0.57 | 0.54 | 0.34 | 0.25 | 0.14 | 0.55 | 0.54 | 0.53 | 0.14 | 0.11 | 0.07 | 0.29 | 0.22 | 0.13 | n/a | n/a | n/a |
| | 2 | (51) | 0.60 | 0.57 | 0.54 | 0.35 | 0.25 | 0.15 | 0.55 | 0.54 | 0.53 | 0.16 | 0.12 | 0.07 | 0.32 | 0.24 | 0.14 | n/a | n/a | n/a |
| | 3 | (76) | 0.65 | 0.61 | 0.57 | 0.45 | 0.33 | 0.19 | 0.57 | 0.56 | 0.54 | 0.29 | 0.22 | 0.13 | 0.45 | 0.33 | 0.19 | n/a | n/a | n/a |
| | 4 | (102) | 0.70 | 0.65 | 0.59 | 0.56 | 0.41 | 0.24 | 0.60 | 0.58 | 0.56 | 0.45 | 0.34 | 0.20 | 0.56 | 0.41 | 0.24 | n/a | n/a | n/a |
| | 4-5/8 | (117) | 0.73 | 0.67 | 0.60 | 0.65 | 0.47 | 0.28 | 0.61 | 0.59 | 0.57 | 0.56 | 0.42 | 0.25 | 0.65 | 0.47 | 0.28 | 0.67 | n/a | n/a |
| | 5 | (127) | 0.75 | 0.69 | 0.61 | 0.71 | 0.51 | 0.30 | 0.62 | 0.60 | 0.57 | 0.63 | 0.47 | 0.28 | 0.71 | 0.51 | 0.30 | 0.70 | n/a | n/a |
| | 5-3/4 | (146) | 0.78 | 0.71 | 0.63 | 0.81 | 0.59 | 0.34 | 0.64 | 0.62 | 0.58 | 0.78 | 0.58 | 0.35 | 0.81 | 0.59 | 0.34 | 0.75 | 0.68 | n/a |
| | 6 | (152) | 0.80 | 0.72 | 0.63 | 0.85 | 0.62 | 0.36 | 0.65 | 0.62 | 0.59 | 0.83 | 0.62 | 0.37 | 0.85 | 0.62 | 0.36 | 0.77 | 0.70 | n/a |
| | 7 | (178) | 0.85 | 0.76 | 0.66 | 0.99 | 0.72 | 0.42 | 0.67 | 0.64 | 0.60 | 1.00 | 0.78 | 0.47 | 0.99 | 0.72 | 0.42 | 0.83 | 0.75 | n/a |
| | 8 | (203) | 0.90 | 0.80 | 0.68 | 1.00 | 0.82 | 0.48 | 0.70 | 0.66 | 0.62 | | 0.96 | 0.57 | 1.00 | 0.82 | 0.48 | 0.89 | 0.80 | n/a |
| | 8-3/4 | (222) | 0.93 | 0.82 | 0.69 | | 0.90 | 0.52 | 0.71 | 0.68 | 0.63 | | 1.00 | 0.66 | | 0.90 | 0.52 | 0.93 | 0.84 | 0.71 |
| | 9 | (229) | 0.94 | 0.83 | 0.70 | | 0.92 | 0.54 | 0.72 | 0.68 | 0.63 | | | 0.68 | | 0.92 | 0.54 | 0.94 | 0.85 | 0.72 |
| | 10 | (254) | 0.99 | 0.87 | 0.72 | | 1.00 | 0.59 | 0.74 | 0.70 | 0.64 | | | 0.80 | | 1.00 | 0.59 | 0.99 | 0.90 | 0.76 |
| | 11 | (279) | 1.00 | 0.91 | 0.74 | | | 0.65 | 0.77 | 0.72 | 0.66 | | | 0.93 | | | 0.65 | 1.00 | 0.94 | 0.80 |
| | 12 | (305) | | 0.94 | 0.77 | | | 0.71 | 0.79 | 0.74 | 0.67 | | | 1.00 | | | 0.71 | | 0.99 | 0.83 |
| | 14 | (356) | | 1.00 | 0.81 | | | 0.83 | 0.84 | 0.78 | 0.70 | | | | | | 0.83 | | 1.00 | 0.90 |
| | 16 | (406) | | | 0.86 | | | 0.95 | 0.89 | 0.82 | 0.73 | | | | | | 0.95 | | | 0.96 |
| | 18 | (457) | | | 0.90 | | | 1.00 | 0.94 | 0.86 | 0.76 | | | | | | 1.00 | | | 1.00 |
| | 24 | (610) | | | 1.00 | | | | 1.00 | 0.99 | 0.85 | | | | | | | | | |
| | 30 | (762) | | | | | | | | 1.00 | 0.93 | | | | | | | | | |
| | 36 | (914) | | | | | | | | | 1.00 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | | | | | | | | | | | |

### Table 24 — Load adjustment factors for #4 rebar in uncracked concrete[1,2,3]

| #4 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.28 | 0.21 | 0.12 | n/a | n/a | n/a | 0.09 | 0.06 | 0.04 | 0.17 | 0.13 | 0.08 | n/a | n/a | n/a |
| | 2-1/2 | (64) | 0.59 | 0.57 | 0.54 | 0.33 | 0.24 | 0.14 | 0.55 | 0.54 | 0.53 | 0.15 | 0.11 | 0.07 | 0.29 | 0.22 | 0.13 | n/a | n/a | n/a |
| | 3 | (76) | 0.61 | 0.58 | 0.55 | 0.36 | 0.27 | 0.16 | 0.56 | 0.55 | 0.53 | 0.19 | 0.14 | 0.09 | 0.36 | 0.27 | 0.16 | n/a | n/a | n/a |
| | 4 | (102) | 0.65 | 0.61 | 0.57 | 0.44 | 0.32 | 0.19 | 0.57 | 0.56 | 0.54 | 0.30 | 0.22 | 0.13 | 0.44 | 0.32 | 0.19 | n/a | n/a | n/a |
| | 5 | (127) | 0.69 | 0.64 | 0.58 | 0.52 | 0.38 | 0.22 | 0.59 | 0.58 | 0.55 | 0.41 | 0.31 | 0.19 | 0.52 | 0.38 | 0.22 | n/a | n/a | n/a |
| | 5-3/4 | (146) | 0.71 | 0.66 | 0.60 | 0.59 | 0.43 | 0.25 | 0.61 | 0.59 | 0.56 | 0.51 | 0.38 | 0.23 | 0.59 | 0.43 | 0.25 | 0.65 | n/a | n/a |
| | 6 | (152) | 0.72 | 0.67 | 0.60 | 0.62 | 0.45 | 0.27 | 0.61 | 0.59 | 0.57 | 0.54 | 0.41 | 0.24 | 0.62 | 0.45 | 0.27 | 0.67 | n/a | n/a |
| | 7 | (178) | 0.76 | 0.69 | 0.62 | 0.72 | 0.53 | 0.31 | 0.63 | 0.61 | 0.58 | 0.68 | 0.51 | 0.31 | 0.72 | 0.53 | 0.31 | 0.72 | n/a | n/a |
| | 7-1/4 | (184) | 0.77 | 0.70 | 0.62 | 0.75 | 0.55 | 0.32 | 0.63 | 0.61 | 0.58 | 0.72 | 0.54 | 0.32 | 0.75 | 0.55 | 0.32 | 0.73 | 0.67 | n/a |
| | 8 | (203) | 0.80 | 0.72 | 0.63 | 0.82 | 0.60 | 0.35 | 0.65 | 0.62 | 0.59 | 0.84 | 0.63 | 0.38 | 0.82 | 0.60 | 0.35 | 0.77 | 0.70 | n/a |
| | 9 | (229) | 0.83 | 0.75 | 0.65 | 0.93 | 0.68 | 0.40 | 0.67 | 0.64 | 0.60 | 1.00 | 0.75 | 0.45 | 0.93 | 0.68 | 0.40 | 0.82 | 0.74 | n/a |
| | 10 | (254) | 0.87 | 0.78 | 0.67 | 1.00 | 0.76 | 0.44 | 0.68 | 0.65 | 0.61 | | 0.88 | 0.53 | 1.00 | 0.76 | 0.44 | 0.86 | 0.78 | n/a |
| | 11-1/4 | (286) | 0.92 | 0.81 | 0.69 | | 0.85 | 0.50 | 0.71 | 0.67 | 0.62 | | 1.00 | 0.63 | | 0.85 | 0.50 | 0.91 | 0.83 | 0.70 |
| | 12 | (305) | 0.94 | 0.83 | 0.70 | | 0.91 | 0.53 | 0.72 | 0.68 | 0.63 | | | 0.69 | | 0.91 | 0.53 | 0.94 | 0.86 | 0.72 |
| | 14 | (356) | 1.00 | 0.89 | 0.73 | | 1.00 | 0.62 | 0.76 | 0.71 | 0.65 | | | 0.87 | | 1.00 | 0.62 | 1.00 | 0.92 | 0.78 |
| | 16 | (406) | | 0.94 | 0.77 | | | 0.71 | 0.80 | 0.74 | 0.67 | | | 1.00 | | | 0.71 | | 0.99 | 0.83 |
| | 18 | (457) | | 1.00 | 0.80 | | | 0.80 | 0.83 | 0.77 | 0.70 | | | | | | 0.80 | | 1.00 | 0.88 |
| | 20 | (508) | | | 0.83 | | | 0.88 | 0.87 | 0.81 | 0.72 | | | | | | 0.88 | | | 0.93 |
| | 22 | (559) | | | 0.87 | | | 0.97 | 0.91 | 0.84 | 0.74 | | | | | | 0.97 | | | 0.98 |
| | 24 | (610) | | | 0.90 | | | 1.00 | 0.94 | 0.87 | 0.76 | | | | | | 1.00 | | | 1.00 |
| | 30 | (762) | | | 1.00 | | | | 1.00 | 0.96 | 0.83 | | | | | | | | | |
| | 36 | (914) | | | | | | | | 1.00 | 0.89 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | | 1.00 | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 25 — Load adjustment factors for #5 rebar in uncracked concrete[1,2,3]

| #5 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | || To edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) | 4-1/2 (114) | 6 (152) | 10 (254) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.26 | 0.19 | 0.11 | n/a | n/a | n/a | 0.06 | 0.05 | 0.03 | 0.12 | 0.09 | 0.06 | n/a | n/a | n/a |
| | 3-1/8 | (79) | 0.59 | 0.57 | 0.54 | 0.33 | 0.24 | 0.14 | 0.55 | 0.54 | 0.53 | 0.15 | 0.11 | 0.07 | 0.30 | 0.22 | 0.13 | n/a | n/a | n/a |
| | 4 | (102) | 0.62 | 0.59 | 0.55 | 0.38 | 0.28 | 0.16 | 0.56 | 0.55 | 0.54 | 0.21 | 0.16 | 0.10 | 0.38 | 0.28 | 0.16 | n/a | n/a | n/a |
| | 5 | (127) | 0.65 | 0.61 | 0.57 | 0.44 | 0.32 | 0.19 | 0.57 | 0.56 | 0.54 | 0.30 | 0.23 | 0.14 | 0.44 | 0.32 | 0.19 | n/a | n/a | n/a |
| | 6 | (152) | 0.68 | 0.63 | 0.58 | 0.50 | 0.37 | 0.21 | 0.59 | 0.57 | 0.55 | 0.39 | 0.30 | 0.18 | 0.50 | 0.37 | 0.21 | n/a | n/a | n/a |
| | 7 | (178) | 0.71 | 0.66 | 0.59 | 0.58 | 0.42 | 0.25 | 0.60 | 0.59 | 0.56 | 0.50 | 0.37 | 0.22 | 0.58 | 0.42 | 0.25 | n/a | n/a | n/a |
| | 7-1/8 | (181) | 0.71 | 0.66 | 0.60 | 0.59 | 0.43 | 0.25 | 0.61 | 0.59 | 0.56 | 0.51 | 0.38 | 0.23 | 0.59 | 0.43 | 0.25 | 0.65 | n/a | n/a |
| | 8 | (203) | 0.74 | 0.68 | 0.61 | 0.66 | 0.49 | 0.28 | 0.62 | 0.60 | 0.57 | 0.61 | 0.46 | 0.27 | 0.66 | 0.49 | 0.28 | 0.69 | n/a | n/a |
| | 9 | (229) | 0.77 | 0.70 | 0.62 | 0.74 | 0.55 | 0.32 | 0.63 | 0.61 | 0.58 | 0.72 | 0.54 | 0.33 | 0.74 | 0.55 | 0.32 | 0.73 | 0.67 | n/a |
| | 10 | (254) | 0.80 | 0.72 | 0.63 | 0.83 | 0.61 | 0.36 | 0.65 | 0.62 | 0.59 | 0.85 | 0.64 | 0.38 | 0.83 | 0.61 | 0.36 | 0.77 | 0.70 | n/a |
| | 11 | (279) | 0.83 | 0.74 | 0.65 | 0.91 | 0.67 | 0.39 | 0.66 | 0.64 | 0.60 | 0.98 | 0.73 | 0.44 | 0.91 | 0.67 | 0.39 | 0.81 | 0.74 | n/a |
| | 12 | (305) | 0.86 | 0.77 | 0.66 | 0.99 | 0.73 | 0.43 | 0.68 | 0.65 | 0.61 | 1.00 | 0.84 | 0.50 | 0.99 | 0.73 | 0.43 | 0.85 | 0.77 | n/a |
| | 14 | (356) | 0.91 | 0.81 | 0.69 | 1.00 | 0.85 | 0.50 | 0.71 | 0.67 | 0.62 | | 1.00 | 0.63 | 1.00 | 0.85 | 0.50 | 0.91 | 0.83 | 0.70 |
| | 16 | (406) | 0.97 | 0.86 | 0.71 | | 0.97 | 0.57 | 0.74 | 0.70 | 0.64 | | | 0.77 | | 0.97 | 0.57 | 0.98 | 0.89 | 0.75 |
| | 18 | (457) | 1.00 | 0.90 | 0.74 | | 1.00 | 0.64 | 0.77 | 0.72 | 0.66 | | | 0.92 | | 1.00 | 0.64 | 1.00 | 0.94 | 0.79 |
| | 20 | (508) | | 0.94 | 0.77 | | | 0.71 | 0.80 | 0.75 | 0.68 | | | 1.00 | | | 0.71 | | 0.99 | 0.84 |
| | 22 | (559) | | 0.99 | 0.79 | | | 0.78 | 0.83 | 0.77 | 0.69 | | | | | | 0.78 | | 1.00 | 0.88 |
| | 24 | (610) | | 1.00 | 0.82 | | | 0.85 | 0.86 | 0.80 | 0.71 | | | | | | 0.85 | | | 0.92 |
| | 26 | (660) | | | 0.85 | | | 0.92 | 0.89 | 0.82 | 0.73 | | | | | | 0.92 | | | 0.96 |
| | 28 | (711) | | | 0.87 | | | 1.00 | 0.92 | 0.85 | 0.75 | | | | | | 1.00 | | | 0.99 |
| | 30 | (762) | | | 0.90 | | | | 0.95 | 0.87 | 0.76 | | | | | | | | | 1.00 |
| | 36 | (914) | | | 0.98 | | | | 1.00 | 0.94 | 0.82 | | | | | | | | | |
| | > 48 | (1219) | | | 1.00 | | | | | 1.00 | 0.92 | | | | | | | | | |

## Table 26 — Load adjustment factors for #6 rebar in uncracked concrete[1,2,3]

| #6 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | || To edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) | 6-3/4 (171) | 9 (229) | 15 (381) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.24 | 0.18 | 0.10 | n/a | n/a | n/a | 0.05 | 0.04 | 0.02 | 0.09 | 0.07 | 0.04 | n/a | n/a | n/a |
| | 3-3/4 | (95) | 0.59 | 0.57 | 0.54 | 0.33 | 0.24 | 0.14 | 0.55 | 0.54 | 0.53 | 0.15 | 0.11 | 0.07 | 0.30 | 0.22 | 0.13 | n/a | n/a | n/a |
| | 4 | (102) | 0.60 | 0.57 | 0.54 | 0.34 | 0.25 | 0.15 | 0.55 | 0.54 | 0.53 | 0.16 | 0.12 | 0.07 | 0.33 | 0.24 | 0.15 | n/a | n/a | n/a |
| | 5 | (127) | 0.62 | 0.59 | 0.56 | 0.39 | 0.28 | 0.17 | 0.56 | 0.55 | 0.54 | 0.23 | 0.17 | 0.10 | 0.39 | 0.28 | 0.17 | n/a | n/a | n/a |
| | 6 | (152) | 0.65 | 0.61 | 0.57 | 0.44 | 0.32 | 0.19 | 0.57 | 0.56 | 0.54 | 0.30 | 0.22 | 0.13 | 0.44 | 0.32 | 0.19 | n/a | n/a | n/a |
| | 7 | (178) | 0.67 | 0.63 | 0.58 | 0.49 | 0.36 | 0.21 | 0.59 | 0.57 | 0.55 | 0.38 | 0.28 | 0.17 | 0.49 | 0.36 | 0.21 | n/a | n/a | n/a |
| | 8 | (203) | 0.70 | 0.65 | 0.59 | 0.55 | 0.41 | 0.24 | 0.60 | 0.58 | 0.56 | 0.46 | 0.34 | 0.21 | 0.55 | 0.41 | 0.24 | n/a | n/a | n/a |
| | 8-1/2 | (216) | 0.71 | 0.66 | 0.59 | 0.59 | 0.43 | 0.25 | 0.61 | 0.59 | 0.56 | 0.50 | 0.38 | 0.23 | 0.59 | 0.43 | 0.25 | 0.65 | n/a | n/a |
| | 9 | (229) | 0.72 | 0.67 | 0.60 | 0.62 | 0.46 | 0.27 | 0.61 | 0.59 | 0.57 | 0.55 | 0.41 | 0.25 | 0.62 | 0.46 | 0.27 | 0.67 | n/a | n/a |
| | 10 | (254) | 0.75 | 0.69 | 0.61 | 0.69 | 0.51 | 0.30 | 0.62 | 0.60 | 0.57 | 0.64 | 0.48 | 0.29 | 0.69 | 0.51 | 0.30 | 0.70 | n/a | n/a |
| | 10-3/4 | (273) | 0.77 | 0.70 | 0.62 | 0.74 | 0.55 | 0.32 | 0.63 | 0.61 | 0.58 | 0.72 | 0.54 | 0.32 | 0.74 | 0.55 | 0.32 | 0.73 | 0.66 | n/a |
| | 12 | (305) | 0.80 | 0.72 | 0.63 | 0.83 | 0.61 | 0.36 | 0.65 | 0.62 | 0.59 | 0.84 | 0.63 | 0.38 | 0.83 | 0.61 | 0.36 | 0.77 | 0.70 | n/a |
| | 14 | (356) | 0.85 | 0.76 | 0.66 | 0.97 | 0.71 | 0.42 | 0.67 | 0.64 | 0.60 | 1.00 | 0.80 | 0.48 | 0.97 | 0.71 | 0.42 | 0.83 | 0.76 | n/a |
| | 16 | (406) | 0.90 | 0.80 | 0.68 | 1.00 | 0.81 | 0.48 | 0.70 | 0.66 | 0.62 | | 0.98 | 0.59 | 1.00 | 0.81 | 0.48 | 0.89 | 0.81 | n/a |
| | 16-3/4 | (425) | 0.91 | 0.81 | 0.69 | | 0.85 | 0.50 | 0.71 | 0.67 | 0.62 | | 1.00 | 0.63 | | 0.85 | 0.50 | 0.91 | 0.83 | 0.70 |
| | 18 | (457) | 0.94 | 0.83 | 0.70 | | 0.91 | 0.54 | 0.72 | 0.68 | 0.63 | | | 0.70 | | 0.91 | 0.54 | 0.95 | 0.86 | 0.72 |
| | 20 | (508) | 0.99 | 0.87 | 0.72 | | 1.00 | 0.60 | 0.75 | 0.70 | 0.65 | | | 0.82 | | 1.00 | 0.60 | 1.00 | 0.91 | 0.76 |
| | 22 | (559) | 1.00 | 0.91 | 0.74 | | | 0.65 | 0.77 | 0.73 | 0.66 | | | 0.94 | | | 0.65 | | 0.95 | 0.80 |
| | 24 | (610) | | 0.94 | 0.77 | | | 0.71 | 0.80 | 0.75 | 0.67 | | | 1.00 | | | 0.71 | | 0.99 | 0.84 |
| | 26 | (660) | | 0.98 | 0.79 | | | 0.77 | 0.82 | 0.77 | 0.69 | | | | | | 0.77 | | 1.00 | 0.87 |
| | 28 | (711) | | 1.00 | 0.81 | | | 0.83 | 0.85 | 0.79 | 0.70 | | | | | | 0.83 | | | 0.90 |
| | 30 | (762) | | | 0.83 | | | 0.89 | 0.87 | 0.81 | 0.72 | | | | | | 0.89 | | | 0.94 |
| | 36 | (914) | | | 0.90 | | | 1.00 | 0.95 | 0.87 | 0.76 | | | | | | 1.00 | | | 1.00 |
| | > 48 | (1219) | | | 1.00 | | | | 1.00 | 0.99 | 0.85 | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

### Table 27 — Load adjustment factors for #7 rebar in uncracked concrete[1,2,3]

| #7 Rebar uncracked Concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) | 7-7/8 (200) | 10-1/2 (267) | 17-1/2 (445) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.23 | 0.17 | 0.10 | n/a | n/a | n/a | 0.03 | 0.03 | 0.02 | 0.07 | 0.05 | 0.03 | n/a | n/a | n/a |
| | 4-3/8 | (111) | 0.59 | 0.57 | 0.54 | 0.33 | 0.24 | 0.14 | 0.54 | 0.54 | 0.53 | 0.14 | 0.10 | 0.06 | 0.28 | 0.21 | 0.12 | n/a | n/a | n/a |
| | 5 | (127) | 0.61 | 0.58 | 0.55 | 0.35 | 0.26 | 0.15 | 0.55 | 0.54 | 0.53 | 0.17 | 0.13 | 0.08 | 0.34 | 0.25 | 0.15 | n/a | n/a | n/a |
| | 6 | (152) | 0.63 | 0.60 | 0.56 | 0.39 | 0.29 | 0.17 | 0.56 | 0.55 | 0.54 | 0.22 | 0.17 | 0.10 | 0.39 | 0.29 | 0.17 | n/a | n/a | n/a |
| | 7 | (178) | 0.65 | 0.61 | 0.57 | 0.44 | 0.32 | 0.19 | 0.57 | 0.56 | 0.54 | 0.28 | 0.21 | 0.13 | 0.44 | 0.32 | 0.19 | n/a | n/a | n/a |
| | 8 | (203) | 0.67 | 0.63 | 0.58 | 0.48 | 0.35 | 0.21 | 0.58 | 0.57 | 0.55 | 0.34 | 0.26 | 0.15 | 0.48 | 0.35 | 0.21 | n/a | n/a | n/a |
| | 9 | (229) | 0.69 | 0.64 | 0.59 | 0.53 | 0.39 | 0.23 | 0.59 | 0.58 | 0.55 | 0.41 | 0.31 | 0.18 | 0.53 | 0.39 | 0.23 | n/a | n/a | n/a |
| | 9-7/8 | (251) | 0.71 | 0.66 | 0.59 | 0.59 | 0.43 | 0.25 | 0.60 | 0.58 | 0.56 | 0.47 | 0.35 | 0.21 | 0.59 | 0.43 | 0.25 | 0.63 | n/a | n/a |
| | 10 | (254) | 0.71 | 0.66 | 0.60 | 0.59 | 0.44 | 0.26 | 0.60 | 0.58 | 0.56 | 0.48 | 0.36 | 0.21 | 0.59 | 0.44 | 0.26 | 0.64 | n/a | n/a |
| | 11 | (279) | 0.73 | 0.67 | 0.60 | 0.65 | 0.48 | 0.28 | 0.61 | 0.59 | 0.57 | 0.55 | 0.41 | 0.25 | 0.65 | 0.48 | 0.28 | 0.67 | n/a | n/a |
| | 12 | (305) | 0.75 | 0.69 | 0.61 | 0.71 | 0.52 | 0.31 | 0.62 | 0.60 | 0.57 | 0.63 | 0.47 | 0.28 | 0.71 | 0.52 | 0.31 | 0.70 | n/a | n/a |
| | 12-1/2 | (318) | 0.76 | 0.70 | 0.62 | 0.74 | 0.55 | 0.32 | 0.63 | 0.60 | 0.57 | 0.67 | 0.50 | 0.30 | 0.74 | 0.55 | 0.32 | 0.71 | 0.65 | n/a |
| | 14 | (356) | 0.80 | 0.72 | 0.63 | 0.83 | 0.61 | 0.36 | 0.64 | 0.62 | 0.58 | 0.79 | 0.59 | 0.36 | 0.83 | 0.61 | 0.36 | 0.75 | 0.69 | n/a |
| | 16 | (406) | 0.84 | 0.75 | 0.65 | 0.95 | 0.70 | 0.41 | 0.66 | 0.63 | 0.60 | 0.97 | 0.72 | 0.43 | 0.95 | 0.70 | 0.41 | 0.81 | 0.73 | n/a |
| | 18 | (457) | 0.88 | 0.79 | 0.67 | 1.00 | 0.79 | 0.46 | 0.68 | 0.65 | 0.61 | 1.00 | 0.86 | 0.52 | 1.00 | 0.79 | 0.46 | 0.86 | 0.78 | n/a |
| | 19-1/2 | (495) | 0.91 | 0.81 | 0.69 | | 0.85 | 0.50 | 0.70 | 0.66 | 0.62 | | 0.97 | 0.58 | | 0.85 | 0.50 | 0.89 | 0.81 | 0.68 |
| | 20 | (508) | 0.92 | 0.82 | 0.69 | | 0.87 | 0.51 | 0.70 | 0.67 | 0.62 | | 1.00 | 0.61 | | 0.87 | 0.51 | 0.90 | 0.82 | 0.69 |
| | 22 | (559) | 0.97 | 0.85 | 0.71 | | 0.96 | 0.56 | 0.72 | 0.68 | 0.63 | | | 0.70 | | 0.96 | 0.56 | 0.95 | 0.86 | 0.73 |
| | 24 | (610) | 1.00 | 0.88 | 0.73 | | 1.00 | 0.61 | 0.74 | 0.70 | 0.64 | | | 0.80 | | 1.00 | 0.61 | 0.99 | 0.90 | 0.76 |
| | 26 | (660) | | 0.91 | 0.75 | | | 0.67 | 0.76 | 0.72 | 0.66 | | | 0.90 | | | 0.67 | 1.00 | 0.93 | 0.79 |
| | 28 | (711) | | 0.94 | 0.77 | | | 0.72 | 0.78 | 0.74 | 0.67 | | | 1.00 | | | 0.72 | | 0.97 | 0.82 |
| | 30 | (762) | | 0.98 | 0.79 | | | 0.77 | 0.81 | 0.75 | 0.68 | | | | | | 0.77 | | 1.00 | 0.85 |
| | 36 | (914) | | 1.00 | 0.84 | | | 0.92 | 0.87 | 0.80 | 0.72 | | | | | | 0.92 | | | 0.93 |
| | > 48 | (1219) | | | 0.96 | | | 1.00 | 0.99 | 0.90 | 0.79 | | | | | | 1.00 | | | 1.00 |

### Table 28 — Load adjustment factors for #8 rebar in uncracked concrete[1,2,3]

| #8 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | (mm) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) | 9 (229) | 12 (305) | 20 (508) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.23 | 0.17 | 0.10 | n/a | n/a | n/a | 0.03 | 0.02 | 0.01 | 0.05 | 0.04 | 0.02 | n/a | n/a | n/a |
| | 5 | (127) | 0.59 | 0.57 | 0.54 | 0.33 | 0.24 | 0.14 | 0.54 | 0.54 | 0.53 | 0.13 | 0.10 | 0.06 | 0.26 | 0.20 | 0.12 | n/a | n/a | n/a |
| | 6 | (152) | 0.61 | 0.58 | 0.55 | 0.36 | 0.27 | 0.16 | 0.55 | 0.54 | 0.53 | 0.17 | 0.13 | 0.08 | 0.34 | 0.26 | 0.16 | n/a | n/a | n/a |
| | 7 | (178) | 0.63 | 0.60 | 0.56 | 0.40 | 0.29 | 0.17 | 0.56 | 0.55 | 0.54 | 0.22 | 0.16 | 0.10 | 0.40 | 0.29 | 0.17 | n/a | n/a | n/a |
| | 8 | (203) | 0.65 | 0.61 | 0.57 | 0.44 | 0.32 | 0.19 | 0.57 | 0.56 | 0.54 | 0.27 | 0.20 | 0.12 | 0.44 | 0.32 | 0.19 | n/a | n/a | n/a |
| | 9 | (229) | 0.67 | 0.63 | 0.58 | 0.48 | 0.35 | 0.21 | 0.58 | 0.56 | 0.55 | 0.32 | 0.24 | 0.14 | 0.48 | 0.35 | 0.21 | n/a | n/a | n/a |
| | 10 | (254) | 0.69 | 0.64 | 0.58 | 0.52 | 0.38 | 0.23 | 0.59 | 0.57 | 0.55 | 0.37 | 0.28 | 0.17 | 0.52 | 0.38 | 0.23 | n/a | n/a | n/a |
| | 11 | (279) | 0.70 | 0.65 | 0.59 | 0.57 | 0.42 | 0.25 | 0.59 | 0.58 | 0.56 | 0.43 | 0.32 | 0.19 | 0.57 | 0.42 | 0.25 | n/a | n/a | n/a |
| | 11-1/4 | (286) | 0.71 | 0.66 | 0.59 | 0.59 | 0.43 | 0.25 | 0.60 | 0.58 | 0.56 | 0.44 | 0.33 | 0.20 | 0.59 | 0.43 | 0.25 | 0.62 | n/a | n/a |
| | 12 | (305) | 0.72 | 0.67 | 0.60 | 0.63 | 0.46 | 0.27 | 0.60 | 0.59 | 0.56 | 0.49 | 0.37 | 0.22 | 0.63 | 0.46 | 0.27 | 0.64 | n/a | n/a |
| | 13 | (330) | 0.74 | 0.68 | 0.61 | 0.68 | 0.50 | 0.29 | 0.61 | 0.59 | 0.57 | 0.55 | 0.41 | 0.25 | 0.68 | 0.50 | 0.29 | 0.67 | n/a | n/a |
| | 14 | (356) | 0.76 | 0.69 | 0.62 | 0.73 | 0.54 | 0.32 | 0.62 | 0.60 | 0.57 | 0.61 | 0.46 | 0.28 | 0.73 | 0.54 | 0.32 | 0.69 | n/a | n/a |
| | 14-1/4 | (362) | 0.76 | 0.70 | 0.62 | 0.74 | 0.55 | 0.32 | 0.62 | 0.60 | 0.57 | 0.63 | 0.47 | 0.28 | 0.74 | 0.55 | 0.32 | 0.70 | 0.64 | n/a |
| | 16 | (406) | 0.80 | 0.72 | 0.63 | 0.84 | 0.61 | 0.36 | 0.64 | 0.61 | 0.58 | 0.75 | 0.56 | 0.34 | 0.84 | 0.61 | 0.36 | 0.74 | 0.67 | n/a |
| | 18 | (457) | 0.83 | 0.75 | 0.65 | 0.94 | 0.69 | 0.41 | 0.65 | 0.63 | 0.59 | 0.90 | 0.67 | 0.40 | 0.94 | 0.69 | 0.41 | 0.79 | 0.72 | n/a |
| | 20 | (508) | 0.87 | 0.78 | 0.67 | 1.00 | 0.77 | 0.45 | 0.67 | 0.64 | 0.60 | 1.00 | 0.79 | 0.47 | 1.00 | 0.77 | 0.45 | 0.83 | 0.75 | n/a |
| | 22 | (559) | 0.91 | 0.81 | 0.68 | | 0.85 | 0.50 | 0.69 | 0.66 | 0.61 | | 0.91 | 0.54 | | 0.85 | 0.50 | 0.87 | 0.79 | n/a |
| | 22-1/4 | (565) | 0.91 | 0.81 | 0.69 | | 0.85 | 0.50 | 0.69 | 0.66 | 0.61 | | 0.92 | 0.55 | | 0.85 | 0.50 | 0.88 | 0.80 | 0.67 |
| | 24 | (610) | 0.94 | 0.83 | 0.70 | | 0.92 | 0.54 | 0.71 | 0.67 | 0.62 | | 1.00 | 0.62 | | 0.92 | 0.54 | 0.91 | 0.83 | 0.70 |
| | 26 | (660) | 0.98 | 0.86 | 0.72 | | 1.00 | 0.59 | 0.72 | 0.68 | 0.63 | | | 0.70 | | 1.00 | 0.59 | 0.95 | 0.86 | 0.72 |
| | 28 | (711) | 1.00 | 0.89 | 0.73 | | | 0.63 | 0.74 | 0.70 | 0.64 | | | 0.78 | | | 0.63 | 0.98 | 0.89 | 0.75 |
| | 30 | (762) | | 0.92 | 0.75 | | | 0.68 | 0.76 | 0.71 | 0.65 | | | 0.87 | | | 0.68 | 1.00 | 0.92 | 0.78 |
| | 36 | (914) | | 1.00 | 0.80 | | | 0.81 | 0.81 | 0.76 | 0.68 | | | 1.00 | | | 0.81 | | 1.00 | 0.85 |
| | > 48 | (1219) | | | 0.90 | | | 1.00 | 0.91 | 0.84 | 0.74 | | | | | | 1.00 | | | 0.98 |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 29 — Load adjustment factors for #9 rebar in uncracked concrete[1,2,3]

| #9 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | ∥ To edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) | 10-1/8 (257) | 13-1/2 (343) | 22-1/2 (572) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.22 | 0.16 | 0.10 | n/a | n/a | n/a | 0.02 | 0.02 | 0.01 | 0.04 | 0.03 | 0.02 | n/a | n/a | n/a |
| | 5-5/8 | (143) | 0.59 | 0.57 | 0.54 | 0.33 | 0.24 | 0.14 | 0.54 | 0.53 | 0.52 | 0.13 | 0.09 | 0.06 | 0.25 | 0.19 | 0.11 | n/a | n/a | n/a |
| | 6 | (152) | 0.60 | 0.57 | 0.54 | 0.34 | 0.25 | 0.15 | 0.54 | 0.54 | 0.53 | 0.14 | 0.10 | 0.06 | 0.28 | 0.21 | 0.12 | n/a | n/a | n/a |
| | 7 | (178) | 0.62 | 0.59 | 0.55 | 0.38 | 0.28 | 0.16 | 0.55 | 0.54 | 0.53 | 0.17 | 0.13 | 0.08 | 0.35 | 0.26 | 0.16 | n/a | n/a | n/a |
| | 8 | (203) | 0.63 | 0.60 | 0.56 | 0.41 | 0.30 | 0.18 | 0.56 | 0.55 | 0.53 | 0.21 | 0.16 | 0.10 | 0.41 | 0.30 | 0.18 | n/a | n/a | n/a |
| | 9 | (229) | 0.65 | 0.61 | 0.57 | 0.44 | 0.33 | 0.19 | 0.57 | 0.56 | 0.54 | 0.25 | 0.19 | 0.11 | 0.44 | 0.33 | 0.19 | n/a | n/a | n/a |
| | 10 | (254) | 0.66 | 0.62 | 0.57 | 0.48 | 0.35 | 0.21 | 0.57 | 0.56 | 0.54 | 0.30 | 0.22 | 0.13 | 0.48 | 0.35 | 0.21 | n/a | n/a | n/a |
| | 11 | (279) | 0.68 | 0.64 | 0.58 | 0.52 | 0.38 | 0.22 | 0.58 | 0.57 | 0.55 | 0.34 | 0.26 | 0.15 | 0.52 | 0.38 | 0.22 | n/a | n/a | n/a |
| | 12 | (305) | 0.70 | 0.65 | 0.59 | 0.56 | 0.41 | 0.24 | 0.59 | 0.57 | 0.55 | 0.39 | 0.29 | 0.18 | 0.56 | 0.41 | 0.24 | n/a | n/a | n/a |
| | 12-7/8 | (327) | 0.71 | 0.66 | 0.60 | 0.61 | 0.44 | 0.26 | 0.60 | 0.58 | 0.56 | 0.43 | 0.33 | 0.20 | 0.61 | 0.44 | 0.26 | 0.62 | n/a | n/a |
| | 13 | (330) | 0.71 | 0.66 | 0.60 | 0.61 | 0.45 | 0.26 | 0.60 | 0.58 | 0.56 | 0.44 | 0.33 | 0.20 | 0.61 | 0.45 | 0.26 | 0.62 | n/a | n/a |
| | 14 | (356) | 0.73 | 0.67 | 0.60 | 0.66 | 0.48 | 0.28 | 0.60 | 0.59 | 0.56 | 0.49 | 0.37 | 0.22 | 0.66 | 0.48 | 0.28 | 0.65 | n/a | n/a |
| | 16 | (406) | 0.76 | 0.70 | 0.62 | 0.75 | 0.55 | 0.32 | 0.62 | 0.60 | 0.57 | 0.60 | 0.45 | 0.27 | 0.75 | 0.55 | 0.32 | 0.69 | n/a | n/a |
| | 16-1/4 | (413) | 0.77 | 0.70 | 0.62 | 0.76 | 0.56 | 0.33 | 0.62 | 0.60 | 0.57 | 0.62 | 0.46 | 0.28 | 0.76 | 0.56 | 0.33 | 0.69 | 0.63 | n/a |
| | 18 | (457) | 0.80 | 0.72 | 0.63 | 0.85 | 0.62 | 0.36 | 0.63 | 0.61 | 0.58 | 0.72 | 0.54 | 0.32 | 0.85 | 0.62 | 0.36 | 0.73 | 0.66 | n/a |
| | 20 | (508) | 0.83 | 0.75 | 0.65 | 0.94 | 0.69 | 0.40 | 0.65 | 0.62 | 0.59 | 0.84 | 0.63 | 0.38 | 0.94 | 0.69 | 0.40 | 0.77 | 0.70 | n/a |
| | 22 | (559) | 0.86 | 0.77 | 0.66 | 1.00 | 0.76 | 0.44 | 0.66 | 0.63 | 0.60 | 0.97 | 0.73 | 0.44 | 1.00 | 0.76 | 0.44 | 0.81 | 0.73 | n/a |
| | 24 | (610) | 0.90 | 0.80 | 0.68 | | 0.83 | 0.49 | 0.68 | 0.65 | 0.60 | 1.00 | 0.83 | 0.50 | | 0.83 | 0.49 | 0.84 | 0.77 | n/a |
| | 25-1/4 | (641) | 0.92 | 0.81 | 0.69 | | 0.87 | 0.51 | 0.69 | 0.65 | 0.61 | | 0.90 | 0.54 | | 0.87 | 0.51 | 0.87 | 0.79 | 0.66 |
| | 26 | (660) | 0.93 | 0.82 | 0.69 | | 0.90 | 0.53 | 0.69 | 0.66 | 0.61 | | 0.94 | 0.56 | | 0.90 | 0.53 | 0.88 | 0.80 | 0.67 |
| | 28 | (711) | 0.96 | 0.85 | 0.71 | | 0.97 | 0.57 | 0.71 | 0.67 | 0.62 | | 1.00 | 0.63 | | 0.97 | 0.57 | 0.91 | 0.83 | 0.70 |
| | 30 | (762) | 0.99 | 0.87 | 0.72 | | 1.00 | 0.61 | 0.72 | 0.68 | 0.63 | | | 0.70 | | 1.00 | 0.61 | 0.94 | 0.86 | 0.72 |
| | 36 | (914) | 1.00 | 0.94 | 0.77 | | | 0.73 | 0.77 | 0.72 | 0.66 | | | 0.92 | | | 0.73 | 1.00 | 0.94 | 0.79 |
| | > 48 | (1219) | | 1.00 | 0.86 | | | 0.97 | 0.86 | 0.79 | 0.71 | | | 1.00 | | | 0.97 | | 1.00 | 0.92 |

## Table 30 — Load adjustment factors for #10 rebar in uncracked concrete[1,2,3]

| #10 Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | ∥ To edge $f_{RV}$ | | | | | |
| Embedment $h_{ef}$ | | in. (mm) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) | 11-1/4 (286) | 15 (381) | 25 (635) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.22 | 0.16 | 0.09 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.03 | 0.02 | n/a | n/a | n/a |
| | 6-1/4 | (159) | 0.59 | 0.57 | 0.54 | 0.33 | 0.24 | 0.14 | 0.54 | 0.53 | 0.52 | 0.12 | 0.09 | 0.05 | 0.24 | 0.18 | 0.11 | n/a | n/a | n/a |
| | 7 | (178) | 0.60 | 0.58 | 0.55 | 0.35 | 0.26 | 0.15 | 0.55 | 0.54 | 0.53 | 0.14 | 0.11 | 0.06 | 0.29 | 0.22 | 0.13 | n/a | n/a | n/a |
| | 8 | (203) | 0.62 | 0.59 | 0.55 | 0.38 | 0.28 | 0.16 | 0.55 | 0.54 | 0.53 | 0.18 | 0.13 | 0.08 | 0.35 | 0.26 | 0.16 | n/a | n/a | n/a |
| | 9 | (229) | 0.63 | 0.60 | 0.56 | 0.41 | 0.30 | 0.18 | 0.56 | 0.55 | 0.53 | 0.21 | 0.16 | 0.09 | 0.41 | 0.30 | 0.18 | n/a | n/a | n/a |
| | 10 | (254) | 0.65 | 0.61 | 0.57 | 0.44 | 0.33 | 0.19 | 0.57 | 0.55 | 0.54 | 0.25 | 0.18 | 0.11 | 0.44 | 0.33 | 0.19 | n/a | n/a | n/a |
| | 11 | (279) | 0.66 | 0.62 | 0.57 | 0.48 | 0.35 | 0.20 | 0.57 | 0.56 | 0.54 | 0.28 | 0.21 | 0.13 | 0.48 | 0.35 | 0.20 | n/a | n/a | n/a |
| | 12 | (305) | 0.68 | 0.63 | 0.58 | 0.51 | 0.38 | 0.22 | 0.58 | 0.56 | 0.55 | 0.32 | 0.24 | 0.14 | 0.51 | 0.38 | 0.22 | n/a | n/a | n/a |
| | 13 | (330) | 0.69 | 0.64 | 0.59 | 0.55 | 0.41 | 0.24 | 0.58 | 0.57 | 0.55 | 0.36 | 0.27 | 0.16 | 0.55 | 0.41 | 0.24 | n/a | n/a | n/a |
| | 14 | (356) | 0.71 | 0.66 | 0.59 | 0.60 | 0.44 | 0.26 | 0.59 | 0.58 | 0.55 | 0.41 | 0.30 | 0.18 | 0.60 | 0.44 | 0.26 | n/a | n/a | n/a |
| | 14-1/4 | (362) | 0.71 | 0.66 | 0.60 | 0.61 | 0.45 | 0.26 | 0.59 | 0.58 | 0.55 | 0.42 | 0.31 | 0.19 | 0.61 | 0.45 | 0.26 | 0.61 | n/a | n/a |
| | 15 | (381) | 0.72 | 0.67 | 0.60 | 0.64 | 0.47 | 0.27 | 0.60 | 0.58 | 0.56 | 0.45 | 0.34 | 0.20 | 0.64 | 0.47 | 0.27 | 0.63 | n/a | n/a |
| | 16 | (406) | 0.74 | 0.68 | 0.61 | 0.68 | 0.50 | 0.29 | 0.60 | 0.59 | 0.56 | 0.50 | 0.37 | 0.22 | 0.68 | 0.50 | 0.29 | 0.65 | n/a | n/a |
| | 17 | (432) | 0.75 | 0.69 | 0.61 | 0.72 | 0.53 | 0.31 | 0.61 | 0.59 | 0.57 | 0.54 | 0.41 | 0.24 | 0.72 | 0.53 | 0.31 | 0.67 | n/a | n/a |
| | 18 | (457) | 0.77 | 0.70 | 0.62 | 0.77 | 0.56 | 0.33 | 0.62 | 0.60 | 0.57 | 0.59 | 0.44 | 0.27 | 0.77 | 0.56 | 0.33 | 0.69 | 0.62 | n/a |
| | 20 | (508) | 0.80 | 0.72 | 0.63 | 0.85 | 0.63 | 0.37 | 0.63 | 0.61 | 0.58 | 0.69 | 0.52 | 0.31 | 0.85 | 0.63 | 0.37 | 0.72 | 0.66 | n/a |
| | 22 | (559) | 0.83 | 0.74 | 0.65 | 0.94 | 0.69 | 0.40 | 0.64 | 0.62 | 0.58 | 0.80 | 0.60 | 0.36 | 0.94 | 0.69 | 0.40 | 0.76 | 0.69 | n/a |
| | 24 | (610) | 0.86 | 0.77 | 0.66 | 1.00 | 0.75 | 0.44 | 0.66 | 0.63 | 0.59 | 0.91 | 0.68 | 0.41 | 1.00 | 0.75 | 0.44 | 0.79 | 0.72 | n/a |
| | 26 | (660) | 0.89 | 0.79 | 0.67 | | 0.81 | 0.48 | 0.67 | 0.64 | 0.60 | 1.00 | 0.77 | 0.46 | | 0.81 | 0.48 | 0.82 | 0.75 | n/a |
| | 28 | (711) | 0.91 | 0.81 | 0.69 | | 0.88 | 0.51 | 0.68 | 0.65 | 0.61 | | 0.86 | 0.52 | | 0.88 | 0.51 | 0.86 | 0.78 | 0.66 |
| | 30 | (762) | 0.94 | 0.83 | 0.70 | | 0.94 | 0.55 | 0.70 | 0.66 | 0.61 | | 0.96 | 0.57 | | 0.94 | 0.55 | 0.89 | 0.80 | 0.68 |
| | 36 | (914) | 1.00 | 0.90 | 0.74 | | 1.00 | 0.66 | 0.73 | 0.69 | 0.64 | | 1.00 | 0.75 | | 1.00 | 0.66 | 0.97 | 0.88 | 0.74 |
| | > 48 | (1219) | | 1.00 | 0.82 | | | 0.88 | 0.81 | 0.76 | 0.68 | | | 1.00 | | | 0.88 | 1.00 | 1.00 | 0.86 |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

### HIT-ICE with HIS-N Inserts



**Figure 6 - Hilti HIS-N and HIS-RN internally threaded insert installation conditions**

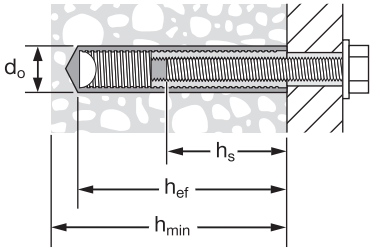
| | | | | | |
|---|---|---|---|---|---|
| Permissible concrete conditions | Uncracked concrete | Dry concrete | Permissible Drilling Method | Hammer drilling with carbide tipped drill bit | |
| | Cracked concrete | Water saturated concrete | | Hilti TE-CD or TE-YD Hollow Drill Bit | |



**Table 31 — Hilti HIS-N and HIS-RN installation specifications**

| Setting information | | Symbol | Units | Thread size | | | |
|---|---|---|---|---|---|---|---|
| | | | | 3/8-16 UNC | 1/2-13 UNC | 5/8-11 UNC | 3/4-10 UNC |
| Outside diameter of insert | | | in. | 0.65 | 0.81 | 1.00 | 1.09 |
| Nominal bit diameter | | $d_o$ | in. | 11/16 | 7/8 | 1-1/8 | 1-1/4 |
| Effective embedment | | $h_{ef}$ | in.<br>(mm) | 4-3/8<br>(110) | 5<br>(125) | 6-3/8<br>(170) | 8-1/8<br>(205) |
| Thread engagement | minimum<br>maximum | $h_s$ | in.<br>in. | 3/8<br>15/16 | 1/2<br>1-3/16 | 5/8<br>1-1/2 | 3/4<br>1-7/8 |
| Installation torque | | $T_{inst}$ | ft-lb<br>(Nm) | 15<br>(20) | 30<br>(40) | 60<br>(81) | 100<br>(136) |
| Minimum concrete thickness | | $h_{min}$ | in.<br>(mm) | 5.9<br>(150) | 6.7<br>(170) | 9.1<br>(230) | 10.6<br>(270) |

**Figure 7 — HIS-N and HIS-RN specifications**



## Table 32 — Hilti HIT-ICE design information with Hilti HIS-R and HIS-RN holes drilled with a hammer drill and carbide bit (or hollow drill bit) accordance with ACI 318 Ch. 17[1]

| Design parameter | | Symbol | Units | Nominal rod diameter (in.) | | | | Ref |
|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | ACI 318 |
| Nominal anchor diameter | | $d_a$ | in<br>(mm) | 0.65<br>(16.5) | 0.81<br>(20.5) | 1.00<br>(25.4) | 1.09<br>(27.6) | |
| Effective embedment[2] | | $h_{ef}$ | in<br>(mm) | 4 3/8<br>(110) | 5<br>(125) | 6 3/4<br>(170) | 8 1/8<br>(205) | |
| Minimum concrete thickness[2] | | $h_{min}$ | in<br>(mm) | 5.9<br>(150) | 6.7<br>(170) | 9.1<br>(230) | 10.6<br>(270) | |
| Critical edge distance | | $c_{ac}$ | in<br>(mm) | $c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{1160}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4<br>$\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$<br>$\left(c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4<br>$\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}\right)$ | | | | |
| Minimum edge distance | | $c_{min}$ | in<br>(mm) | 3 1/4<br>(83) | 4<br>(102) | 5<br>(127) | 5 1/2<br>(140) | |
| Minimum anchor spacing | | $s_{min}$ | in<br>(mm) | 3 1/4<br>(83) | 4<br>(102) | 5<br>(127) | 5 1/2<br>(140) | |
| Effectiveness factor for uncracked concrete[4] | | $k_{c,uncr}$ | - | 24<br>(10) | | | | 17.4.2.2 |
| Effectiveness factor for cracked concrete[4] | | $k_{c,cr}$ | - | 17<br>(7.1) | | | | 17.4.2.2 |
| Strength reduction factor for tension, concrete failure modes[5] | | $\Phi_{c,N}$ | - | 0.65 | | | | 17.3.3 |
| Strength reduction factor for shear, concrete failure modes[5] | | $\Phi_{c,V}$ | - | 0.70 | | | | 17.3.3 |
| Temperature range A[6] | Characteristic bond stress in cracked concrete[7] | $\tau_{k,cr}$ | psi<br>MPa | 350<br>(2.4) | 300<br>(2.1) | n/a | n/a | 17.4.5 |
| | Characteristic bond stress in uncracked concrete[7] | $\tau_{k,uncr}$ | psi<br>(MPa) | 830<br>(5.7) | 855<br>(5.9) | 840<br>(5.8) | 830<br>(5.7) | 17.4.5 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | - | n/a | | | | |
| Permissible installation conditions | Strength reduction factor for tension, bond failure modes, dry concrete | Anchor category | - | 2 | 1 | 1 | 1 | |
| | | $\Phi_{b,dry}$ | - | 0.55 | 0.65 | 0.65 | 0.65 | |
| | Strength reduction factor for tension, bond failure modes, water saturated concrete | Anchor category | - | 2 | 1 | 1 | 1 | |
| | | $\Phi_{b,ws}$ | - | 0.55 | 0.65 | 0.65 | 0.65 | |

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See figure 7 of this section.

3 Minimum edge distance may be reduced to 1-3/4" (44mm) < $c_{min}$ < 5d provided $T_{inst}$ is reduced to 0.30 $T_{inst}$ for 5d < s < 16-in. and to 0.5$T_{ins}$t for s >16-in.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (54°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2500 psi (17.2 Mpa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 Mpa) and 8,000 psi (55.2 Mpa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

8 $d_0$ = drilled hole diameter.

### Table 33 — Hilti HIT-ICE adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8]

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8-16 UNC | 4-3/8 (111) | 4,080 (18.1) | 4,155 (18.5) | 4,275 (19.0) | 4,450 (19.8) | 10,380 (46.2) | 10,570 (47.0) | 10,880 (48.4) | 11,330 (50.4) |
| 1/2-13 UNC | 5 (127) | 7,070 (31.4) | 7,200 (32.0) | 7,410 (33.0) | 7,720 (34.3) | 15,230 (67.7) | 15,510 (69.0) | 15,965 (71.0) | 16,625 (74.0) |
| 5/8-11 UNC | 6-3/4 (171) | 11,580 (51.5) | 11,790 (52.4) | 12,135 (54.0) | 12,640 (56.2) | 24,940 (110.9) | 25,395 (113.0) | 26,140 (116.3) | 27,220 (121.1) |
| 3/4-10 UNC | 8-1/8 (206) | 15,010 (66.8) | 15,285 (68.0) | 15,735 (70.0) | 16,385 (72.9) | 32,330 (143.8) | 32,925 (146.5) | 33,885 (150.7) | 35,290 (157.0) |

### Table 34 — Hilti HIT-ICE adhesive design strength with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9]

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 3/8-16 UNC | 4-3/8 (111) | 1,720 (7.7) | 1,750 (7.8) | 1,805 (8.0) | 1,875 (8.3) | 4,380 (19.5) | 4,460 (19.8) | 4,590 (20.4) | 4,780 (21.3) |
| 1/2-13 UNC | 5 (127) | 2,480 (11.0) | 2,525 (11.2) | 2,600 (11.6) | 2,710 (12.1) | 5,345 (23.8) | 5,440 (24.2) | 5,600 (24.9) | 5,835 (26.0) |

1 See section 3.1.8 for explanation on development of load values.
2 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 36-37 as necessary to the above values. Compare to the steel values in table 35. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130° F (55° C), max. long term temperature = 110° F (43° C). Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength (factored resistance) by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see section 3.1.8.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength (factored resistance) by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic applications are not permitted.

### Table 35 — Steel design strength for steel bolt / cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

| Thread size | ACI 318 Chapter 17 Based Design | | | |
|---|---|---|---|---|
| | ASTM A193 B7 | | ASTM A193 Grade B8M stainless steel | |
| | Tensile[4] $\phi N_{sa}$ lb (kN) | Shear[5] $\phi V_{sa}$ lb (kN) | Tensile[4] $\phi N_{sa}$ lb (kN) | Shear[5] $\phi V_{sa}$ lb (kN) |
| 3/8-16 UNC | 6,300 (28.0) | 3,490 (15.5) | 5,540 (24.6) | 3,070 (13.7) |
| 1/2-13 UNC | 10,525 (46.8) | 6,385 (28.4) | 10,145 (45.1) | 5,620 (25.0) |
| 5/8-11 UNC | 17,500 (77.8) | 10,170 (45.2) | 16,160 (71.9) | 8,950 (39.8) |
| 3/4-10 UNC | 17,785 (79.1) | 15,055 (67.0) | 23,915 (106.4) | 13,245 (58.9) |

1 See section 3.1.8 to convert design strength value to ASD value.
2 Hilti HIS-N and HIS-RN inserts with steel bolts are to be considered brittle steel elements.
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.
4 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
5 Shear = $\phi$ 0.60 $A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17. For 3/8-in diameter insert shear = $\phi$ 0.50 $A_{se,V} f_{uta}$

## Table 36 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2]

| HIS-N and HIS-RN all diameters uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear[4] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Concrete thickness factor in shear[5] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | | | ∥ To edge $f_{RV}$ | | | | | | | |
| Internal diameter | | in. | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 |
| | | (mm) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) | (9.5) | (12.7) | (15.9) | (19.1) |
| Embedment $h_{ef}$ | | in. | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 |
| | | (mm) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) |
| Spacing (s) / Edge distanc ($c_a$) / Concrete thickness (h), - in. (mm) | 3-1/4 | (83) | 0.62 | n/a | n/a | n/a | 0.46 | n/a | n/a | n/a | 0.56 | n/a | n/a | n/a | 0.23 | n/a | n/a | n/a | 0.46 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4 | (102) | 0.65 | 0.63 | n/a | n/a | 0.52 | 0.50 | n/a | n/a | 0.58 | 0.56 | n/a | n/a | 0.31 | 0.23 | n/a | n/a | 0.52 | 0.46 | n/a | n/a | n/a | n/a | n/a | n/a |
| | 5 | (127) | 0.69 | 0.67 | 0.62 | n/a | 0.61 | 0.57 | 0.46 | n/a | 0.60 | 0.58 | 0.56 | n/a | 0.44 | 0.32 | 0.20 | n/a | 0.61 | 0.57 | 0.40 | n/a | n/a | n/a | n/a | n/a |
| | 5-1/2 | (140) | 0.71 | 0.68 | 0.64 | 0.61 | 0.65 | 0.60 | 0.49 | 0.41 | 0.61 | 0.59 | 0.56 | 0.55 | 0.50 | 0.37 | 0.23 | 0.18 | 0.65 | 0.60 | 0.46 | 0.35 | n/a | n/a | n/a | n/a |
| | 6 | (152) | 0.73 | 0.70 | 0.65 | 0.62 | 0.70 | 0.64 | 0.51 | 0.44 | 0.62 | 0.59 | 0.57 | 0.56 | 0.57 | 0.43 | 0.26 | 0.20 | 0.70 | 0.64 | 0.51 | 0.40 | 0.68 | n/a | n/a | n/a |
| | 7 | (178) | 0.77 | 0.73 | 0.67 | 0.64 | 0.82 | 0.72 | 0.57 | 0.48 | 0.63 | 0.61 | 0.58 | 0.57 | 0.72 | 0.54 | 0.33 | 0.25 | 0.82 | 0.72 | 0.57 | 0.48 | 0.73 | 0.66 | n/a | n/a |
| | 8 | (203) | 0.80 | 0.77 | 0.70 | 0.66 | 0.94 | 0.81 | 0.62 | 0.52 | 0.65 | 0.63 | 0.59 | 0.58 | 0.88 | 0.66 | 0.40 | 0.31 | 0.94 | 0.81 | 0.62 | 0.52 | 0.78 | 0.71 | n/a | n/a |
| | 9 | (229) | 0.84 | 0.80 | 0.72 | 0.68 | 1.00 | 0.91 | 0.68 | 0.57 | 0.67 | 0.64 | 0.60 | 0.59 | 1.00 | 0.78 | 0.48 | 0.37 | 1.00 | 0.91 | 0.68 | 0.57 | 0.83 | 0.75 | n/a | n/a |
| | 10 | (254) | 0.88 | 0.83 | 0.75 | 0.71 | | 1.00 | 0.75 | 0.62 | 0.69 | 0.66 | 0.61 | 0.60 | | 0.92 | 0.56 | 0.43 | | 1.00 | 0.75 | 0.62 | 0.88 | 0.79 | 0.67 | n/a |
| | 11 | (279) | 0.92 | 0.87 | 0.77 | 0.73 | | | 0.83 | 0.68 | 0.71 | 0.67 | 0.62 | 0.60 | | 1.00 | 0.65 | 0.50 | | | 0.83 | 0.68 | 0.92 | 0.83 | 0.71 | 0.65 |
| | 12 | (305) | 0.96 | 0.90 | 0.80 | 0.75 | | | 0.91 | 0.75 | 0.73 | 0.69 | 0.64 | 0.61 | | | 0.74 | 0.57 | | | 0.91 | 0.75 | 0.96 | 0.87 | 0.74 | 0.68 |
| | 14 | (356) | 1.00 | 0.97 | 0.85 | 0.79 | | | 1.00 | 0.87 | 0.77 | 0.72 | 0.66 | 0.63 | | | 0.93 | 0.71 | | | 1.00 | 0.87 | 1.00 | 0.94 | 0.80 | 0.73 |
| | 16 | (406) | | 1.00 | 0.90 | 0.83 | | | | 0.99 | 0.81 | 0.75 | 0.68 | 0.65 | | | 1.00 | 0.87 | | | | 0.99 | | 1.00 | 0.85 | 0.78 |
| | 18 | (457) | | | 0.94 | 0.87 | | | | 1.00 | 0.85 | 0.78 | 0.70 | 0.67 | | | | 1.00 | | | | 1.00 | | | 0.90 | 0.83 |
| | 24 | (610) | | | 1.00 | 0.99 | | | | | 0.96 | 0.88 | 0.77 | 0.73 | | | | | | | | | | | 1.00 | 0.96 |
| | 30 | (762) | | | | 1.00 | | | | | 1.00 | 0.97 | 0.84 | 0.79 | | | | | | | | | | | | 1.00 |
| | 36 | (914) | | | | | | | | | | 1.00 | 0.91 | 0.84 | | | | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | | | | 1.00 | 0.96 | | | | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 37 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2]

| HIS-N and HIS-RN all diameters uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[4] $f_{AV}$ | | Edge distance in shear | | | | Concrete thickness factor in shear[5] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | ∥ To edge $f_{RV}$ | | | |
| Internal diameter | | in. | 3/8 | 1/2 | 3/8 | 1/2 | 3/8 | 1/2 | 3/8 | 1/2 | 3/8 | 1/2 | 3/8 | 1/2 |
| | | (mm) | (9.5) | (12.7) | (9.5) | (12.7) | (9.5) | (12.7) | (9.5) | (12.7) | (9.5) | (12.7) | (9.5) | (12.7) |
| Embedment $h_{ef}$ | | in. | 4-3/8 | 5 | 4-3/8 | 5 | 4-3/8 | 5 | 4-3/8 | 5 | 4-3/8 | 5 | 4-3/8 | 5 |
| | | (mm) | (111) | (127) | (111) | (127) | (111) | (127) | (111) | (127) | (111) | (127) | (111) | (127) |
| Spacing (s) / Edge distanc ($c_a$) / Concrete thickness (h), - in. (mm) | 3-1/4 | (83) | 0.62 | n/a | 0.63 | n/a | 0.59 | n/a | 0.39 | n/a | 0.63 | n/a | n/a | n/a |
| | 4 | (102) | 0.65 | 0.63 | 0.71 | 0.66 | 0.61 | 0.60 | 0.53 | 0.47 | 0.71 | 0.66 | n/a | n/a |
| | 5 | (127) | 0.69 | 0.67 | 0.82 | 0.75 | 0.64 | 0.63 | 0.74 | 0.66 | 0.82 | 0.75 | n/a | n/a |
| | 5-1/2 | (140) | 0.71 | 0.68 | 0.87 | 0.80 | 0.65 | 0.64 | 0.85 | 0.76 | 0.87 | 0.80 | n/a | n/a |
| | 6 | (152) | 0.73 | 0.70 | 0.93 | 0.85 | 0.66 | 0.65 | 0.97 | 0.87 | 0.93 | 0.85 | 0.81 | n/a |
| | 7 | (178) | 0.77 | 0.73 | 1.00 | 0.95 | 0.69 | 0.68 | 1.00 | 1.00 | 1.00 | 0.95 | 0.87 | 0.84 |
| | 8 | (203) | 0.80 | 0.77 | | 1.00 | 0.72 | 0.70 | | | | 1.00 | 0.93 | 0.90 |
| | 9 | (229) | 0.84 | 0.80 | | | 0.75 | 0.73 | | | | | 0.99 | 0.95 |
| | 10 | (254) | 0.88 | 0.83 | | | 0.77 | 0.75 | | | | | 1.00 | 1.00 |
| | 11 | (279) | 0.92 | 0.87 | | | 0.80 | 0.78 | | | | | | |
| | 12 | (305) | 0.96 | 0.90 | | | 0.83 | 0.80 | | | | | | |
| | 14 | (356) | 1.00 | 0.97 | | | 0.88 | 0.85 | | | | | | |
| | 16 | (406) | | 1.00 | | | 0.94 | 0.90 | | | | | | |
| | 18 | (457) | | | | | 0.99 | 0.95 | | | | | | |
| | 24 | (610) | | | | | 1.00 | 1.00 | | | | | | |
| | 30 | (762) | | | | | | | | | | | | |
| | 36 | (914) | | | | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

# DESIGN DATA IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on testing in accordance with ACI 355.4. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.



For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8 Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

**Table 38 — Hilti HIT-ICE design information with HAS threaded rods in hammer drilled holes in accordance with CSA A23.3 Annex D[1]**

| Design parameter | | Symbol | Units | Nominal rod diameter (in.) | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 | A23.3-14 |
| Nominal anchor O.D. | | $d_a$ | mm | 9.5 | 12.7 | 15.9 | 19.1 | 22.2 | 25.4 | 31.8 | |
| Effective minimum embedment[2] | | $h_{ef,min}$ | mm | 60 | 70 | 79 | 89 | 89 | 102 | 127 | |
| Effective maximum embedment[2] | | $h_{ef,max}$ | mm | 191 | 254 | 318 | 381 | 445 | 508 | 635 | |
| Minimum concrete thickness[2] | | $h_{min}$ | mm | $h_{ef}$ + 30 | | $h_{ef}$ + 2$d_o$ | | | | | |
| Critical edge distance | | $c_{ac}$ | mm | $c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4<br>$\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$ | | | | | | | |
| Minimum edge distance[3] | | $c_{min}$ | mm | 48 | 64 | 79 | 95 | 111 | 127 | 159 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 48 | 64 | 79 | 95 | 111 | 127 | 159 | |
| Coeff. for factored concrete breakout resistance, uncracked concrete[4] | | $k_{c,uncr}$ | – | 10 | | | | | | | D.6.2.2 |
| Coeff. for factored concrete breakout resistance, cracked concrete[4] | | $k_{c,cr}$ | – | 7 | | | | | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_c$ | – | 0.65 | | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | | | | | | D.5.3(c) |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[7] | $\tau_{cr}$ | psi (MPa) | 715 (4.9) | 615 (4.2) | 520 (3.6) | 420 (2.9) | 325 (2.2) | n/a | n/a | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7] | $\tau_{uncr}$ | psi (MPa) | 1,215 (8.4) | 1,200 (8.3) | 1,185 (8.2) | 1,075 (7.4) | 1,060 (7.3) | 1,050 (7.2) | 1,020 (7.0) | D.6.5.2 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | – | n/a | | | | | | | |
| Permissible installation conditions | Resistance modification factor tension & shear, bond failure dry concrete | Anchor category | – | 2 | 1 | 2 | 1 | 1 | 1 | 1 | D.5.3(c) |
| | | $R_{dry}$ | – | 0.85 | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 1.00 | |
| | Resistance modification factor tension & shear, bond failure water-saturated concrete | Anchor category | – | 2 | 1 | 2 | 1 | 1 | 1 | 1 | D.5.3(c) |
| | | $R_{ws}$ | – | 0.85 | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 1.00 | |

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See figure 2 and 3 of this section.

3 Minimum edge distance may be reduced to 44mm < $c_{min}$ < 5d provided $T_{inst}$ is reduced to 0.30 $T_{inst}$ for 5d < s < 16-in. and to 0.5$T_{inst}$ for s >16-in.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2500 psi (17.2 Mpa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 Mpa) and 8,000 psi (55.2 Mpa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

## Table 39 — Hilti HIT-ICE adhesive factored resistance with concrete / bond failure for threaded rod in uncracked concrete [1,2,3,4,5,6,7,8]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 2-3/8 (60) | 1,905 (8.5) | 1,950 (8.7) | 1,985 (8.8) | 2,045 (9.1) | 1,905 (8.5) | 1,950 (8.7) | 1,985 (8.8) | 2,045 (9.1) |
| | 3-3/8 (86) | 2,710 (12.1) | 2,770 (12.3) | 2,825 (12.6) | 2,905 (12.9) | 5,420 (24.1) | 5,545 (24.7) | 5,645 (25.1) | 5,810 (25.8) |
| | 4-1/2 (114) | 3,615 (16.1) | 3,695 (16.4) | 3,765 (16.7) | 3,875 (17.2) | 7,230 (32.2) | 7,390 (32.9) | 7,525 (33.5) | 7,745 (34.5) |
| | 7-1/2 (191) | 6,025 (26.8) | 6,160 (27.4) | 6,270 (27.9) | 6,455 (28.7) | 12,045 (53.6) | 12,320 (54.8) | 12,545 (55.8) | 12,910 (57.4) |
| 1/2 | 2-3/4 (70) | 3,420 (15.2) | 3,500 (15.6) | 3,565 (15.8) | 3,665 (16.3) | 6,845 (30.4) | 6,995 (31.1) | 7,125 (31.7) | 7,335 (32.6) |
| | 4-1/2 (114) | 5,600 (24.9) | 5,725 (25.5) | 5,830 (25.9) | 6,000 (26.7) | 11,200 (49.8) | 11,450 (50.9) | 11,660 (51.9) | 12,000 (53.4) |
| | 6 (152) | 7,465 (33.2) | 7,635 (34.0) | 7,775 (34.6) | 8,000 (35.6) | 14,930 (66.4) | 15,265 (67.9) | 15,550 (69.2) | 16,000 (71.2) |
| | 10 (254) | 12,440 (55.3) | 12,720 (56.6) | 12,955 (57.6) | 13,335 (59.3) | 24,885 (110.7) | 25,445 (113.2) | 25,915 (115.3) | 26,670 (118.6) |
| 5/8 | 3-1/8 (79) | 4,080 (18.1) | 4,170 (18.6) | 4,250 (18.9) | 4,370 (19.4) | 8,160 (36.3) | 8,345 (37.1) | 8,495 (37.8) | 8,745 (38.9) |
| | 5-5/8 (143) | 7,345 (32.7) | 7,510 (33.4) | 7,645 (34.0) | 7,870 (35.0) | 14,685 (65.3) | 15,015 (66.8) | 15,295 (68.0) | 15,740 (70.0) |
| | 7-1/2 (191) | 9,790 (43.6) | 10,010 (44.5) | 10,195 (45.4) | 10,495 (46.7) | 19,580 (87.1) | 20,025 (89.1) | 20,390 (90.7) | 20,985 (93.4) |
| | 12-1/2 (318) | 16,320 (72.6) | 16,685 (74.2) | 16,995 (75.6) | 17,490 (77.8) | 32,635 (145.2) | 33,370 (148.4) | 33,985 (151.2) | 34,975 (155.6) |
| 3/4 | 3-1/2 (89) | 5,480 (24.4) | 5,985 (26.6) | 6,095 (27.1) | 6,270 (27.9) | 10,955 (48.7) | 11,965 (53.2) | 12,185 (54.2) | 12,545 (55.8) |
| | 6-3/4 (171) | 11,285 (50.2) | 11,540 (51.3) | 11,750 (52.3) | 12,095 (53.8) | 22,570 (100.4) | 23,080 (102.7) | 23,505 (104.6) | 24,190 (107.6) |
| | 9 (229) | 15,045 (66.9) | 15,385 (68.4) | 15,670 (69.7) | 16,125 (71.7) | 30,095 (133.9) | 30,770 (136.9) | 31,340 (139.4) | 32,255 (143.5) |
| | 15 (381) | 25,080 (111.6) | 25,645 (114.1) | 26,115 (116.2) | 26,880 (119.6) | 50,155 (223.1) | 51,285 (228.1) | 52,230 (232.3) | 53,755 (239.1) |
| 7/8 | 3-1/2 (89) | 5,480 (24.4) | 6,125 (27.2) | 6,710 (29.8) | 7,215 (32.1) | 10,955 (48.7) | 12,250 (54.5) | 13,420 (59.7) | 14,430 (64.2) |
| | 7-7/8 (200) | 15,145 (67.4) | 15,490 (68.9) | 15,775 (70.2) | 16,235 (72.2) | 30,290 (134.7) | 30,975 (137.8) | 31,545 (140.3) | 32,465 (144.4) |
| | 10-1/2 (267) | 20,195 (89.8) | 20,650 (91.9) | 21,030 (93.5) | 21,645 (96.3) | 40,390 (179.7) | 41,300 (183.7) | 42,060 (187.1) | 43,290 (192.6) |
| | 17-1/2 (445) | 33,655 (149.7) | 34,415 (153.1) | 35,050 (155.9) | 36,075 (160.5) | 67,315 (299.4) | 68,835 (306.2) | 70,100 (311.8) | 72,145 (320.9) |
| 1 | 4 (102) | 6,690 (29.8) | 7,480 (33.3) | 8,195 (36.5) | 9,335 (41.5) | 13,385 (59.5) | 14,965 (66.6) | 16,395 (72.9) | 18,670 (83.0) |
| | 9 (229) | 19,595 (87.2) | 20,040 (89.1) | 20,405 (90.8) | 21,000 (93.4) | 39,190 (174.3) | 40,075 (178.3) | 40,815 (181.5) | 42,005 (186.8) |
| | 12 (305) | 26,130 (116.2) | 26,715 (118.8) | 27,210 (121.0) | 28,005 (124.6) | 52,255 (232.4) | 53,435 (237.7) | 54,415 (242.1) | 56,005 (249.1) |
| | 20 (508) | 43,545 (193.7) | 44,530 (198.1) | 45,350 (201.7) | 46,670 (207.6) | 87,090 (387.4) | 89,055 (396.1) | 90,695 (403.4) | 93,345 (415.2) |
| 1-1/4 | 5 (127) | 9,355 (41.6) | 10,455 (46.5) | 11,455 (51.0) | 13,225 (58.8) | 18,705 (83.2) | 20,915 (93.0) | 22,910 (101.9) | 26,455 (117.7) |
| | 11-1/4 (286) | 29,745 (132.3) | 30,415 (135.3) | 30,975 (137.8) | 31,880 (141.8) | 59,485 (264.6) | 60,830 (270.6) | 61,950 (275.6) | 63,755 (283.6) |
| | 15 (381) | 39,660 (176.4) | 40,555 (180.4) | 41,300 (183.7) | 42,505 (189.1) | 79,315 (352.8) | 81,105 (360.8) | 82,600 (367.4) | 85,010 (378.1) |
| | 25 (635) | 66,095 (294.0) | 67,590 (300.6) | 68,830 (306.2) | 70,840 (315.1) | 132,195 (588.0) | 135,175 (601.3) | 137,665 (612.4) | 141,680 (630.2) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 10-21 as necessary to the above values. Compare to the steel values in table 43. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength (factored resistance) by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45

## Table 40 — Hilti HIT-ICE adhesive factored resistance with concrete / bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 2-3/8 (60) | 1,120 (5.0) | 1,150 (5.1) | 1,170 (5.2) | 1,205 (5.4) | 1,120 (5.0) | 1,150 (5.1) | 1,170 (5.2) | 1,205 (5.4) |
| | 3-3/8 (86) | 1,595 (7.1) | 1,630 (7.3) | 1,660 (7.4) | 1,710 (7.6) | 3,190 (14.2) | 3,260 (14.5) | 3,320 (14.8) | 3,420 (15.2) |
| | 4-1/2 (114) | 2,125 (9.5) | 2,175 (9.7) | 2,215 (9.9) | 2,280 (10.1) | 4,255 (18.9) | 4,350 (19.3) | 4,430 (19.7) | 4,560 (20.3) |
| | 7-1/2 (191) | 3,545 (15.8) | 3,625 (16.1) | 3,690 (16.4) | 3,800 (16.9) | 7,090 (31.5) | 7,250 (32.2) | 7,380 (32.8) | 7,600 (33.8) |
| 1/2 | 2-3/4 (70) | 1,755 (7.8) | 1,795 (8.0) | 1,825 (8.1) | 1,880 (8.4) | 3,505 (15.6) | 3,585 (16.0) | 3,650 (16.2) | 3,760 (16.7) |
| | 4-1/2 (114) | 2,870 (12.8) | 2,935 (13.1) | 2,990 (13.3) | 3,075 (13.7) | 5,740 (25.5) | 5,870 (26.1) | 5,975 (26.6) | 6,150 (27.4) |
| | 6 (152) | 3,825 (17.0) | 3,910 (17.4) | 3,985 (17.7) | 4,100 (18.2) | 7,650 (34.0) | 7,825 (34.8) | 7,970 (35.4) | 8,200 (36.5) |
| | 10 (254) | 6,375 (28.4) | 6,520 (29.0) | 6,640 (29.5) | 6,835 (30.4) | 12,755 (56.7) | 13,040 (58.0) | 13,280 (59.1) | 13,670 (60.8) |
| 5/8 | 3-1/8 (79) | 1,790 (8.0) | 1,830 (8.1) | 1,865 (8.3) | 1,920 (8.5) | 3,580 (15.9) | 3,660 (16.3) | 3,730 (16.6) | 3,835 (17.1) |
| | 5-5/8 (143) | 3,220 (14.3) | 3,295 (14.7) | 3,355 (14.9) | 3,455 (15.4) | 6,445 (28.7) | 6,590 (29.3) | 6,710 (29.9) | 6,905 (30.7) |
| | 7-1/2 (191) | 4,295 (19.1) | 4,395 (19.5) | 4,475 (19.9) | 4,605 (20.5) | 8,595 (38.2) | 8,785 (39.1) | 8,950 (39.8) | 9,210 (41.0) |
| | 12-1/2 (318) | 7,160 (31.9) | 7,320 (32.6) | 7,455 (33.2) | 7,675 (34.1) | 14,320 (63.7) | 14,645 (65.1) | 14,915 (66.3) | 15,350 (68.3) |
| 3/4 | 3-1/2 (89) | 2,285 (10.2) | 2,340 (10.4) | 2,380 (10.6) | 2,450 (10.9) | 4,570 (20.3) | 4,675 (20.8) | 4,760 (21.2) | 4,900 (21.8) |
| | 6-3/4 (171) | 4,410 (19.6) | 4,510 (20.1) | 4,590 (20.4) | 4,725 (21.0) | 8,820 (39.2) | 9,015 (40.1) | 9,185 (40.8) | 9,450 (42.0) |
| | 9 (229) | 5,880 (26.1) | 6,010 (26.7) | 6,120 (27.2) | 6,300 (28.0) | 11,755 (52.3) | 12,025 (53.5) | 12,245 (54.5) | 12,600 (56.1) |
| | 15 (381) | 9,800 (43.6) | 10,020 (44.6) | 10,205 (45.4) | 10,500 (46.7) | 19,595 (87.2) | 20,040 (89.1) | 20,405 (90.8) | 21,000 (93.4) |
| 7/8 | 3-1/2 (89) | 2,065 (9.2) | 2,110 (9.4) | 2,150 (9.6) | 2,210 (9.8) | 4,130 (18.4) | 4,220 (18.8) | 4,300 (19.1) | 4,425 (19.7) |
| | 7-7/8 (200) | 4,645 (20.7) | 4,750 (21.1) | 4,835 (21.5) | 4,975 (22.1) | 9,290 (41.3) | 9,495 (42.2) | 9,670 (43.0) | 9,955 (44.3) |
| | 10-1/2 (267) | 6,190 (27.5) | 6,330 (28.2) | 6,450 (28.7) | 6,635 (29.5) | 12,385 (55.1) | 12,665 (56.3) | 12,895 (57.4) | 13,270 (59.0) |
| | 17-1/2 (445) | 10,320 (45.9) | 10,550 (46.9) | 10,745 (47.8) | 11,060 (49.2) | 20,640 (91.8) | 21,105 (93.9) | 21,495 (95.6) | 22,120 (98.4) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7-18 as necessary to the above values. Compare to the steel values in table 41. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C). Seismic applicaitons are not permitted. Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength (factored resistance) by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45
9 Tabular values are for static loads only. For seismic loads, multiply cracked concrete tabular values in tension and shear by the following reduction factors: Seismic applicaitons are not permitted.

## Table 41 — Steel factored resistance for Hilti HIT-V and HAS threaded rods

| Nominal anchor diameter in. | HAS-V / HAS-V HDG ASTM F1554 Gr. 36[3,5] | | HAS-E / HAS-E HDG ASTM F1554 Gr. 55[3,5] | | HAS-B and HAS-B HDG[3,5] ASTM A193 B7 and ASTM F 1554 Gr. 105 | | HAS-R Stainless Steel[4] ASTM F593 (3/8-in to 1-in) ASTM A193 (1-1/8-in to 1-1/4-in) | | HAS-R stainless steel ASTM F 593 - AISI 304/316 SS[4] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tensile[1] $N_{sar}$ lb (kN) | Shear[2] $V_{sar}$ lb (kN) | Tensile[1] $N_{sar}$ lb (kN) | Shear[2] $V_{sar}$ lb (kN) | Tensile[1] $N_{sar}$ lb (kN) | Shear[2] $V_{sar}$ lb (kN) | Tensile[1] $N_{sar}$ lb (kN) | Shear[2] $V_{sar}$ lb (kN) | Tensile[1] $N_{sar}$ lb (kN) | Shear[2] $V_{sar}$ lb (kN) |
| 3/8 | 3,055 (13.6) | 1,720 (7.7) | 3,955 (17.6) | 2,225 (9.9) | 6,590 (29.3) | 3,705 (16.5) | 4,610 (20.5) | 2,570 (11.4) | 4,610 (20.5) | 2,140 (9.5) |
| 1/2 | 5,595 (24.9) | 3,150 (14.0) | 7,240 (32.2) | 4,070 (18.1) | 12,065 (53.7) | 6,785 (30.2) | 8,445 (37.6) | 4,705 (20.9) | 8,445 (37.6) | 4,705 (20.9) |
| 5/8 | 8,915 (39.7) | 5,015 (22.3) | 11,525 (51.3) | 6,485 (28.8) | 19,210 (85.4) | 10,805 (48.1) | 13,445 (59.8) | 7,490 (33.3) | 13,445 (59.8) | 7,490 (33.3) |
| 3/4 | 13,190 (58.7) | 7,420 (33.0) | 17,060 (75.9) | 9,600 (42.7) | 28,435 (126.5) | 15,995 (71.1) | 16,920 (75.3) | 9,425 (41.9) | 16,915 (75.2) | 9,425 (41.9) |
| 7/8 | 18,210 (81.0) | 10,245 (45.6) | 23,550 (104.8) | 13,245 (58.9) | 39,245 (174.6) | 22,075 (98.2) | 23,350 (103.9) | 13,010 (57.9) | 23,350 (103.9) | 13,010 (57.9) |
| 1 | 23,890 (106.3) | 13,440 (59.8) | 30,890 (137.4) | 17,380 (77.3) | 51,485 (229.0) | 28,960 (128.8) | 30,635 (136.3) | 17,065 (75.9) | 30,635 (136.3) | 17,065 (75.9) |
| 1-1/4 | 38,225 (170.0) | 21,500 (95.6) | 49,425 (219.9) | 27,800 (123.7) | 82,375 (366.4) | 46,335 (206.1) | 37,565 (167.1) | 21,130 (94.0) | 49,010 (218.0) | 27,305 (121.5) |

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## Table 42 — Hilti HIT-ICE adhesive design information with CA rebar in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Rebar size | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 10M | 15M | 20M | 25M | 30M | A23.3-14 |
| Anchor O.D. | | $d_a$ | mm | 11.3 | 16.0 | 19.5 | 25.2 | 29.9 | |
| Effective minimum embedment[2] | | $h_{ef,min}$ | mm | 70 | 80 | 90 | 101 | 120 | |
| Effective maximum embedment[2] | | $h_{ef,max}$ | mm | 226 | 320 | 390 | 504 | 598 | |
| Minimum concrete thickness[2] | | $h_{min}$ | mm | $h_{ef}$ + 30 | $h_{ef}$ + $2d_o$ | | | | |
| Critical edge distance | | $c_{ac}$ | mm | $c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4<br>$\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$ | | | | | |
| Minimum edge distance[3] | | $c_{min}$ | mm | 57 | 80 | 98 | 126 | 150 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 57 | 80 | 98 | 126 | 150 | |
| Coeff. for factored concrete breakout resistance, uncracked concrete[4] | | $k_{c,uncr}$ | – | 10 | | | | | D.6.2.2 |
| Coeff. for factored concrete breakout resistance, cracked concrete[4] | | $k_{c,cr}$ | – | 7 | | | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_c$ | – | 0.65 | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | $R_{conc}$ | – | 1.00 | | | | | D.5.3(c) |
| Temp. range A[6] | Characteristic bond stress in cracked concrete[7] | $\tau_{cr}$ | psi (MPa) | n/a | n/a | n/a | n/a | n/a | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[7] | $\tau_{uncr}$ | psi (MPa) | 1,010 (7.0) | 990 (6.8) | 975 (6.7) | 950 (6.6) | 930 (6.4) | D.6.5.2 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | – | n/a | | | | | |
| Permissible installation conditions | Resistance modification factor tension & shear, bond failure dry concrete | Anchor category | – | 1 | 1 | 2 | 2 | 1 | D.5.3(c) |
| | | $R_{dry}$ | – | 1.00 | 1.00 | 0.85 | 0.85 | 1.00 | |
| | Resistance modification factor tension & shear, bond failure water-saturated concrete | Anchor category | – | 1 | 1 | 2 | 2 | 1 | D.5.3(c) |
| | | $R_{ws}$ | – | 1.00 | 1.00 | 0.85 | 0.85 | 1.00 | |

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See figure 5 of this section.

3 Minimum edge distance may be reduced to 45mm provided rebar remains untorqued.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

## Table 43 — CA rebar installation specifications with Hilti HIT-ICE adhesive anchor system[1]

| Setting information | | Symbol | Units | Rebar size | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 10M | 15M | 20M | 25M | 30M |
| Nominal bit diameter | | $d_o$ | in. | 9/16 | 3/4 | 1 | 1-1/4 | 1-3/8 |
| Effective embedment | minimum | $h_{ef,min}$ | mm | 60 | 80 | 90 | 100 | 120 |
| | maximum | $h_{ef,max}$ | mm | 226 | 320 | 390 | 504 | 598 |
| Minimum concrete thickness | | $h_{min}$ | mm | $h_{ef}$ + 30 | $h_{ef}$ + $2d_o$ | | | |

1 See figure 5 of this section.

## Table 44 — Hilti HIT-ICE adhesive factored resistance with concrete / bond failure for CA rebar in uncracked concrete [1,2,3,4,5,6,7,8]

| Rebar size | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 10M | 4-1/2 (115) | 4,220 (18.8) | 4,315 (19.2) | 4,395 (19.5) | 4,520 (20.1) | 8,435 (37.5) | 8,625 (38.4) | 8,785 (39.1) | 9,045 (40.2) |
| | 7-1/16 (180) | 6,605 (29.4) | 6,750 (30.0) | 6,875 (30.6) | 7,075 (31.5) | 13,205 (58.7) | 13,505 (60.1) | 13,750 (61.2) | 14,155 (63.0) |
| | 8-7/8 (226) | 8,290 (36.9) | 8,475 (37.7) | 8,635 (38.4) | 8,885 (39.5) | 16,580 (73.8) | 16,955 (75.4) | 17,265 (76.8) | 17,770 (79.0) |
| 15M | 5-11/16 (145) | 7,380 (32.8) | 7,550 (33.6) | 7,690 (34.2) | 7,910 (35.2) | 14,765 (65.7) | 15,100 (67.2) | 15,375 (68.4) | 15,825 (70.4) |
| | 9-13/16 (250) | 12,730 (56.6) | 13,015 (57.9) | 13,255 (59.0) | 13,640 (60.7) | 25,455 (113.2) | 26,030 (115.8) | 26,510 (117.9) | 27,285 (121.4) |
| | 12-5/8 (320) | 16,290 (72.5) | 16,660 (74.1) | 16,965 (75.5) | 17,460 (77.7) | 32,585 (144.9) | 33,320 (148.2) | 33,930 (150.9) | 34,920 (155.3) |
| 20M | 7-7/8 (200) | 10,390 (46.2) | 10,625 (47.3) | 10,820 (48.1) | 11,135 (49.5) | 20,775 (92.4) | 21,245 (94.5) | 21,635 (96.2) | 22,270 (99.1) |
| | 14 (355) | 18,440 (82.0) | 18,855 (83.9) | 19,200 (85.4) | 19,765 (87.9) | 36,880 (164.0) | 37,710 (167.7) | 38,405 (170.8) | 39,525 (175.8) |
| | 15-3/8 (390) | 20,255 (90.1) | 20,715 (92.1) | 21,095 (93.8) | 21,710 (96.6) | 40,515 (180.2) | 41,430 (184.3) | 42,190 (187.7) | 43,425 (193.2) |
| 25M | 9-1/16 (230) | 15,045 (66.9) | 15,380 (68.4) | 15,665 (69.7) | 16,125 (71.7) | 30,085 (133.8) | 30,765 (136.8) | 31,330 (139.4) | 32,245 (143.4) |
| | 15-15/16 (405) | 26,490 (117.8) | 27,085 (120.5) | 27,585 (122.7) | 28,390 (126.3) | 52,975 (235.7) | 54,175 (241.0) | 55,170 (245.4) | 56,780 (252.6) |
| | 19-13/16 (504) | 32,965 (146.6) | 33,705 (149.9) | 34,330 (152.7) | 35,330 (157.2) | 65,925 (293.3) | 67,415 (299.9) | 68,655 (305.4) | 70,660 (314.3) |
| 30M | 10-1/4 (260) | 23,235 (103.4) | 23,760 (105.7) | 24,200 (107.6) | 24,905 (110.8) | 46,475 (206.7) | 47,525 (211.4) | 48,400 (215.3) | 49,810 (221.6) |
| | 17-15/16 (455) | 40,665 (180.9) | 41,585 (185.0) | 42,350 (188.4) | 43,585 (193.9) | 81,330 (361.8) | 83,165 (369.9) | 84,695 (376.7) | 87,170 (387.7) |
| | 23-9/16 (598) | 53,445 (237.7) | 54,650 (243.1) | 55,660 (247.6) | 57,280 (254.8) | 106,890 (475.5) | 109,305 (486.2) | 111,315 (495.2) | 114,565 (509.6) |

1 See Section 3.1.8 for explanation on development of load values.

2 See Section 3.1.8 to convert design strength value to ASD value.

3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

4 Apply spacing, edge distance, and concrete thickness factors in tables 46-50 as necessary. Compare to the steel values in table 45. The lesser of the values is to be used for the design.

5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength (factored resistance) by 0.85.

7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.

8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.

## Table 45 — Steel factored resistance for CA rebar[1]

| Rebar size | CSA-G30.18 Grade 400 [2] | |
|---|---|---|
| | Tensile[3] $N_{sa}$ lb (kN) | Shear[4] $V_{sa}$ lb (kN) |
| 10M | 7,245 (32.2) | 4,035 (17.9) |
| 15M | 14,525 (64.6) | 8,090 (36.0) |
| 20M | 21,570 (95.9) | 12,020 (53.5) |
| 25M | 36,025 (160.2) | 20,070 (89.3) |
| 30M | 50,715 (225.6) | 28,255 (125.7) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 CSA-G30.18 Grade 400 rebar are considered ductile steel elements.
3 Tensile = $A_{se,N}\,\Phi_s\,f_{uta}$ R as noted in CSA A23.3 Annex D
4 Shear = $A_{se,V}\,\Phi_s$ 0.60 $f_{uta}$ R as noted in CSA A23.3 Annex D.

## Table 46 — Load adjustment factors for 10M rebar in uncracked concrete[1,2,3]

| 10M Rebar uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. (mm) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-9/16 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) | 4-1/2 (115) | 7-1/16 (180) | 8-7/8 (226) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | 0.26 | 0.16 | 0.13 | n/a | n/a | n/a | 0.10 | 0.06 | 0.05 | 0.19 | 0.12 | 0.10 | n/a | n/a | n/a |
| 2-3/16 | (55) | 0.58 | 0.55 | 0.54 | 0.28 | 0.18 | 0.14 | 0.54 | 0.53 | 0.53 | 0.13 | 0.08 | 0.07 | 0.26 | 0.17 | 0.13 | n/a | n/a | n/a |
| 3 | (76) | 0.61 | 0.57 | 0.56 | 0.34 | 0.21 | 0.17 | 0.56 | 0.54 | 0.54 | 0.22 | 0.14 | 0.11 | 0.34 | 0.21 | 0.17 | n/a | n/a | n/a |
| 4 | (102) | 0.65 | 0.59 | 0.57 | 0.42 | 0.26 | 0.20 | 0.58 | 0.56 | 0.55 | 0.33 | 0.21 | 0.17 | 0.42 | 0.26 | 0.20 | n/a | n/a | n/a |
| 5 | (127) | 0.68 | 0.62 | 0.59 | 0.51 | 0.32 | 0.25 | 0.60 | 0.57 | 0.56 | 0.47 | 0.30 | 0.24 | 0.51 | 0.32 | 0.25 | n/a | n/a | n/a |
| 5-11/16 | (145) | 0.71 | 0.63 | 0.61 | 0.58 | 0.36 | 0.28 | 0.61 | 0.58 | 0.57 | 0.57 | 0.36 | 0.29 | 0.58 | 0.36 | 0.28 | 0.68 | n/a | n/a |
| 6 | (152) | 0.72 | 0.64 | 0.61 | 0.61 | 0.38 | 0.30 | 0.62 | 0.59 | 0.58 | 0.61 | 0.39 | 0.31 | 0.61 | 0.38 | 0.30 | 0.69 | n/a | n/a |
| 7 | (178) | 0.76 | 0.66 | 0.63 | 0.71 | 0.44 | 0.35 | 0.64 | 0.60 | 0.59 | 0.77 | 0.49 | 0.39 | 0.71 | 0.44 | 0.35 | 0.75 | n/a | n/a |
| 8 | (203) | 0.79 | 0.69 | 0.65 | 0.81 | 0.51 | 0.40 | 0.66 | 0.62 | 0.60 | 0.94 | 0.60 | 0.48 | 0.81 | 0.51 | 0.40 | 0.80 | n/a | n/a |
| 8-1/4 | (210) | 0.80 | 0.69 | 0.65 | 0.84 | 0.52 | 0.41 | 0.67 | 0.62 | 0.61 | 0.99 | 0.63 | 0.50 | 0.84 | 0.52 | 0.41 | 0.81 | 0.70 | n/a |
| 9 | (229) | 0.83 | 0.71 | 0.67 | 0.92 | 0.57 | 0.45 | 0.68 | 0.63 | 0.61 | 1.00 | 0.72 | 0.57 | 0.92 | 0.57 | 0.45 | 0.85 | 0.73 | n/a |
| 10-1/16 | (256) | 0.87 | 0.74 | 0.69 | 1.00 | 0.64 | 0.50 | 0.70 | 0.65 | 0.63 | | 0.85 | 0.68 | 1.00 | 0.64 | 0.50 | 0.90 | 0.77 | 0.72 |
| 11 | (279) | 0.90 | 0.76 | 0.71 | | 0.69 | 0.55 | 0.72 | 0.66 | 0.64 | | 0.97 | 0.77 | | 0.69 | 0.55 | 0.94 | 0.81 | 0.75 |
| 12 | (305) | 0.94 | 0.78 | 0.72 | | 0.76 | 0.60 | 0.74 | 0.68 | 0.65 | | 1.00 | 0.88 | | 0.76 | 0.60 | 0.98 | 0.84 | 0.78 |
| 14 | (356) | 1.00 | 0.83 | 0.76 | | 0.88 | 0.70 | 0.78 | 0.71 | 0.68 | | | 1.00 | | 0.88 | 0.70 | 1.00 | 0.91 | 0.85 |
| 16 | (406) | | 0.88 | 0.80 | | 1.00 | 0.80 | 0.82 | 0.74 | 0.70 | | | | | 1.00 | 0.80 | | 0.98 | 0.90 |
| 18 | (457) | | 0.92 | 0.84 | | | 0.90 | 0.86 | 0.77 | 0.73 | | | | | | 0.90 | | 1.00 | 0.96 |
| 24 | (610) | | 1.00 | 0.95 | | | 1.00 | 0.98 | 0.86 | 0.81 | | | | | | 1.00 | | | 1.00 |
| 30 | (762) | | | 1.00 | | | | 1.00 | 0.95 | 0.88 | | | | | | | | | |
| 36 | (914) | | | | | | | | 1.00 | 0.96 | | | | | | | | | |
| > 48 | (1219) | | | | | | | | | 1.00 | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 47 — Load adjustment factors for 15M rebar in uncracked concrete[1,2,3]

| 15M Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | in. | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 | 5-11/16 | 9-13/16 | 12-5/8 |
| | | (mm) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) | (145) | (250) | (320) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.25 | 0.14 | 0.11 | n/a | n/a | n/a | 0.07 | 0.04 | 0.03 | 0.13 | 0.08 | 0.06 | n/a | n/a | n/a |
| | 3-1/8 | (80) | 0.59 | 0.55 | 0.54 | 0.33 | 0.18 | 0.14 | 0.55 | 0.53 | 0.53 | 0.16 | 0.09 | 0.07 | 0.32 | 0.18 | 0.14 | n/a | n/a | n/a |
| | 4 | (102) | 0.62 | 0.57 | 0.55 | 0.37 | 0.21 | 0.16 | 0.56 | 0.54 | 0.54 | 0.23 | 0.13 | 0.10 | 0.37 | 0.21 | 0.16 | n/a | n/a | n/a |
| | 5 | (127) | 0.65 | 0.58 | 0.57 | 0.43 | 0.24 | 0.19 | 0.58 | 0.55 | 0.55 | 0.32 | 0.18 | 0.14 | 0.43 | 0.24 | 0.19 | n/a | n/a | n/a |
| | 6 | (152) | 0.68 | 0.60 | 0.58 | 0.49 | 0.28 | 0.21 | 0.59 | 0.56 | 0.55 | 0.42 | 0.24 | 0.19 | 0.49 | 0.28 | 0.21 | n/a | n/a | n/a |
| | 7 | (178) | 0.70 | 0.62 | 0.59 | 0.57 | 0.32 | 0.25 | 0.61 | 0.58 | 0.56 | 0.52 | 0.30 | 0.24 | 0.57 | 0.32 | 0.25 | n/a | n/a | n/a |
| | 7-1/4 | (184) | 0.71 | 0.62 | 0.60 | 0.59 | 0.33 | 0.26 | 0.61 | 0.58 | 0.57 | 0.55 | 0.32 | 0.25 | 0.59 | 0.33 | 0.26 | 0.67 | n/a | n/a |
| | 8 | (203) | 0.73 | 0.64 | 0.61 | 0.65 | 0.37 | 0.28 | 0.62 | 0.59 | 0.57 | 0.64 | 0.37 | 0.29 | 0.65 | 0.37 | 0.28 | 0.70 | n/a | n/a |
| | 9 | (229) | 0.76 | 0.65 | 0.62 | 0.73 | 0.41 | 0.32 | 0.64 | 0.60 | 0.58 | 0.76 | 0.44 | 0.35 | 0.73 | 0.41 | 0.32 | 0.75 | n/a | n/a |
| | 10 | (254) | 0.79 | 0.67 | 0.63 | 0.81 | 0.46 | 0.35 | 0.65 | 0.61 | 0.59 | 0.90 | 0.52 | 0.41 | 0.81 | 0.46 | 0.35 | 0.79 | n/a | n/a |
| | 11-3/8 | (289) | 0.83 | 0.69 | 0.65 | 0.93 | 0.52 | 0.40 | 0.68 | 0.62 | 0.60 | 1.00 | 0.63 | 0.49 | 0.93 | 0.52 | 0.40 | 0.84 | 0.70 | n/a |
| | 12 | (305) | 0.85 | 0.70 | 0.66 | 0.98 | 0.55 | 0.42 | 0.69 | 0.63 | 0.61 | | 0.68 | 0.53 | 0.98 | 0.55 | 0.42 | 0.86 | 0.72 | n/a |
| | 14-1/8 | (359) | 0.91 | 0.74 | 0.69 | 1.00 | 0.65 | 0.50 | 0.72 | 0.65 | 0.63 | | 0.87 | 0.68 | 1.00 | 0.65 | 0.50 | 0.94 | 0.78 | 0.72 |
| | 16 | (406) | 0.97 | 0.77 | 0.71 | | 0.73 | 0.56 | 0.75 | 0.67 | 0.65 | | 1.00 | 0.82 | | 0.73 | 0.56 | 1.00 | 0.83 | 0.76 |
| | 18 | (457) | 1.00 | 0.80 | 0.74 | | 0.82 | 0.64 | 0.78 | 0.69 | 0.66 | | | 0.98 | | 0.82 | 0.64 | | 0.88 | 0.81 |
| | 20 | (508) | | 0.84 | 0.76 | | 0.91 | 0.71 | 0.81 | 0.72 | 0.68 | | | 1.00 | | 0.91 | 0.71 | | 0.93 | 0.85 |
| | 22 | (559) | | 0.87 | 0.79 | | 1.00 | 0.78 | 0.84 | 0.74 | 0.70 | | | | | 1.00 | 0.78 | | 0.97 | 0.90 |
| | 24 | (610) | | 0.91 | 0.82 | | | 0.85 | 0.87 | 0.76 | 0.72 | | | | | | 0.85 | | 1.00 | 0.94 |
| | 30 | (762) | | 1.00 | 0.90 | | | 1.00 | 0.96 | 0.82 | 0.77 | | | | | | 1.00 | | | 1.00 |
| | 36 | (914) | | | 0.98 | | | | 1.00 | 0.89 | 0.83 | | | | | | | | | |
| | > 48 | (1219) | | | 1.00 | | | | | 1.00 | 0.94 | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV} = 1.0$.

## Table 48 — Load adjustment factors for 20M rebar in uncracked concrete[1,2,3]

| 20M Rebar uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | | in. | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 | 7-7/8 | 14 | 15-3/8 |
| | | (mm) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) | (200) | (355) | (390) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.21 | 0.12 | 0.10 | n/a | n/a | n/a | 0.05 | 0.03 | 0.03 | 0.10 | 0.06 | 0.05 | n/a | n/a | n/a |
| | 3-7/8 | (98) | 0.58 | 0.55 | 0.54 | 0.29 | 0.16 | 0.14 | 0.55 | 0.53 | 0.53 | 0.16 | 0.09 | 0.08 | 0.29 | 0.16 | 0.14 | n/a | n/a | n/a |
| | 4 | (102) | 0.58 | 0.55 | 0.54 | 0.29 | 0.16 | 0.14 | 0.55 | 0.54 | 0.53 | 0.17 | 0.10 | 0.09 | 0.29 | 0.16 | 0.14 | n/a | n/a | n/a |
| | 5 | (127) | 0.61 | 0.56 | 0.55 | 0.33 | 0.18 | 0.16 | 0.56 | 0.54 | 0.54 | 0.24 | 0.14 | 0.12 | 0.33 | 0.18 | 0.16 | n/a | n/a | n/a |
| | 6 | (152) | 0.63 | 0.57 | 0.57 | 0.38 | 0.20 | 0.19 | 0.58 | 0.55 | 0.55 | 0.32 | 0.18 | 0.16 | 0.38 | 0.20 | 0.19 | n/a | n/a | n/a |
| | 7 | (178) | 0.65 | 0.58 | 0.58 | 0.42 | 0.23 | 0.21 | 0.59 | 0.56 | 0.56 | 0.40 | 0.22 | 0.20 | 0.42 | 0.23 | 0.21 | n/a | n/a | n/a |
| | 8 | (203) | 0.67 | 0.60 | 0.59 | 0.47 | 0.26 | 0.23 | 0.60 | 0.57 | 0.57 | 0.49 | 0.27 | 0.25 | 0.47 | 0.26 | 0.23 | n/a | n/a | n/a |
| | 9 | (229) | 0.69 | 0.61 | 0.60 | 0.53 | 0.29 | 0.26 | 0.62 | 0.58 | 0.57 | 0.58 | 0.33 | 0.30 | 0.53 | 0.29 | 0.26 | n/a | n/a | n/a |
| | 10 | (254) | 0.71 | 0.62 | 0.61 | 0.59 | 0.32 | 0.29 | 0.63 | 0.59 | 0.58 | 0.68 | 0.38 | 0.35 | 0.59 | 0.32 | 0.29 | 0.72 | n/a | n/a |
| | 11 | (279) | 0.73 | 0.63 | 0.62 | 0.65 | 0.35 | 0.32 | 0.64 | 0.60 | 0.59 | 0.78 | 0.44 | 0.40 | 0.65 | 0.35 | 0.32 | 0.75 | n/a | n/a |
| | 12 | (305) | 0.75 | 0.64 | 0.63 | 0.71 | 0.39 | 0.35 | 0.65 | 0.61 | 0.60 | 0.89 | 0.50 | 0.46 | 0.71 | 0.39 | 0.35 | 0.79 | n/a | n/a |
| | 14 | (356) | 0.80 | 0.67 | 0.65 | 0.83 | 0.45 | 0.41 | 0.68 | 0.62 | 0.62 | 1.00 | 0.63 | 0.58 | 0.83 | 0.45 | 0.41 | 0.85 | n/a | n/a |
| | 16 | (406) | 0.84 | 0.69 | 0.67 | 0.95 | 0.52 | 0.47 | 0.71 | 0.64 | 0.63 | | 0.77 | 0.70 | 0.95 | 0.52 | 0.47 | 0.91 | 0.75 | n/a |
| | 18 | (457) | 0.88 | 0.71 | 0.70 | 1.00 | 0.58 | 0.53 | 0.73 | 0.66 | 0.65 | | 0.92 | 0.84 | 1.00 | 0.58 | 0.53 | 0.96 | 0.80 | 0.77 |
| | 20 | (508) | 0.92 | 0.74 | 0.72 | | 0.64 | 0.58 | 0.76 | 0.68 | 0.66 | | 1.00 | 0.98 | | 0.64 | 0.58 | 1.00 | 0.84 | 0.81 |
| | 22 | (559) | 0.97 | 0.76 | 0.74 | | 0.71 | 0.64 | 0.78 | 0.69 | 0.68 | | | 1.00 | | 0.71 | 0.64 | | 0.88 | 0.85 |
| | 24 | (610) | 1.00 | 0.79 | 0.76 | | 0.77 | 0.70 | 0.81 | 0.71 | 0.70 | | | | | 0.77 | 0.70 | | 0.92 | 0.89 |
| | 26 | (660) | | 0.81 | 0.78 | | 0.84 | 0.76 | 0.83 | 0.73 | 0.71 | | | | | 0.84 | 0.76 | | 0.96 | 0.93 |
| | 28 | (711) | | 0.83 | 0.80 | | 0.90 | 0.82 | 0.86 | 0.75 | 0.73 | | | | | 0.90 | 0.82 | | 0.99 | 0.96 |
| | 30 | (762) | | 0.86 | 0.83 | | 0.97 | 0.88 | 0.89 | 0.76 | 0.75 | | | | | 0.97 | 0.88 | | 1.00 | 0.99 |
| | 36 | (914) | | 0.93 | 0.89 | | 1.00 | 1.00 | 0.96 | 0.82 | 0.80 | | | | | 1.00 | 1.00 | | | 1.00 |
| | > 48 | (1219) | | 1.00 | 1.00 | | | | 1.00 | 0.92 | 0.90 | | | | | | | | | |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV} = 1.0$.

## Table 49 — Load adjustment factors for 25M rebar in uncracked concrete[1,2,3]

| 25M Rebar uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | 9-1/16 | 15-15/16 | 19-13/16 | 9-1/16 | 15-15/16 | 19-13/16 | 9-1/16 | 15-15/16 | 19-13/16 | 9-1/16 | 15-15/16 | 19-13/16 | 9-1/16 | 15-15/16 | 19-13/16 | 9-1/16 | 15-15/16 | 19-13/16 |
| | (mm) | (230) | (405) | (504) | (230) | (405) | (504) | (230) | (405) | (504) | (230) | (405) | (504) | (230) | (405) | (504) | (230) | (405) | (504) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | 0.22 | 0.12 | 0.10 | n/a | n/a | n/a | 0.03 | 0.02 | 0.02 | 0.07 | 0.04 | 0.03 | n/a | n/a | n/a |
| 5 | (127) | 0.59 | 0.55 | 0.54 | 0.33 | 0.18 | 0.14 | 0.55 | 0.53 | 0.53 | 0.17 | 0.09 | 0.08 | 0.33 | 0.18 | 0.14 | n/a | n/a | n/a |
| 6 | (152) | 0.61 | 0.56 | 0.55 | 0.36 | 0.20 | 0.16 | 0.56 | 0.54 | 0.54 | 0.22 | 0.12 | 0.10 | 0.36 | 0.20 | 0.16 | n/a | n/a | n/a |
| 7 | (178) | 0.63 | 0.57 | 0.56 | 0.40 | 0.22 | 0.17 | 0.57 | 0.55 | 0.54 | 0.27 | 0.16 | 0.13 | 0.40 | 0.22 | 0.17 | n/a | n/a | n/a |
| 8 | (203) | 0.65 | 0.58 | 0.57 | 0.44 | 0.24 | 0.19 | 0.58 | 0.56 | 0.55 | 0.34 | 0.19 | 0.15 | 0.44 | 0.24 | 0.19 | n/a | n/a | n/a |
| 9 | (229) | 0.67 | 0.59 | 0.58 | 0.48 | 0.26 | 0.21 | 0.59 | 0.56 | 0.55 | 0.40 | 0.23 | 0.18 | 0.48 | 0.26 | 0.21 | n/a | n/a | n/a |
| 10 | (254) | 0.68 | 0.60 | 0.58 | 0.52 | 0.29 | 0.23 | 0.60 | 0.57 | 0.56 | 0.47 | 0.27 | 0.21 | 0.52 | 0.29 | 0.23 | n/a | n/a | n/a |
| 11-9/16 | (294) | 0.71 | 0.62 | 0.60 | 0.61 | 0.33 | 0.26 | 0.62 | 0.58 | 0.57 | 0.58 | 0.33 | 0.27 | 0.61 | 0.33 | 0.26 | 0.68 | n/a | n/a |
| 12 | (305) | 0.72 | 0.63 | 0.60 | 0.63 | 0.34 | 0.27 | 0.62 | 0.58 | 0.57 | 0.62 | 0.35 | 0.28 | 0.63 | 0.34 | 0.27 | 0.69 | n/a | n/a |
| 14 | (356) | 0.76 | 0.65 | 0.62 | 0.73 | 0.40 | 0.32 | 0.64 | 0.60 | 0.58 | 0.78 | 0.44 | 0.35 | 0.73 | 0.40 | 0.32 | 0.75 | n/a | n/a |
| 16 | (406) | 0.79 | 0.67 | 0.63 | 0.84 | 0.46 | 0.37 | 0.66 | 0.61 | 0.60 | 0.95 | 0.54 | 0.43 | 0.84 | 0.46 | 0.37 | 0.80 | n/a | n/a |
| 18 | (457) | 0.83 | 0.69 | 0.65 | 0.94 | 0.52 | 0.41 | 0.68 | 0.62 | 0.61 | 1.00 | 0.64 | 0.52 | 0.94 | 0.52 | 0.41 | 0.85 | n/a | n/a |
| 18-7/16 | (469) | 0.84 | 0.69 | 0.66 | 0.97 | 0.53 | 0.42 | 0.69 | 0.63 | 0.61 | | 0.67 | 0.54 | 0.97 | 0.53 | 0.42 | 0.86 | 0.71 | n/a |
| 20 | (508) | 0.87 | 0.71 | 0.67 | 1.00 | 0.57 | 0.46 | 0.70 | 0.64 | 0.62 | | 0.75 | 0.60 | 1.00 | 0.57 | 0.46 | 0.90 | 0.74 | n/a |
| 22-3/8 | (568) | 0.91 | 0.73 | 0.69 | | 0.64 | 0.51 | 0.72 | 0.65 | 0.63 | | 0.89 | 0.72 | | 0.64 | 0.51 | 0.95 | 0.79 | 0.73 |
| 24 | (610) | 0.94 | 0.75 | 0.70 | | 0.69 | 0.55 | 0.74 | 0.67 | 0.64 | | 0.99 | 0.80 | | 0.69 | 0.55 | 0.98 | 0.81 | 0.76 |
| 26 | (660) | 0.98 | 0.77 | 0.72 | | 0.75 | 0.59 | 0.76 | 0.68 | 0.65 | | 1.00 | 0.90 | | 0.75 | 0.59 | 1.00 | 0.85 | 0.79 |
| 28 | (711) | 1.00 | 0.79 | 0.74 | | 0.80 | 0.64 | 0.78 | 0.69 | 0.67 | | | 1.00 | | 0.80 | 0.64 | | 0.88 | 0.82 |
| 30 | (762) | | 0.81 | 0.75 | | 0.86 | 0.68 | 0.80 | 0.71 | 0.68 | | | | | 0.86 | 0.68 | | 0.91 | 0.85 |
| 36 | (914) | | 0.88 | 0.80 | | 1.00 | 0.82 | 0.86 | 0.75 | 0.71 | | | | | 1.00 | 0.82 | | 1.00 | 0.93 |
| > 48 | (1219) | | 1.00 | 0.90 | | | 1.00 | 0.98 | 0.83 | 0.79 | | | | | | 1.00 | | | 1.00 |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$ is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 50 — Load adjustment factors for 30M rebar in uncracked concrete[1,2,3]

| 30M Rebar uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear: ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear: ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ | in. | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 10-1/4 | 17-15/16 | 23-9/16 | 23-9/16 |
| | (mm) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (260) | (455) | (598) | (598) |
| Spacing (s) / Edge distance ($c_a$) / Concrete thickness (h), - in. (mm) | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | (44) | n/a | n/a | n/a | 0.23 | 0.13 | 0.09 | n/a | n/a | n/a | 0.02 | 0.01 | 0.01 | 0.04 | 0.03 | 0.02 | n/a | n/a | n/a |
| 5-7/8 | (150) | 0.60 | 0.55 | 0.54 | 0.35 | 0.19 | 0.14 | 0.54 | 0.53 | 0.53 | 0.14 | 0.08 | 0.06 | 0.28 | 0.16 | 0.12 | n/a | n/a | n/a |
| 6 | (152) | 0.60 | 0.56 | 0.54 | 0.35 | 0.19 | 0.14 | 0.55 | 0.53 | 0.53 | 0.14 | 0.08 | 0.06 | 0.28 | 0.16 | 0.12 | n/a | n/a | n/a |
| 7 | (178) | 0.61 | 0.57 | 0.55 | 0.38 | 0.21 | 0.16 | 0.55 | 0.54 | 0.53 | 0.18 | 0.10 | 0.08 | 0.36 | 0.20 | 0.15 | n/a | n/a | n/a |
| 8 | (203) | 0.63 | 0.57 | 0.56 | 0.41 | 0.23 | 0.17 | 0.56 | 0.54 | 0.53 | 0.22 | 0.12 | 0.09 | 0.41 | 0.23 | 0.17 | n/a | n/a | n/a |
| 9 | (229) | 0.65 | 0.58 | 0.56 | 0.45 | 0.25 | 0.18 | 0.57 | 0.55 | 0.54 | 0.26 | 0.15 | 0.11 | 0.45 | 0.25 | 0.18 | n/a | n/a | n/a |
| 10 | (254) | 0.66 | 0.59 | 0.57 | 0.48 | 0.27 | 0.20 | 0.58 | 0.55 | 0.54 | 0.30 | 0.17 | 0.13 | 0.48 | 0.27 | 0.20 | n/a | n/a | n/a |
| 11 | (279) | 0.68 | 0.60 | 0.58 | 0.52 | 0.29 | 0.21 | 0.58 | 0.56 | 0.55 | 0.35 | 0.20 | 0.15 | 0.52 | 0.29 | 0.21 | n/a | n/a | n/a |
| 12 | (305) | 0.70 | 0.61 | 0.58 | 0.56 | 0.31 | 0.23 | 0.59 | 0.56 | 0.55 | 0.40 | 0.23 | 0.17 | 0.56 | 0.31 | 0.23 | n/a | n/a | n/a |
| 13-1/4 | (337) | 0.72 | 0.62 | 0.59 | 0.62 | 0.34 | 0.26 | 0.60 | 0.57 | 0.56 | 0.46 | 0.26 | 0.20 | 0.62 | 0.34 | 0.26 | 0.63 | n/a | n/a |
| 14 | (356) | 0.73 | 0.63 | 0.60 | 0.66 | 0.36 | 0.27 | 0.61 | 0.57 | 0.56 | 0.50 | 0.29 | 0.22 | 0.66 | 0.36 | 0.27 | 0.65 | n/a | n/a |
| 16 | (406) | 0.76 | 0.65 | 0.61 | 0.75 | 0.41 | 0.31 | 0.62 | 0.58 | 0.57 | 0.61 | 0.35 | 0.27 | 0.75 | 0.41 | 0.31 | 0.69 | n/a | n/a |
| 18 | (457) | 0.79 | 0.67 | 0.63 | 0.85 | 0.46 | 0.35 | 0.64 | 0.59 | 0.58 | 0.73 | 0.42 | 0.32 | 0.85 | 0.46 | 0.35 | 0.74 | n/a | n/a |
| 20 | (508) | 0.83 | 0.69 | 0.64 | 0.94 | 0.52 | 0.39 | 0.65 | 0.60 | 0.59 | 0.86 | 0.49 | 0.37 | 0.94 | 0.52 | 0.39 | 0.78 | n/a | n/a |
| 20-7/8 | (531) | 0.84 | 0.69 | 0.65 | 0.98 | 0.54 | 0.41 | 0.66 | 0.61 | 0.59 | 0.92 | 0.52 | 0.40 | 0.98 | 0.54 | 0.41 | 0.79 | n/a | n/a |
| 22 | (559) | 0.86 | 0.70 | 0.66 | 1.00 | 0.57 | 0.43 | 0.67 | 0.61 | 0.60 | 0.99 | 0.57 | 0.43 | 1.00 | 0.57 | 0.43 | 0.81 | 0.68 | n/a |
| 24 | (610) | 0.89 | 0.72 | 0.67 | | 0.62 | 0.47 | 0.68 | 0.62 | 0.60 | 1.00 | 0.64 | 0.49 | | 0.62 | 0.47 | 0.85 | 0.71 | n/a |
| 26-9/16 | (675) | 0.93 | 0.75 | 0.69 | | 0.69 | 0.52 | 0.70 | 0.64 | 0.61 | | 0.75 | 0.57 | | 0.69 | 0.52 | 0.89 | 0.74 | 0.68 |
| 28 | (711) | 0.96 | 0.76 | 0.70 | | 0.72 | 0.54 | 0.71 | 0.65 | 0.62 | | 0.81 | 0.62 | | 0.72 | 0.54 | 0.92 | 0.76 | 0.70 |
| 30 | (762) | 0.99 | 0.78 | 0.71 | | 0.77 | 0.58 | 0.73 | 0.66 | 0.63 | | 0.90 | 0.69 | | 0.77 | 0.58 | 0.95 | 0.79 | 0.72 |
| 36 | (914) | 1.00 | 0.83 | 0.75 | | 0.93 | 0.70 | 0.77 | 0.69 | 0.66 | | 1.00 | 0.90 | | 0.93 | 0.70 | 1.00 | 0.86 | 0.79 |
| > 48 | (1219) | | 0.95 | 0.84 | | 1.00 | 0.93 | 0.86 | 0.75 | 0.71 | | | 1.00 | | 1.00 | 0.93 | | 1.00 | 0.91 |

1 Linear interpolation not permitted
2 Shaded area with reduced edge distance is permitted provided the installation torque is reduced to 0.30 $T_{max}$ for 5d ≤ s ≤ 16-in. and to 0.5 $T_{max}$ for s > 16-in.
3 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
4 Spacing factor reduction in shear applicable when c < 3*$h_{ef}$. $f_{AV}$ is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
5 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance, c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 51 — Hilti HIT-ICE design information with Hilti HIS-N and HIS-RN internally threaded inserts in hammer drilled holes in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Nominal bolt/cap screw diameter (in.) | | | | Ref |
|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | A23.3-14 |
| HIS insert outside diameter | | D | mm | 16.5 | 20.5 | 25.4 | 27.6 | |
| Effective embedment[2] | | $h_{ef}$ | mm | 110 | 125 | 170 | 205 | |
| Minimum concrete thickness[2] | | $h_{min}$ | mm | 150 | 170 | 230 | 270 | |
| Critical edge distance | | $c_{min}$ | mm | $c_{ac} = h_{ef} * \left(\frac{\tau_{k,uncr}}{8}\right)^{0.4} * \left[3.1 - 0.7 * \frac{h}{h_{ef}}\right]; \left(\frac{h}{h_{ef}}\right)$ need not be larger than 2.4<br>$\tau_{k,uncr}$ need not be taken as greater than: $\tau_{k,uncr} = \frac{k_{uncr}\sqrt{h_{ef} * f'_c}}{\pi * d_a}$ | | | | |
| Minimum edge distance | | $s_{min}$ | mm | 83 | 102 | 127 | 140 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 83 | 102 | 127 | 140 | |
| Coeff. for factored concrete breakout resistance, uncracked concrete[3] | | $k_{c,uncr}$ | – | 10 | | | | D.6.2.2 |
| Coeff. for factored concrete breakout resistance, cracked concrete[3] | | $k_{c,cr}$ | – | 7 | | | | D.6.2.2 |
| Concrete material resistance factor | | $\phi_c$ | – | 0.65 | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[4] | | $R_{conc}$ | – | 1.00 | | | | D.5.3(c) |
| Temp. range A[5] | Characteristic bond stress in cracked concrete[6] | $\tau_{cr}$ | psi (MPa) | 350 (2.4) | 30 (0.2) | n/a | n/a | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete[6] | $\tau_{uncr}$ | psi (MPa) | 830 (5.7) | 855 (5.9) | 840 (5.8) | 830 (5.7) | D.6.5.2 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | – | n/a | | | | |
| Permissible installation conditions | Resistance modification factor tension & shear, bond failure dry concrete | Anchor category | – | 2 | 1 | 1 | 1 | D.5.3(c) |
| | | $R_{dry}$ | – | 0.85 | 1.00 | 1.00 | 1.00 | |
| | Resistance modification factor tension & shear, bond failure water-saturated concrete | Anchor category | – | 2 | 1 | 1 | 1 | D.5.3(c) |
| | | $R_{ws}$ | – | 0.85 | 1.00 | 1.00 | 1.00 | |

1 Design information in this table is based on testing in accordance with ACI 355.4.

2 See figure 7 of this section.

3 Minimum edge distance may be reduced to 44mm < $c_{min}$ < 5d provided $T_{inst}$ is reduced.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3. For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.

6 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

7 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.1}$ [for SI: $(f'_c / 17.2)^{0.1}$].

## Table 52 — Hilti HIT-ICE adhesive factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete[1,2,3,4,5,6,7,8]

| Thread size | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8-16 UNC | 4-3/8 (110) | 4,120 (18.3) | 4,210 (18.7) | 4,290 (19.1) | 4,415 (19.6) | 8,235 (36.6) | 8,420 (37.5) | 8,575 (38.2) | 8,825 (39.3) |
| 1/2-13 UNC | 5 (125) | 7,065 (31.4) | 7,225 (32.1) | 7,360 (32.7) | 7,575 (33.7) | 14,135 (62.9) | 14,455 (64.3) | 14,720 (65.5) | 15,150 (67.4) |
| 5/8-11 UNC | 6-3/4 (170) | 11,660 (51.9) | 11,920 (53.0) | 12,140 (54.0) | 12,495 (55.6) | 23,315 (103.7) | 23,840 (106.1) | 24,280 (108.0) | 24,990 (111.2) |
| 3/4-10 UNC | 8-1/8 (205) | 15,140 (67.3) | 15,485 (68.9) | 15,765 (70.1) | 16,230 (72.2) | 30,280 (134.7) | 30,965 (137.7) | 31,535 (140.3) | 32,455 (144.4) |

## Table 53 — Hilti HIT-ICE adhesive factored resistance with concrete / bond failure for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete[1,2,3,4,5,6,7,8,9]

| Thread size | Effective embedment in. (mm) | Tension $N_r$ | | | | Shear $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8-16 UNC | 4-3/8 (110) | 1,735 (7.7) | 1,775 (7.9) | 1,810 (8.0) | 1,860 (8.3) | 3,475 (15.4) | 3,550 (15.8) | 3,615 (16.1) | 3,720 (16.6) |
| 1/2-13 UNC | 5 (125) | 2,480 (11.0) | 2,535 (11.3) | 2,580 (11.5) | 2,660 (11.8) | 4,960 (22.1) | 5,070 (22.6) | 5,165 (23.0) | 5,315 (23.6) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 36-37 as necessary. Compare to the steel values in table 54. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry concrete conditions. For water saturated concrete multiply design strength value by 0.85.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $l_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for static loads only. Seismic applications are not permitted.

## Table 54 — Steel factored resistance for steel bolt / cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

| Thread size | ASTM A193 B7 | | ASTM A193 Grade B8M stainless steel | |
|---|---|---|---|---|
| | Tensile[4] $N_{sar}$ lb (kN) | Shear[5] $V_{sar}$ lb (kN) | Tensile[4] $N_{sar}$ lb (kN) | Shear[5] $V_{sar}$ lb (kN) |
| 3/8-16 UNC | 5,765 (25.6) | 3,215 (14.3) | 5,070 (22.6) | 2,825 (12.6) |
| 1/2-13 UNC | 9,635 (42.9) | 5,880 (26.2) | 9,290 (41.3) | 5,175 (23.0) |
| 5/8-11 UNC | 16,020 (71.3) | 9,365 (41.7) | 14,790 (65.8) | 8,240 (36.7) |
| 3/4-10 UNC | 16,280 (72.4) | 13,860 (61.7) | 21,895 (97.4) | 12,195 (54.2) |

1 See section 3.1.8 to convert design strength value to ASD value.
2 Hilti HIS-N and HIS-RN inserts with steel bolts are considered brittle steel elements.
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.
4 Tensile = $A_{se,N}$ $\Phi_s$ $f_{uta}$ R as noted in CSA A23.3 Annex D
5 Shear = $A_{se,V}$ $\Phi_s$ 0.60 $f_{uta}$ R as noted in CSA A23.3 Annex D. For 3/8-in diameter insert, shear = $A_{se,V}$ $\Phi_s$ 0.50 $f_{uta}$ R.

**Figure 8 — HIT-ICE installation conditions for masonry construction**

| Permissible masonry conditions | | Permissible drilling method | |
|---|---|---|---|
| |  Grout-filed concrete masonry | |  Hammer drilling with carbide tip |

**Table 55 — Hilti HIT-ICE allowable loads for threaded rods in grout-filled concrete masonry units[1, 2, 3, 4]**

| Nominal anchor diameter in. | Effective embedment in. (mm) | Distance from edge | | Tension[5,6] | | Shear lb (kN)[5,6] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HAS-E ISO 898 Class 5.5 | | HAS-E B7 ASTM A193 Grade B7 | | HAS-R AISI 304 / 316 | |
| | | in. | (mm) | lb | (kN) | | | | | | |
| 3/8 | 3-1/2 (89) | 4 | (102) | 1,550 | (6.9) | 1360 | (6.0) | 2020 | (9.0) | 1875 | (8.3) |
| | | ≥12 | (305) | | | | | | | | |
| 1/2 | 4-1/4 (108) | 4 | (102) | 1,785 | (7.9) | 2,020 | (9.0) | 2,020 | (9.0) | 2,020 | (9.0) |
| | | ≥12 | (305) | | | 2,420 | (10.8) | 4,170 | (18.5) | 3,335 | (14.8) |
| 5/8 | 5 (127) | 4 | (102) | 2,265 | (10.1) | 2,020 | (9.0) | 2,020 | (9.0) | 2,020 | (9.0) |
| | | ≥12 | (305) | | | 3,780 | (16.8) | 5,625 | (25.0) | 5,215 | (23.2) |
| 3/4 | 6-5/8 (168) | 4 | (102) | 3,740 | (16.6) | 2,020 | (9.0) | 2,020 | (9.0) | 2,020 | (9.0) |
| | | ≥12 | (305) | | | 5,445 | (24.2) | 5,625 | (25.0) | 5,625 | (25.0) |

**Table 56 — Hilti HIT-ICE ultimate loads for threaded rods in grout-filled concrete masonry units[1, 2, 3, 4]**

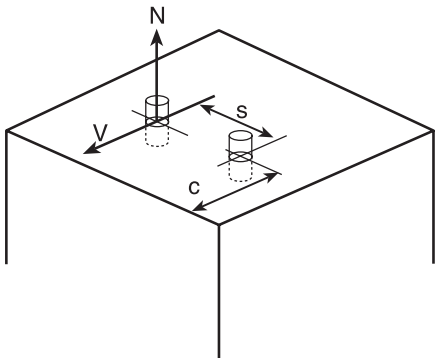
| Nominal anchor diameter in. | Effective embedment in. (mm) | Distance from edge | | Tension lb (kN)[5,6] | | Shear lb (kN)[5,6] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HAS-E ISO 898 Class 5.5 | | HAS-E B7 ASTM A193 Grade B7 | | HAS-R AISI 304 / 316 | |
| | | in. | (mm) | lb | (kN) | | | | | | |
| 3/8 | 3-1/2 (90) | 4 | (102) | 6,005 | (26.7) | 3,605 | (16.0) | 6,210 | (27.6) | 4,970 | (22.1) |
| | | ≥12 | (305) | | | | | | | | |
| 1/2 | 4-1/4 (108) | 4 | (102) | 7,140 | (31.8) | 6,405 | (28.5) | 8,075 | (35.9) | 8,075 | (35.9) |
| | | ≥12 | (305) | | | | | 11,040 | (49.1) | 8,835 | (39.3) |
| 5/8 | 5 (127) | 4 | (102) | 9,060 | (40.3) | 8,075 | (35.9) | 8,075 | (35.9) | 8,075 | (35.9) |
| | | ≥12 | (305) | | | 10,010 | (44.2) | 17,260 | (76.8) | 13,805 | (61.4) |
| 3/4 | 6-5/8 (168) | 4 | (102) | 14,970 | (66.6) | 8,075 | (35.9) | 8,075 | (35.9) | 8,075 | (35.9) |
| | | ≥12 | (305) | | | 14,415 | (64.1) | 22,500 | (100.1) | 16,800 | (75.2) |

1 Values are for lightweight, medium-weight or normal-weight concrete masonry units conforming to ASTM C90 with 2,000 psi grout conforming to ASTM C476.
2 Embedment depth is measured from the outside face of the concrete masonry unit.
3 Values are for anchors located in the grouted cell, head joint, bed joint, T-joint, cross web or any combination of the above.
4 Values for edge distances between 4 inches and 12 inches can be calculated by linear interpolation.
5 Loads are based on the lesser of bond strength, steel strength or base material strength.
6 Steel values in accordance with AISC

**Allowable load values**
Tension = $0.33 \times F_u \times A_{nom}$
Shear = $0.17 \times F_u \times A_{nom}$

**Ultimate load values**
Tension = $0.75 \times F_u \times A_{nom}$
Shear = $0.45 \times F_u \times A_{nom}$

**Figure 9 — Anchor spacing and edge distance**




**Edge distance for shear and tension:**
**Grout-filled, normal-weight and lightweight block**

$c_{cr}$ = 12 in. minimum from free edge

$c_{min}$ = 4 in. minimum from free edge

**Anchor spacing for shear and tension:**
**Grout-filled, normal-weight and lightweight block**

$s_{cr}$ = $s_{min}$ = maximum (1) anchor per cell and minimum 8 inches center-to-center spacing between anchors

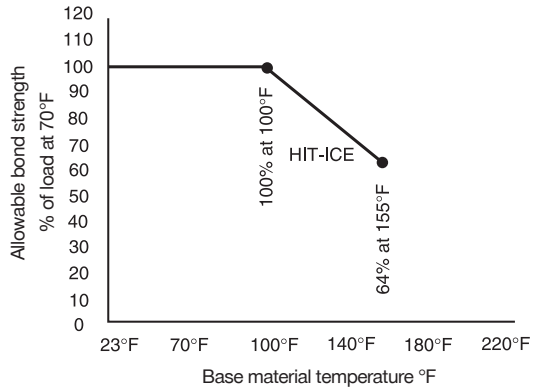


**Table 57 — Allowable loads for anchorage to the top of grout-filled block walls with Hilti HIT-ICE[1,2,3,4]**

| Nominal anchor diameter in. | Effective embedment in. (mm) | Edge distance | | Tension | | Shear lb (kN) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | in. | (mm) | lb | (kN) | Load II to edge | | Load ⊥ to edge | |
| 1/2 | 4-1/4 (108) | 1-3/4 | (45) | 1,120 | (5.0) | 1,425 | (6.3) | 560 | (2.5) |
| | | 2-3/4 | (70) | 1,440 | (6.4) | 2,085 | (9.3) | 1,110 | (4.9) |
| 5/8 | 5 (127) | 1-3/4 | (45) | 1,475 | (6.5) | 1,800 | (8.0) | 680 | (3.0) |
| | | 2-3/4 | (70) | 1,630 | (7.2) | 3,070 | (13.7) | 1,110 | (4.9) |

1 Allowable loads calculated using a factor of safety of 4.
2 Allowable loads are based on masonry capacity. The steel strength must be checked.
3 Minimum edge distance is 1-3/4 inches.
4 Minimum masonry prism strength is 1,500 psi.

**Figure 10 — Influence of temperature on masonry bond strength[1,2]**




1 Test procedure involves the concrete being held at the elevated temperature for 24 hours them removing it from the controlled environment and testing to failure.

2 Long term creep test in accordance with ICC-ES Acceptance Criteria AC58.

**Table 58 -Gel time[1,2]**

| Base material temperature | | HIT-ICE |
|---|---|---|
| °F | °C | |
| –10 | –23 | 1.5 h |
| 0 | –18 | 1.5 h |
| 20 | –7 | 1 h |
| 40 | 4 | 15 |
| 60 | 16 | 5 min |
| 70 | 21 | 2.5 min |
| 90 | 32 | 1 min |

**Table 59 - Full cure time[1,2]**

| Base material temperature | | HIT-ICE |
|---|---|---|
| °F | °C | |
| –10 | –23 | 36 h |
| 0 | –18 | 24 h |
| 20 | –7 | 6 h |
| 40 | 4 | 1.5 h |
| 60 | 16 | 1 h |
| 70 | 21 | 45 min |
| 90 | 32 | 35 min |

1 Product temperatures must be maintained above 0°F (–18°C) prior to installation.

2 Gel times and full cure times are approximate.

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com (US), or www.hilti.ca (Canada). Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## ORDERING INFORMATION

| Description | Contents |
|---|---|
| HIT-ICE Cartridge 10 oz (297 ml) | 24 Cartridges, 24 Mixers |



HIT-ICE Cartridge

| Description | Notes | Qty/Pkg |
|---|---|---|
| MD 1000 Dispenser | For use with HIT-ICE cartridges | 1 |



MD 1000 Dispenser

| Description | Notes | Qty/Pkg |
|---|---|---|
| HIT-M2 Mixer for HIT-ICE only | For use with HIT-ICE cartridges | 1 |



HIT-ICE Mixer



HIT Filler Tube

For ordering information on anchor rods and inserts, dispensers, hole cleaning equipment and other accessories, see section 3.2.9.

HIT-ICE Mixer



HIT-ICE Cartridge



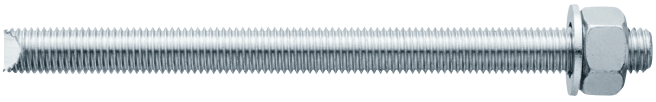
HIT-ICE Dispenser

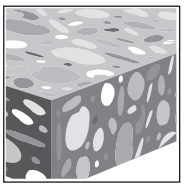


# 3.2.6 HVU2 CAPSULE ADHESIVE ANCHORING SYSTEM

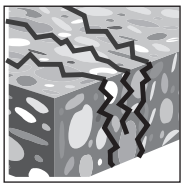
## PRODUCT DESCRIPTION



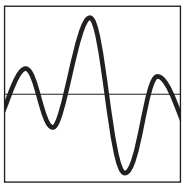
| Mortar system | | Features and Benefits |
|---|---|---|
|  | Hilti HVU2 adhesive capsule | • Combines high performance, versatility, and convenience of nearly instant loading<br>• Rapid cure time — as soon as 5 minutes at room temperature<br>• Diamond core drilling applicable, even in cracked concrete and seismic applications<br>• Tough, resilient soft foil capsule — little risk of breakage<br>• Suitable for tough jobsite conditions including water-saturated concrete and low installation temperature<br>• SafeSet™ automatic hole cleaning with Hilti hollow drill bit and Hilti vacuum for virtually dust free use and OSHA 1926.1153 Table 1 compliance<br>• Faster and more convenient installation with drill driver, impact driver, or hammer drill |
|  | Hilti HAS threaded rod with setting tip | |
|  | Hilti HIS-N and HIS-RN internally threaded inserts | |



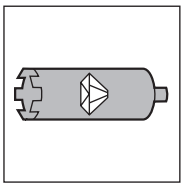
Uncracked concrete



Cracked concrete



Seismic Desing Categories A-F



Diamond core drilling permitted

SAFESET

Hollow Drill Bit




PROFIS Anchor design software

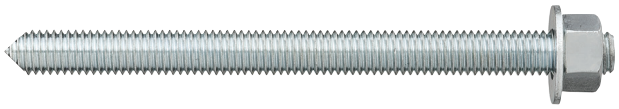
| Listings/Approvals | |
|---|---|
| **ICC-ES (International Code Council)**<br>**- 2021 International Building Code / International Residential Code** | ESR-4372 in concrete per ACI 318 Ch. 17 / ACI 355.4 / ICC-ES AC308 |
| **NSF/ANSI Std 61** | Certification for use in potable water |
| **European Technical Approval** | ETA-18/0184, ETA-18/0185 |
| **City of Los Angeles** | 2020 LABC Supplement (within ESR-4372) |
| **Florida Building Code** | 2020 FBC Supplement (within ESR-4372) w/ High Velocity Hurricane Zone |
| **U.S. Green Building Council** | LEED® Credit 4.1-Low Emitting Materials |

# DESIGN DATA IN CONCRETE PER ACI 318

### ACI 318 Chapter 17 design

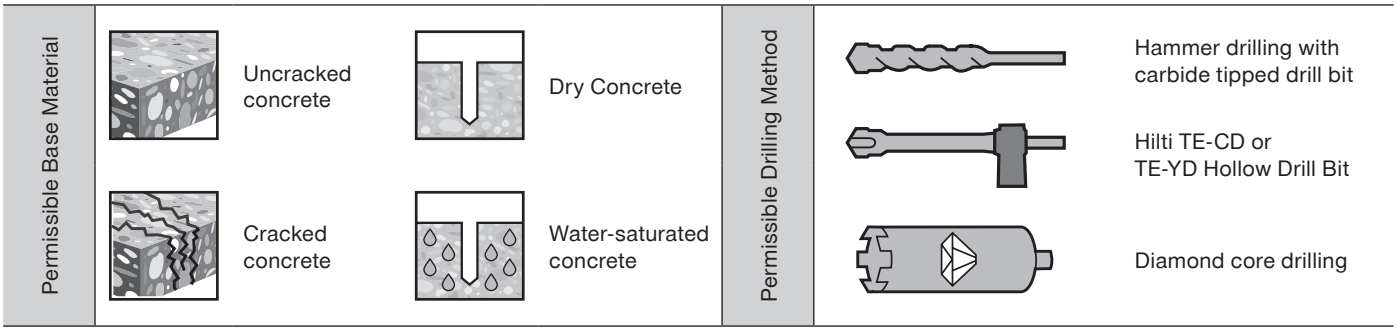
The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-4372 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-4372 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

### Hilti HVU2 Adhesive Capsule with Hilti HAS Threaded Rod



Hilti HAS threaded rod with setting tip

## Figure 1 — Hilti HAS threaded rod installation conditions

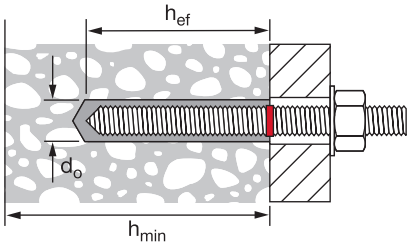



## Table 1 — Hilti HAS threaded rod installation specifications [1]

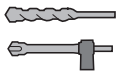
| Setting information | | Symbol | Units | Nominal rod diameter (in.) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 [2] |
| Nominal bit diameter | | $d_o$ | - | 7/16” | 9/16” | 11/16” | 7/8” | 1” | 1-1/8” | 1-3/8” |
| | | $d_o$ | - | 12mm | 9/16” | 11/16” | 7/8” | 1” | 1-1/8” | 1-3/8” |
| | | $d_o$ | - | - | 9/16” | 11/16” | 7/8” | 1” | 1-1/8” | 1-3/8” |
| Effective embedment | | $h_{ef}$ | in. | 3-1/2 | 4-1/4 | 5 | 6-5/8 | 6-5/8 | 8-1/4 | 11 |
| | | | (mm) | (89) | (108) | (127) | (168) | (168) | (210) | (279) |
| Diameter of fixture hole | | $d_f$ | in. | 7/16 | 9/16 | 11/16 | 13/16 | 15/16 | 1-1/8 | 1-3/8 |
| Installation torque | | $T_{inst}$ | ft-lb | 15 | 30 | 60 | 100 | 125 | 150 | 200 |
| | | | (Nm) | (20) | (41) | (81) | (136) | (169) | (203) | (271) |
| Minimum concrete thickness | | $h_{min}$ | in. | 4-3/4 | 5-1/2 | 6-3/8 | 8-3/8 | 8-5/8 | 10-1/2 | 13-3/4 |
| | | | (mm) | (121) | (140) | (162) | (213) | (219) | (267) | (349) |
| Minimum edge distance | | $c_{min}$ | in. | 1-7/8 | 2-1/2 | 3-1/8 | 3-1/4 | 4-3/8 | 5 | 6-1/4 |
| | | | (mm) | (48) | (64) | (79) | (95) | (111) | (127) | (159) |
| Minimum anchor spacing | | $s_{min}$ | in. | 1-7/8 | 2-1/2 | 3-1/8 | 3-1/4 | 4-3/8 | 5 | 6-1/4 |
| | | | (mm) | (48) | (64) | (79) | (95) | (111) | (127) | (159) |

1 Material specifications for Hilti HAS threaded rods are listed in section 3.2.7.
2 1-1/4-in. diameter threaded rods to be installed in generally vertical down direction only.

## Figure 2 — Hilti HAS threaded rods installed with Hilti HVU2 adhesive capsule



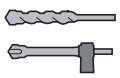
## Table 2 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for threaded rod in uncracked concrete [1,2,3,4,5,6,7,8,9]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) |
| 3/8 | 3-1/2 | 3,955 | 4,145 | 4,465 | 4,965 | 8,515 | 8,930 | 9,620 | 10,690 |
| | (89) | (17.6) | (18.4) | (19.9) | (22.1) | (37.9) | (39.7) | (42.8) | (47.6) |
| 1/2 | 4-1/4 | 6,835 | 7,485 | 8,645 | 10,585 | 14,720 | 16,125 | 18,620 | 22,805 |
| | (108) | (30.4) | (33.3) | (38.5) | (47.1) | (65.5) | (71.7) | (82.8) | (101.4) |
| 5/8 | 5 | 8,720 | 9,555 | 11,030 | 13,510 | 18,785 | 20,575 | 23,760 | 29,100 |
| | (127) | (38.8) | (42.5) | (49.1) | (60.1) | (83.6) | (91.5) | (105.7) | (129.4) |
| 3/4 | 6-5/8 | 13,300 | 14,570 | 16,825 | 20,605 | 28,650 | 31,380 | 36,235 | 44,380 |
| | (168) | (59.2) | (64.8) | (74.8) | (91.7) | (127.4) | (139.6) | (161.2) | (197.4) |
| 7/8 | 6-5/8 | 13,300 | 14,570 | 16,825 | 20,605 | 28,650 | 31,380 | 36,235 | 44,380 |
| | (168) | (59.2) | (64.8) | (74.8) | (91.7) | (127.4) | (139.6) | (161.2) | (197.4) |
| 1 | 8-1/4 | 18,485 | 20,245 | 23,380 | 28,635 | 39,810 | 43,610 | 50,355 | 61,675 |
| | (210) | (82.2) | (90.1) | (104.0) | (127.4) | (177.1) | (194.0) | (224.0) | (274.3) |
| 1-1/4 [10] | 11 | 28,455 | 31,175 | 35,995 | 44,085 | 61,290 | 67,140 | 77,530 | 94,950 |
| | (279) | (126.6) | (138.7) | (160.1) | (196.1) | (272.6) | (298.7) | (344.9) | (422.4) |

## Table 3 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9,11]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) |
| 1/2 | 4-1/4 | 4,580 | 4,695 | 4,890 | 5,175 | 9,860 | 10,115 | 10,530 | 11,145 |
| | (108) | (20.4) | (20.9) | (21.8) | (23.0) | (43.9) | (45.0) | (46.8) | (49.6) |
| 5/8 | 5 | 6,175 | 6,765 | 7,190 | 7,610 | 13,305 | 14,575 | 15,485 | 16,390 |
| | (127) | (27.5) | (30.1) | (32.0) | (33.9) | (59.2) | (64.8) | (68.9) | (72.9) |
| 3/4 | 6-5/8 | 9,420 | 10,320 | 11,430 | 12,100 | 20,290 | 22,230 | 24,625 | 26,060 |
| | (168) | (41.9) | (45.9) | (50.8) | (53.8) | (90.3) | (98.9) | (109.5) | (115.9) |
| 7/8 | 6-5/8 | 9,420 | 10,320 | 11,915 | 14,115 | 20,290 | 22,230 | 25,670 | 30,405 |
| | (168) | (41.9) | (45.9) | (53.0) | (62.8) | (90.3) | (98.9) | (114.2) | (135.2) |
| 1 | 8-1/4 | 13,090 | 14,340 | 16,560 | 20,090 | 28,200 | 30,890 | 35,670 | 43,275 |
| | (210) | (58.2) | (63.8) | (73.7) | (89.4) | (125.4) | (137.4) | (158.7) | (192.5) |
| 1-1/4 [10] | 11 | 20,155 | 22,080 | 25,495 | 31,225 | 43,415 | 47,560 | 54,915 | 67,260 |
| | (279) | (89.7) | (98.2) | (113.4) | (138.9) | (193.1) | (211.6) | (244.3) | (299.2) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7 – 10 as necessary to the above values. Compare to the steel values in table 6. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 For 3/8-in to 1-in dia. threaded rods, tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 1-1/4-in diameter rods to be installed in generally vertically downward direction only.
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.75.
See section 3.1.8 for additional information on seismic applications.

## Table 4 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for threaded rod in uncracked concrete [1,2,3,4,5,6,7,8,9]

 Diamond core drilling

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) |
| 1/2 | 4-1/4 | 6,835 | 7,485 | 8,645 | 9,970 | 14,720 | 16,125 | 18,620 | 21,475 |
| | (108) | (30.4) | (33.3) | (38.5) | (44.3) | (65.5) | (71.7) | (82.8) | (95.5) |
| 5/8 | 5 | 8,720 | 9,555 | 11,030 | 13,510 | 18,785 | 20,575 | 23,760 | 29,100 |
| | (127) | (38.8) | (42.5) | (49.1) | (60.1) | (83.6) | (91.5) | (105.7) | (129.4) |
| 3/4 | 6-5/8 | 13,300 | 14,570 | 16,825 | 20,605 | 28,650 | 31,380 | 36,235 | 44,380 |
| | (168) | (59.2) | (64.8) | (74.8) | (91.7) | (127.4) | (139.6) | (161.2) | (197.4) |
| 7/8 | 6-5/8 | 13,300 | 14,570 | 16,825 | 20,605 | 28,650 | 31,380 | 36,235 | 44,380 |
| | (168) | (59.2) | (64.8) | (74.8) | (91.7) | (127.4) | (139.6) | (161.2) | (197.4) |
| 1 | 8-1/4 | 18,485 | 20,245 | 23,380 | 28,635 | 39,810 | 43,610 | 50,355 | 61,675 |
| | (210) | (82.2) | (90.1) | (104.0) | (127.4) | (177.1) | (194.0) | (224.0) | (274.3) |
| 1-1/4 [10] | 11 | 28,455 | 31,175 | 35,995 | 44,085 | 61,290 | 67,140 | 77,530 | 94,950 |
| | (279) | (126.6) | (138.7) | (160.1) | (196.1) | (272.6) | (298.7) | (344.9) | (422.4) |

## Table 5 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9,11]

 Diamond core drilling

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) |
| 1/2 | 4-1/4 | 4,665 | 4,665 | 4,665 | 4,665 | 10,045 | 10,045 | 10,045 | 10,045 |
| | (108) | (20.8) | (20.8) | (20.8) | (20.8) | (44.7) | (44.7) | (44.7) | (44.7) |
| 5/8 | 5 | 6,175 | 6,765 | 6,860 | 6,860 | 13,305 | 14,575 | 14,775 | 14,775 |
| | (127) | (27.5) | (30.1) | (30.5) | (30.5) | (59.2) | (64.8) | (65.7) | (65.7) |
| 3/4 | 6-5/8 | 9,420 | 10,320 | 10,905 | 10,905 | 20,290 | 22,230 | 23,495 | 23,495 |
| | (168) | (41.9) | (45.9) | (48.5) | (48.5) | (90.3) | (98.9) | (104.5) | (104.5) |
| 7/8 | 6-5/8 | 9,420 | 10,320 | 11,915 | 12,725 | 20,290 | 22,230 | 25,670 | 27,410 |
| | (168) | (41.9) | (45.9) | (53.0) | (56.6) | (90.3) | (98.9) | (114.2) | (121.9) |
| 1 | 8-1/4 | 13,090 | 14,340 | 16,560 | 18,110 | 28,200 | 30,890 | 35,670 | 39,005 |
| | (210) | (58.2) | (63.8) | (73.7) | (80.6) | (125.4) | (137.4) | (158.7) | (173.5) |
| 1-1/4 [10] | 11 | 20,155 | 22,080 | 25,495 | 30,185 | 43,415 | 47,560 | 54,915 | 65,010 |
| | (279) | (89.7) | (98.2) | (113.4) | (134.3) | (193.1) | (211.6) | (244.3) | (289.2) |

1 See Section 3.1.8 of for explanation on development of load values.
2 See Section 3.1.8 of to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7 – 10 as necessary to the above values. Compare to the steel values in table 6. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 For 1/2-in to 1-in dia. threaded rods, tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 1-1/4-in diameter rods to be installed in generally vertically downward direction only.
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.75.
See section 3.1.8 for additional information on seismic applications.

## Table 6 — Steel design strength for Hilti HAS threaded rods for use with ACI 318 Chapter 17

| Nominal anchor diameter in. | HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6] | | | HAS-B-105 and HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6] | | | HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4] | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) | Tensile[1] $\Phi N_{sa}$ lb (kN) | Shear[2] $\Phi V_{sa}$ lb (kN) | Seismic Shear[3] $\Phi V_{sa,eq}$ lb (kN) |
| 3/8 | 4,360 (19.4) | 2,270 (10.1) | 1,590 (7.1) | 7,270 (32.3) | 3,780 (16.8) | 2,645 (11.8) | 5,040 (22.4) | 2,790 (12.4) | 1,955 (8.7) |
| 1/2 | 7,985 (35.5) | 4,150 (18.5) | 2,905 (12.9) | 13,305 (59.2) | 6,920 (30.8) | 4,845 (21.6) | 9,225 (41.0) | 5,110 (22.7) | 3,575 (15.9) |
| 5/8 | 12,715 (56.6) | 6,610 (29.4) | 4,625 (20.6) | 21,190 (94.3) | 11,020 (49.0) | 7,715 (34.3) | 14,690 (65.3) | 8,135 (36.2) | 5,695 (25.3) |
| 3/4 | 18,820 (83.7) | 9,785 (43.5) | 6,850 (30.5) | 31,360 (139.5) | 16,310 (72.6) | 11,415 (50.8) | 18,485 (82.2) | 10,235 (45.5) | 7,165 (31.9) |
| 7/8 | 25,975 (115.5) | 13,505 (60.1) | 9,455 (42.1) | 43,285 (192.5) | 22,510 (100.1) | 15,755 (70.1) | 25,510 (113.5) | 14,125 (62.8) | 9,890 (44.0) |
| 1 | 34,075 (151.6) | 17,720 (78.8) | 12,405 (55.2) | 56,785 (252.6) | 29,530 (131.4) | 20,670 (91.9) | 33,465 (148.9) | 18,535 (82.4) | 12,975 (57.7) |
| 1-1/4 | 54,515 (242.5) | 28,345 (126.1) | 19,840 (88.3) | 90,855 (404.1) | 47,245 (210.2) | 33,070 (147.1) | 41,430 (184.3) | 21,545 (95.8) | 12,925 (57.5) |

1 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 17.4.1.2

2 Shear = $\phi$ 0.60 $A_{se,V} f_{uta}$ as noted in ACI 318 17.5.1.2b.

3 Seismic Shear = $\alpha_{V,seis} \phi V_{sa}$ : Reduction factor for seismic shear only. See ACI 318 for additional information on seismic applications.

4 HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).

5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.

6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-E-55, and HAS-B-105 (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

## Table 7 — Load adjustment factors for 3/8, 1/2, 5/8, and 3/4-in. diameter threaded rods in uncracked concrete [1,2]

| 3/8, 1/2, 5/8 & 3/4-in. threaded rods uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear [3] $f_{AV}$ | | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | | Concrete thickness factor in shear [4] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thread size, in. | | | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 |
| Embedment $h_{ef}$ | in. | | 3-1/2 | 4-1/4 | 5 | 6-5/8 | 3-1/2 | 4-1/4 | 5 | 6-5/8 | 3-1/2 | 4-1/4 | 5 | 6-5/8 | 3-1/2 | 4-1/4 | 5 | 6-5/8 | 3-1/2 | 4-1/4 | 5 | 6-5/8 | 3-1/2 | 4-1/4 | 5 | 6-5/8 |
| | (mm) | | (89) | (108) | (127) | (168) | (89) | (108) | (127) | (168) | (89) | (108) | (127) | (168) | (89) | (108) | (127) | (168) | (89) | (108) | (127) | (168) | (89) | (108) | (127) | (168) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in (mm) | 1-7/8 | (48) | 0.59 | n/a | n/a | n/a | 0.30 | n/a | n/a | n/a | 0.53 | n/a | n/a | n/a | 0.10 | n/a | n/a | n/a | 0.19 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 2 | (51) | 0.60 | n/a | n/a | n/a | 0.31 | n/a | n/a | n/a | 0.54 | n/a | n/a | n/a | 0.11 | n/a | n/a | n/a | 0.21 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 2-1/2 | (64) | 0.62 | 0.58 | n/a | n/a | 0.35 | 0.29 | n/a | n/a | 0.55 | 0.54 | n/a | n/a | 0.15 | 0.10 | n/a | n/a | 0.30 | 0.20 | n/a | 0.54 | n/a | n/a | n/a | n/a |
| | 3 | (76) | 0.64 | 0.60 | n/a | n/a | 0.38 | 0.31 | n/a | n/a | 0.56 | 0.54 | n/a | n/a | 0.19 | 0.13 | n/a | n/a | 0.38 | 0.26 | n/a | 0.54 | n/a | n/a | n/a | n/a |
| | 3-1/8 | (79) | 0.65 | 0.60 | 0.58 | n/a | 0.39 | 0.32 | 0.31 | n/a | 0.56 | 0.54 | 0.54 | n/a | 0.21 | 0.14 | 0.12 | n/a | 0.39 | 0.28 | 0.24 | 0.54 | n/a | n/a | n/a | n/a |
| | 3-1/4 | (83) | 0.65 | 0.61 | 0.59 | 0.57 | 0.40 | 0.33 | 0.32 | 0.29 | 0.56 | 0.55 | 0.54 | 0.53 | 0.22 | 0.15 | 0.13 | 0.09 | 0.40 | 0.29 | 0.26 | 0.18 | n/a | n/a | n/a | n/a |
| | 4 | (102) | 0.69 | 0.63 | 0.61 | 0.59 | 0.46 | 0.37 | 0.35 | 0.31 | 0.57 | 0.56 | 0.55 | 0.54 | 0.30 | 0.20 | 0.18 | 0.12 | 0.46 | 0.37 | 0.35 | 0.25 | n/a | n/a | n/a | n/a |
| | 4-3/4 | (121) | 0.73 | 0.66 | 0.63 | 0.61 | 0.53 | 0.41 | 0.39 | 0.34 | 0.59 | 0.57 | 0.56 | 0.55 | 0.39 | 0.26 | 0.23 | 0.16 | 0.53 | 0.41 | 0.39 | 0.32 | 0.60 | n/a | n/a | n/a |
| | 5 | (127) | 0.74 | 0.67 | 0.63 | 0.61 | 0.55 | 0.42 | 0.40 | 0.35 | 0.59 | 0.57 | 0.57 | 0.55 | 0.42 | 0.28 | 0.24 | 0.17 | 0.55 | 0.42 | 0.40 | 0.34 | 0.61 | n/a | n/a | n/a |
| | 5-1/2 | (140) | 0.76 | 0.68 | 0.65 | 0.62 | 0.61 | 0.45 | 0.43 | 0.36 | 0.60 | 0.58 | 0.57 | 0.56 | 0.48 | 0.32 | 0.28 | 0.20 | 0.61 | 0.45 | 0.43 | 0.36 | 0.64 | 0.56 | n/a | n/a |
| | 6 | (152) | 0.79 | 0.70 | 0.66 | 0.63 | 0.66 | 0.48 | 0.45 | 0.38 | 0.61 | 0.59 | 0.58 | 0.56 | 0.55 | 0.37 | 0.32 | 0.23 | 0.66 | 0.48 | 0.45 | 0.38 | 0.67 | 0.58 | n/a | n/a |
| | 6-3/8 | (162) | 0.80 | 0.71 | 0.67 | 0.64 | 0.70 | 0.51 | 0.47 | 0.40 | 0.62 | 0.59 | 0.58 | 0.57 | 0.60 | 0.40 | 0.35 | 0.25 | 0.70 | 0.51 | 0.47 | 0.40 | 0.69 | 0.60 | 0.58 | n/a |
| | 7 | (178) | 0.83 | 0.73 | 0.69 | 0.66 | 0.77 | 0.56 | 0.51 | 0.42 | 0.63 | 0.60 | 0.59 | 0.57 | 0.69 | 0.46 | 0.41 | 0.29 | 0.77 | 0.56 | 0.51 | 0.42 | 0.72 | 0.63 | 0.60 | n/a |
| | 8 | (203) | 0.88 | 0.77 | 0.71 | 0.68 | 0.88 | 0.64 | 0.57 | 0.46 | 0.65 | 0.61 | 0.60 | 0.58 | 0.85 | 0.57 | 0.50 | 0.35 | 0.88 | 0.64 | 0.57 | 0.46 | 0.77 | 0.68 | 0.65 | n/a |
| | 8-3/8 | (213) | 0.90 | 0.78 | 0.72 | 0.69 | 0.92 | 0.67 | 0.60 | 0.48 | 0.66 | 0.62 | 0.61 | 0.59 | 0.91 | 0.61 | 0.53 | 0.37 | 0.92 | 0.67 | 0.60 | 0.48 | 0.79 | 0.69 | 0.66 | 0.59 |
| | 10 | (254) | 0.98 | 0.84 | 0.77 | 0.72 | 1.00 | 0.80 | 0.71 | 0.54 | 0.69 | 0.64 | 0.63 | 0.60 | 1.00 | 0.79 | 0.69 | 0.49 | 1.00 | 0.80 | 0.71 | 0.54 | 0.86 | 0.75 | 0.72 | 0.64 |
| | 12 | (305) | 1.00 | 0.90 | 0.82 | 0.77 | | 0.96 | 0.85 | 0.65 | 0.72 | 0.67 | 0.66 | 0.62 | | 1.00 | 0.91 | 0.64 | | 0.96 | 0.85 | 0.65 | 0.95 | 0.83 | 0.79 | 0.70 |
| | 14 | (356) | | 0.97 | 0.88 | 0.81 | | 1.00 | 1.00 | 0.76 | 0.76 | 0.70 | 0.68 | 0.64 | | | 1.00 | 0.81 | | 1.00 | 1.00 | 0.76 | 1.00 | 0.89 | 0.85 | 0.76 |
| | 16 | (406) | | 1.00 | 0.93 | 0.86 | | | | 0.87 | 0.80 | 0.73 | 0.71 | 0.67 | | | | 0.99 | | | | 0.87 | | 0.95 | 0.91 | 0.81 |
| | 18 | (457) | | | 0.98 | 0.90 | | | | 0.98 | 0.84 | 0.76 | 0.73 | 0.69 | | | | 1.00 | | | | 0.98 | | 1.00 | 0.97 | 0.86 |
| | 24 | (610) | | | 1.00 | 1.00 | | | | 1.00 | 0.95 | 0.84 | 0.81 | 0.75 | | | | | | | | 1.00 | | | 1.00 | 1.00 |
| | 30 | (762) | | | | | | | | | 1.00 | 0.93 | 0.89 | 0.81 | | | | | | | | | | | | |
| | 36 | (914) | | | | | | | | | | 1.00 | 0.97 | 0.87 | | | | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | | | | 1.00 | 1.00 | | | | | | | | | | | | |

## Table 8 — Load adjustment factors for 1/2, 5/8, and 3/4-in. diameter threaded rods in cracked concrete[1,2]

| 1/2, 5/8 & 3/4-in. threaded rods cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thread size, in. | | | 1/2 | 5/8 | 3/4 | 1/2 | 5/8 | 3/4 | 1/2 | 5/8 | 3/4 | 1/2 | 5/8 | 3/4 | 1/2 | 5/8 | 3/4 | 1/2 | 5/8 | 3/4 |
| Embedment $h_{ef}$ | in. | | 4-1/4 | 5 | 6-5/8 | 4-1/4 | 5 | 6-5/8 | 4-1/4 | 5 | 6-5/8 | 4-1/4 | 5 | 6-5/8 | 4-1/4 | 5 | 6-5/8 | 4-1/4 | 5 | 6-5/8 |
| | (mm) | | (108) | (127) | (168) | (108) | (127) | (168) | (108) | (127) | (168) | (108) | (127) | (168) | (108) | (127) | (168) | (108) | (127) | (168) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in (mm) | 2-1/2 | (64) | 0.58 | n/a | n/a | 0.53 | n/a | n/a | 0.54 | n/a | n/a | 0.11 | n/a | n/a | 0.21 | n/a | n/a | n/a | n/a | n/a |
| | 3 | (76) | 0.60 | n/a | n/a | 0.58 | n/a | n/a | 0.54 | n/a | n/a | 0.14 | n/a | n/a | 0.28 | n/a | n/a | n/a | n/a | n/a |
| | 3-1/8 | (79) | 0.60 | 0.58 | n/a | 0.59 | 0.53 | n/a | 0.55 | 0.54 | n/a | 0.15 | 0.12 | n/a | 0.29 | 0.24 | n/a | n/a | n/a | n/a |
| | 3-1/4 | (83) | 0.61 | 0.59 | 0.57 | 0.60 | 0.54 | 0.51 | 0.55 | 0.54 | 0.53 | 0.16 | 0.13 | 0.09 | 0.31 | 0.26 | 0.18 | n/a | n/a | n/a |
| | 4 | (102) | 0.63 | 0.61 | 0.59 | 0.66 | 0.59 | 0.55 | 0.56 | 0.55 | 0.54 | 0.21 | 0.18 | 0.12 | 0.43 | 0.35 | 0.25 | n/a | n/a | n/a |
| | 4-3/4 | (121) | 0.66 | 0.63 | 0.61 | 0.73 | 0.64 | 0.59 | 0.57 | 0.56 | 0.55 | 0.28 | 0.23 | 0.16 | 0.55 | 0.46 | 0.32 | n/a | n/a | n/a |
| | 5 | (127) | 0.67 | 0.63 | 0.61 | 0.75 | 0.66 | 0.60 | 0.57 | 0.57 | 0.55 | 0.30 | 0.25 | 0.17 | 0.60 | 0.49 | 0.35 | n/a | n/a | n/a |
| | 5-1/2 | (140) | 0.68 | 0.65 | 0.62 | 0.80 | 0.70 | 0.63 | 0.58 | 0.57 | 0.56 | 0.34 | 0.28 | 0.20 | 0.69 | 0.57 | 0.40 | 0.57 | n/a | n/a |
| | 6 | (152) | 0.70 | 0.66 | 0.63 | 0.85 | 0.73 | 0.66 | 0.59 | 0.58 | 0.56 | 0.39 | 0.32 | 0.23 | 0.78 | 0.65 | 0.46 | 0.60 | n/a | n/a |
| | 6-3/8 | (162) | 0.71 | 0.67 | 0.64 | 0.89 | 0.76 | 0.68 | 0.59 | 0.58 | 0.57 | 0.43 | 0.36 | 0.25 | 0.86 | 0.71 | 0.50 | 0.62 | 0.58 | n/a |
| | 7 | (178) | 0.73 | 0.69 | 0.66 | 0.95 | 0.81 | 0.72 | 0.60 | 0.59 | 0.57 | 0.49 | 0.41 | 0.29 | 0.95 | 0.81 | 0.57 | 0.65 | 0.61 | n/a |
| | 8 | (203) | 0.77 | 0.71 | 0.68 | 1.00 | 0.89 | 0.78 | 0.62 | 0.60 | 0.58 | 0.60 | 0.50 | 0.35 | 1.00 | 0.89 | 0.70 | 0.69 | 0.65 | n/a |
| | 8-3/8 | (213) | 0.78 | 0.72 | 0.69 | | 0.92 | 0.81 | 0.62 | 0.61 | 0.59 | 0.65 | 0.53 | 0.38 | | 0.92 | 0.75 | 0.71 | 0.66 | 0.59 |
| | 10 | (254) | 0.84 | 0.77 | 0.72 | | 1.00 | 0.92 | 0.65 | 0.63 | 0.60 | 0.84 | 0.70 | 0.49 | | 1.00 | 0.92 | 0.77 | 0.72 | 0.64 |
| | 12 | (305) | 0.90 | 0.82 | 0.77 | | | 1.00 | 0.68 | 0.66 | 0.62 | 1.00 | 0.92 | 0.65 | | | 1.00 | 0.84 | 0.79 | 0.71 |
| | 14 | (356) | 0.97 | 0.88 | 0.81 | | | | 0.71 | 0.68 | 0.65 | | 1.00 | 0.81 | | | | 0.91 | 0.86 | 0.76 |
| | 16 | (406) | 1.00 | 0.93 | 0.86 | | | | 0.74 | 0.71 | 0.67 | | | 0.99 | | | | 0.98 | 0.92 | 0.81 |
| | 18 | (457) | | 0.98 | 0.90 | | | | 0.77 | 0.74 | 0.69 | | | 1.00 | | | | 1.00 | 0.97 | 0.86 |
| | 24 | (610) | | 1.00 | 1.00 | | | | 0.86 | 0.81 | 0.75 | | | | | | | | 1.00 | 1.00 |
| | 30 | (762) | | | | | | | 0.95 | 0.89 | 0.81 | | | | | | | | | |
| | 36 | (914) | | | | | | | 1.00 | 0.97 | 0.87 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | 1.00 | 1.00 | | | | | | | | | |

1 Linear interpolation not permitted.
2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV}$ = $f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

## Table 9 — Load adjustment factors for 7/8, 1, and 1-1/4-in. diameter threaded rods in uncracked concrete[1,2]

| 7/8, 1 & 1-1/4-in. threaded rods uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thread size, in. | | 7/8 | 1 | 1 1/4 | 7/8 | 1 | 1 1/4 | 7/8 | 1 | 1 1/4 | 7/8 | 1 | 1 1/4 | 7/8 | 1 | 1 1/4 | 7/8 | 1 | 1 1/4 |
| Embedment $h_{ef}$ | in. | 6-5/8 | 8-1/4 | 11 | 6-5/8 | 8-1/4 | 11 | 6-5/8 | 8-1/4 | 11 | 6-5/8 | 8-1/4 | 11 | 6-5/8 | 8-1/4 | 11 | 6-5/8 | 8-1/4 | 11 |
| | (mm) | (168) | (210) | (279) | (168) | (210) | (279) | (168) | (210) | (279) | (168) | (210) | (279) | (168) | (210) | (279) | (168) | (210) | (279) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in (mm) | | | | | | | | | | | | | | | | | | | |
| 4-3/8 | (111) | 0.58 | n/a | n/a | 0.35 | n/a | n/a | 0.55 | n/a | n/a | 0.14 | n/a | n/a | 0.28 | n/a | n/a | n/a | n/a | n/a |
| 5 | (127) | 0.60 | 0.58 | n/a | 0.37 | 0.34 | n/a | 0.55 | 0.54 | n/a | 0.17 | 0.12 | n/a | 0.34 | 0.25 | n/a | n/a | n/a | n/a |
| 6 | (152) | 0.61 | 0.60 | n/a | 0.41 | 0.37 | n/a | 0.56 | 0.55 | n/a | 0.23 | 0.16 | n/a | 0.41 | 0.33 | n/a | n/a | n/a | n/a |
| 6-1/4 | (159) | 0.62 | 0.60 | 0.58 | 0.42 | 0.37 | 0.34 | 0.56 | 0.55 | 0.54 | 0.24 | 0.17 | 0.11 | 0.42 | 0.35 | 0.22 | n/a | n/a | n/a |
| 7 | (178) | 0.63 | 0.62 | 0.59 | 0.45 | 0.40 | 0.35 | 0.57 | 0.56 | 0.54 | 0.29 | 0.21 | 0.13 | 0.45 | 0.40 | 0.27 | n/a | n/a | n/a |
| 8 | (203) | 0.65 | 0.63 | 0.61 | 0.50 | 0.43 | 0.37 | 0.58 | 0.57 | 0.55 | 0.35 | 0.25 | 0.16 | 0.50 | 0.43 | 0.33 | n/a | n/a | n/a |
| 8-5/8 | (219) | 0.67 | 0.64 | 0.61 | 0.52 | 0.45 | 0.39 | 0.59 | 0.57 | 0.55 | 0.39 | 0.28 | 0.18 | 0.52 | 0.45 | 0.36 | 0.60 | n/a | n/a |
| 9 | (229) | 0.67 | 0.65 | 0.62 | 0.54 | 0.46 | 0.40 | 0.59 | 0.57 | 0.56 | 0.42 | 0.30 | 0.19 | 0.54 | 0.46 | 0.39 | 0.61 | n/a | n/a |
| 10 | (254) | 0.69 | 0.67 | 0.63 | 0.59 | 0.50 | 0.42 | 0.60 | 0.58 | 0.56 | 0.49 | 0.35 | 0.23 | 0.59 | 0.50 | 0.42 | 0.64 | n/a | n/a |
| 10-1/2 | (267) | 0.70 | 0.68 | 0.64 | 0.62 | 0.51 | 0.44 | 0.61 | 0.59 | 0.57 | 0.52 | 0.38 | 0.24 | 0.62 | 0.51 | 0.44 | 0.66 | 0.59 | n/a |
| 11 | (279) | 0.71 | 0.68 | 0.65 | 0.64 | 0.53 | 0.45 | 0.61 | 0.59 | 0.57 | 0.56 | 0.40 | 0.26 | 0.64 | 0.53 | 0.45 | 0.67 | 0.60 | n/a |
| 12 | (305) | 0.73 | 0.70 | 0.66 | 0.70 | 0.57 | 0.47 | 0.62 | 0.60 | 0.57 | 0.64 | 0.46 | 0.30 | 0.70 | 0.57 | 0.47 | 0.70 | 0.63 | n/a |
| 13 | (330) | 0.75 | 0.72 | 0.67 | 0.76 | 0.61 | 0.50 | 0.63 | 0.61 | 0.58 | 0.72 | 0.52 | 0.34 | 0.76 | 0.61 | 0.50 | 0.73 | 0.66 | n/a |
| 13-3/4 | (349) | 0.76 | 0.73 | 0.68 | 0.81 | 0.65 | 0.52 | 0.64 | 0.61 | 0.59 | 0.78 | 0.56 | 0.37 | 0.81 | 0.65 | 0.52 | 0.75 | 0.67 | 0.58 |
| 14 | (356) | 0.77 | 0.73 | 0.68 | 0.82 | 0.66 | 0.53 | 0.64 | 0.62 | 0.59 | 0.81 | 0.58 | 0.38 | 0.82 | 0.66 | 0.53 | 0.76 | 0.68 | 0.59 |
| 15 | (381) | 0.79 | 0.75 | 0.70 | 0.88 | 0.71 | 0.55 | 0.65 | 0.62 | 0.59 | 0.89 | 0.64 | 0.42 | 0.88 | 0.71 | 0.55 | 0.79 | 0.70 | 0.61 |
| 16 | (406) | 0.81 | 0.77 | 0.71 | 0.94 | 0.75 | 0.58 | 0.67 | 0.63 | 0.60 | 0.99 | 0.71 | 0.46 | 0.94 | 0.75 | 0.58 | 0.81 | 0.73 | 0.63 |
| 17 | (432) | 0.83 | 0.78 | 0.72 | 1.00 | 0.80 | 0.62 | 0.68 | 0.64 | 0.61 | 1.00 | 0.78 | 0.50 | 1.00 | 0.80 | 0.62 | 0.84 | 0.75 | 0.65 |
| 18 | (457) | 0.84 | 0.80 | 0.74 | | 0.85 | 0.65 | 0.69 | 0.65 | 0.61 | | 0.85 | 0.55 | | 0.85 | 0.65 | 0.86 | 0.77 | 0.67 |
| 20 | (508) | 0.88 | 0.84 | 0.76 | | 0.94 | 0.72 | 0.71 | 0.67 | 0.62 | | 0.99 | 0.64 | | 0.94 | 0.72 | 0.91 | 0.81 | 0.70 |
| 24 | (610) | 0.96 | 0.90 | 0.82 | | 1.00 | 0.87 | 0.75 | 0.70 | 0.65 | | 1.00 | 0.85 | | 1.00 | 0.87 | 1.00 | 0.89 | 0.77 |
| 30 | (762) | 1.00 | 1.00 | 0.90 | | | 1.00 | 0.81 | 0.75 | 0.69 | | | 1.00 | | | 1.00 | | 1.00 | 0.86 |
| 36 | (914) | | | 0.97 | | | | 0.87 | 0.80 | 0.72 | | | | | | | | | 0.95 |
| > 48 | (1219) | | | 1.00 | | | | 1.00 | 0.90 | 0.80 | | | | | | | | | 1.00 |

## Table 10 — Load adjustment factors for 7/8, 1, and 1-1/4-in. diameter threaded rods in cracked concrete[1,2]

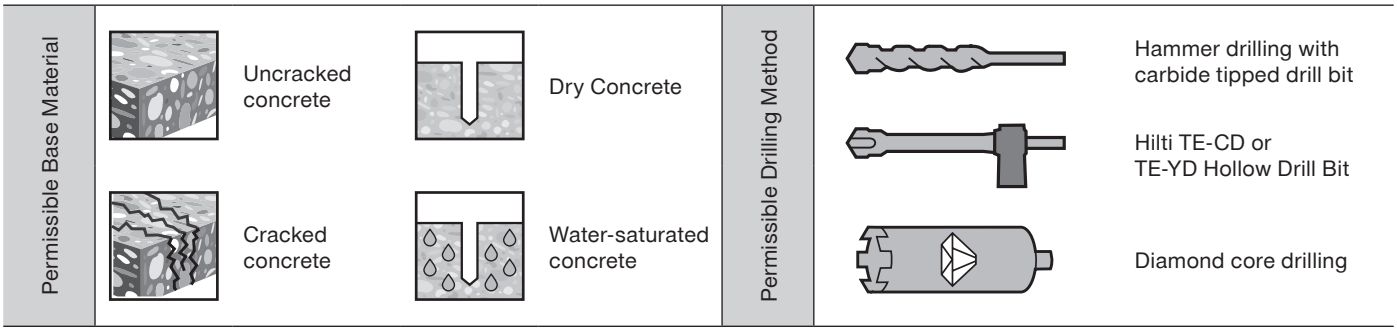
| 7/8, 1 & 1-1/4-in. threaded rods cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[4] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear[5] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thread size, in. | | 7/8 | 1 | 1 1/4 | 7/8 | 1 | 1 1/4 | 7/8 | 1 | 1 1/4 | 7/8 | 1 | 1 1/4 | 7/8 | 1 | 1 1/4 | 7/8 | 1 | 1 1/4 |
| Embedment $h_{ef}$ | in. | 6-5/8 | 8-1/4 | 11 | 6-5/8 | 8-1/4 | 11 | 6-5/8 | 8-1/4 | 11 | 6-5/8 | 8-1/4 | 11 | 6-5/8 | 8-1/4 | 11 | 6-5/8 | 8-1/4 | 11 |
| | (mm) | (168) | (210) | (279) | (168) | (210) | (279) | (168) | (210) | (279) | (168) | (210) | (279) | (168) | (210) | (279) | (168) | (210) | (279) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in (mm) | | | | | | | | | | | | | | | | | | | |
| 4-3/8 | (111) | 0.58 | n/a | n/a | 0.53 | n/a | n/a | 0.55 | n/a | n/a | 0.14 | n/a | n/a | 0.28 | n/a | n/a | n/a | n/a | n/a |
| 5 | (127) | 0.60 | 0.58 | n/a | 0.56 | 0.53 | n/a | 0.55 | 0.54 | n/a | 0.17 | 0.12 | n/a | 0.35 | 0.25 | n/a | n/a | n/a | n/a |
| 6 | (152) | 0.61 | 0.60 | n/a | 0.61 | 0.58 | n/a | 0.56 | 0.55 | n/a | 0.23 | 0.16 | n/a | 0.46 | 0.33 | n/a | n/a | n/a | n/a |
| 6-1/4 | (159) | 0.62 | 0.60 | 0.58 | 0.62 | 0.59 | 0.53 | 0.56 | 0.55 | 0.54 | 0.24 | 0.17 | 0.11 | 0.49 | 0.35 | 0.23 | n/a | n/a | n/a |
| 7 | (178) | 0.63 | 0.62 | 0.59 | 0.66 | 0.62 | 0.56 | 0.57 | 0.56 | 0.54 | 0.29 | 0.21 | 0.13 | 0.57 | 0.41 | 0.27 | n/a | n/a | n/a |
| 8 | (203) | 0.65 | 0.63 | 0.61 | 0.71 | 0.66 | 0.59 | 0.58 | 0.57 | 0.55 | 0.35 | 0.25 | 0.16 | 0.70 | 0.51 | 0.33 | n/a | n/a | n/a |
| 8-5/8 | (219) | 0.67 | 0.64 | 0.61 | 0.75 | 0.69 | 0.61 | 0.59 | 0.57 | 0.55 | 0.39 | 0.28 | 0.18 | 0.75 | 0.57 | 0.37 | 0.60 | n/a | n/a |
| 9 | (229) | 0.67 | 0.65 | 0.62 | 0.77 | 0.71 | 0.62 | 0.59 | 0.57 | 0.56 | 0.42 | 0.30 | 0.20 | 0.77 | 0.60 | 0.39 | 0.61 | n/a | n/a |
| 10 | (254) | 0.69 | 0.67 | 0.63 | 0.82 | 0.75 | 0.66 | 0.60 | 0.58 | 0.56 | 0.49 | 0.35 | 0.23 | 0.82 | 0.71 | 0.46 | 0.64 | n/a | n/a |
| 10-1/2 | (267) | 0.70 | 0.68 | 0.64 | 0.85 | 0.78 | 0.67 | 0.61 | 0.59 | 0.57 | 0.53 | 0.38 | 0.25 | 0.85 | 0.76 | 0.49 | 0.66 | 0.59 | n/a |
| 11 | (279) | 0.71 | 0.68 | 0.65 | 0.88 | 0.80 | 0.69 | 0.61 | 0.59 | 0.57 | 0.57 | 0.41 | 0.26 | 0.88 | 0.80 | 0.53 | 0.68 | 0.61 | n/a |
| 12 | (305) | 0.73 | 0.70 | 0.66 | 0.94 | 0.85 | 0.73 | 0.62 | 0.60 | 0.57 | 0.65 | 0.46 | 0.30 | 0.94 | 0.85 | 0.60 | 0.71 | 0.63 | n/a |
| 13 | (330) | 0.75 | 0.72 | 0.67 | 1.00 | 0.90 | 0.76 | 0.63 | 0.61 | 0.58 | 0.73 | 0.52 | 0.34 | 1.00 | 0.90 | 0.68 | 0.73 | 0.66 | n/a |
| 13-3/4 | (349) | 0.76 | 0.73 | 0.68 | | 0.94 | 0.79 | 0.64 | 0.61 | 0.59 | 0.79 | 0.57 | 0.37 | | 0.94 | 0.74 | 0.76 | 0.68 | 0.59 |
| 14 | (356) | 0.77 | 0.73 | 0.68 | | 0.95 | 0.80 | 0.65 | 0.62 | 0.59 | 0.81 | 0.59 | 0.38 | | 0.95 | 0.76 | 0.76 | 0.68 | 0.59 |
| 15 | (381) | 0.79 | 0.75 | 0.70 | | 1.00 | 0.84 | 0.66 | 0.62 | 0.59 | 0.90 | 0.65 | 0.42 | | 1.00 | 0.84 | 0.79 | 0.71 | 0.61 |
| 16 | (406) | 0.81 | 0.77 | 0.71 | | | 0.88 | 0.67 | 0.63 | 0.60 | 0.99 | 0.71 | 0.46 | | | 0.88 | 0.81 | 0.73 | 0.63 |
| 17 | (432) | 0.83 | 0.78 | 0.72 | | | 0.92 | 0.68 | 0.64 | 0.61 | 1.00 | 0.78 | 0.51 | | | 0.92 | 0.84 | 0.75 | 0.65 |
| 18 | (457) | 0.84 | 0.80 | 0.74 | | | 0.96 | 0.69 | 0.65 | 0.61 | | 0.85 | 0.55 | | | 0.96 | 0.86 | 0.77 | 0.67 |
| 20 | (508) | 0.88 | 0.84 | 0.76 | | | 1.00 | 0.71 | 0.67 | 0.62 | | 1.00 | 0.65 | | | 1.00 | 0.91 | 0.82 | 0.71 |
| 24 | (610) | 0.96 | 0.90 | 0.82 | | | | 0.75 | 0.70 | 0.65 | | | 0.85 | | | | 1.00 | 0.89 | 0.77 |
| 30 | (762) | 1.00 | 1.00 | 0.90 | | | | 0.81 | 0.75 | 0.69 | | | 1.00 | | | | | 1.00 | 0.87 |
| 36 | (914) | | | 0.97 | | | | 0.87 | 0.80 | 0.72 | | | | | | | | | 0.95 |
| > 48 | (1219) | | | 1.00 | | | | 1.00 | 0.90 | 0.80 | | | | | | | | | 1.00 |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance c < 3*$h_{ef}$. If c ≥ 3*$h_{ef}$, then $f_{HV}$ = 1.0.

**Hilti HVU2 with Hilti HIS-N Inserts**



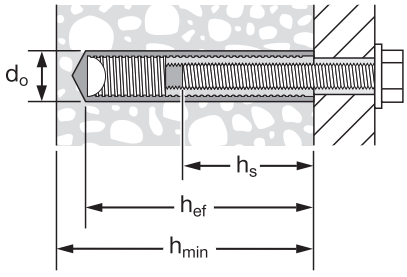
## Figure 3 — Hilti HIS-N and HIS-RN internally threaded insert installation conditions




## Table 11 — Hilti HIS-N and HIS-RN internally threaded insert installation specifications

| Setting information | | Symbol | Units | Thread Size | | | |
|---|---|---|---|---|---|---|---|
| | | | | 3/8-16 UNC | 1/2-13 UNC | 5/8-11 UNC | 3/4-10 UNC |
| Outside diameter of insert | | | in. | 0.65 | 0.81 | 1.00 | 1.09 |
| Nominal bit diameter (all drilling methods) | | $d_o$ | in. | 11/16 | 7/8 | 1-1/8 | 1-1/4 |
| Effective embedment | | $h_{ef}$ | in.<br>(mm) | 4-3/8<br>(110) | 5<br>(125) | 6-3/4<br>(170) | 8-1/8<br>(205) |
| Thread engagement | minimum | $h_s$ | in. | 3/8 | 1/2 | 5/8 | 3/4 |
| | maximum | | in. | 15/16 | 1-3/16 | 1-1/2 | 1-7/8 |
| Installation torque | | $T_{inst}$ | ft-lb<br>(Nm) | 15<br>(20) | 30<br>(41) | 60<br>(81) | 100<br>(136) |
| Minimum Concrete Thickness | | $h_{min}$ | in.<br>(mm) | 5-7/8<br>(150) | 6-3/4<br>(170) | 9<br>(230) | 10-5/8<br>(270) |
| Minimum edge distance | | $c_{min}$ | in.<br>(mm) | 3-1/4<br>(83) | 4<br>(102) | 5<br>(127) | 5-1/2<br>(140) |
| Minimum spacing | | $s_{min}$ | in.<br>(mm) | 3-1/4<br>(83) | 4<br>(102) | 5<br>(127) | 5-1/2<br>(140) |

## Figure 4 — Hilti HIS-N and HIS-RN internally threaded inserts installed with Hilti HVU2 adhesive capsules

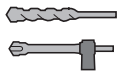


# DESIGN OF HILTI HVU2 ADHESIVE CAPSULES WITH HIS-N AND HIS-RN INSERTS PER ACI 318 CHAPTER 17

Hilti HVU2 adhesive capsule testing for ICC-ES ESR-4372 did not include the Hilti HIS-N and HIS-RN inserts. Additional testing was performed with the HIS-N and HIS-RN inserts and the results evaluated per ACI 355.4 and ICC-ES AC308 and published in the following tables. The tables include the design parameters per ACI 318 Ch. 17 and the parameters are calculated using
ACI 318 Ch. 17 to develop the Hilti Simplified Design Tables. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8.



## Table 12 — HVU2 adhesive capsule design information with Hilti HIS-N and HIS-RN internally threaded inserts per ACI 318 Chapter 17 [1]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

| Setting information | | Symbol | Units | Nominal bolt/cap screw diameter (in) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 |
| HIS insert outside diameter | | $d_a$ | in.<br>(mm) | 0.65<br>(16.5) | 0.81<br>(20.5) | 1.00<br>(25.4) | 1.09<br>(27.6) |
| Effective embedment [2] | | $h_{ef}$ | in.<br>(mm) | 4-1/4<br>(110) | 5<br>(125) | 6-3/4<br>(170) | 8-1/8<br>(205) |
| Minimum concrete thickness [2] | | $h_{min}$ | in.<br>(mm) | 5-7/8<br>(150) | 6-3/4<br>(170) | 9<br>(230) | 10-5/8<br>(270) |
| Critical edge distance | | $c_{ac}$ | - | See footnote 8 below | | | |
| Minimum edge distance | | $c_{min}$ | in.<br>(mm) | 3-1/4<br>(83) | 4<br>(102) | 5<br>(127) | 5-1/2<br>(140) |
| Minimum anchor spacing | | $s_{min}$ | in.<br>(mm) | 3-1/4<br>(83) | 4<br>(102) | 5<br>(127) | 5-1/2<br>(140) |
| Effectiveness factor for uncracked concrete [3] | | $k_{c,uncr}$ | in-lb<br>(SI) | 24<br>(10.0) | | | |
| Effectiveness factor for cracked concrete [3] | | $k_{c,cr}$ | in-lb<br>(SI) | 17<br>(7.1) | | | |
| Strength reduction factor for concrete failure in tension [4] | | $\Phi_{c,N}$ | - | 0.65 | | | |
| Strength reduction factor for concrete failure in shear [4] | | $\Phi_{c,V}$ | - | 0.70 | | | |
| Temp. range A [5] | Characteristic bond stress in cracked concrete [6,7] | $\tau_{cr}$ | psi<br>(MPa) | 725<br>(4.99) | 725<br>(4.99) | 725<br>(4.99) | 725<br>(4.99) |
| | Characteristic bond stress in uncracked concrete [6,7] | $\tau_{uncr}$ | psi<br>(MPa) | 1,490<br>(10.26) | 1,490<br>(10.26) | 1,490<br>(10.26) | 1,490<br>(10.26) |
| Temp. range B [5] | Characteristic bond stress in cracked concrete [6,7] | $\tau_{cr}$ | psi<br>(MPa) | 670<br>(4.63) | 670<br>(4.63) | 670<br>(4.63) | 670<br>(4.63) |
| | Characteristic bond stress in uncracked concrete [6,7] | $\tau_{uncr}$ | psi<br>(MPa) | 1,380<br>(9.53) | 1,380<br>(9.53) | 1,380<br>(9.53) | 1,380<br>(9.53) |
| Temp. range C [5] | Characteristic bond stress in cracked concrete [6,7] | $\tau_{cr}$ | psi<br>(MPa) | 420<br>(2.90) | 420<br>(2.90) | 420<br>(2.90) | 420<br>(2.90) |
| | Characteristic bond stress in uncracked concrete [6,7] | $\tau_{uncr}$ | psi<br>(MPa) | 865<br>(5.97) | 865<br>(5.97) | 865<br>(5.97) | 865<br>(5.97) |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | - | 1.0 | | | |
| Permissible installation conditions | Strength reduction factor for bond failure, dry concrete | Anchor category | - | 1 | | | |
| | | $\Phi_d$ | - | 0.65 | | | |
| | Strength reduction factor for bond failure, water-saturated concrete | Anchor category | - | 1 | | | |
| | | $\Phi_{ws}$ | - | 0.65 | | | |

1 Design information in this table is based on testing in accordance with ACI 355.4.
2 See Figure 4.
3 For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
4 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in ACI 318 17.3.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.
5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^n$ [for SI: $(f'_c / 17.2)^n$], where n is as follows:
n = 0 for uncracked concrete, all drilling methods
n = 0.26 for cracked concrete, carbide bit or Hilti hollow drill bit
7 Characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.
8 $c_{ac} = h_{ef} \cdot \left(\frac{\tau_{k,uncr}}{1{,}160}\right)^{0.4} \cdot \left[3.1 - 0.7 \cdot \frac{h}{h_{ef}}\right]$, where
$\frac{h}{h_{ef}}$ need not be greater than 2.4, and
$\tau_{k,uncr}$ need not be greater than $\tau_{k,uncr} = \frac{\tau_{k,uncr}\sqrt{h_{ef} \cdot f'_c}}{\pi \cdot d_a}$ (use imperial units in all equations)

## Table 13 — HVU2 adhesive capsule design information with Hilti HIS-N and HIS-RN internally threaded inserts per ACI 318 Chapter 17 [1,2]

 Diamond core drilling

| Setting information | | Symbol | Units | Nominal bolt/cap screw diameter (in) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 |
| Temp. range A [3] | Characteristic bond stress in cracked concrete [4,5] | $T_{cr}$ | psi | 505 | 505 | 505 | 505 |
| | | | (MPa) | (3.49) | (3.49) | (3.49) | (3.49) |
| | Characteristic bond stress in uncracked concrete [4,5] | $T_{uncr}$ | psi | 1,415 | 1,415 | 1,415 | 1,415 |
| | | | (MPa) | (9.77) | (9.77) | (9.77) | (9.77) |
| Temp. range B [3] | Characteristic bond stress in cracked concrete [4,5] | $T_{cr}$ | psi | 475 | 475 | 475 | 475 |
| | | | (MPa) | (3.28) | (3.28) | (3.28) | (3.28) |
| | Characteristic bond stress in uncracked concrete [4,5] | $T_{uncr}$ | psi | 1,330 | 1,330 | 1,330 | 1,330 |
| | | | (MPa) | (9.17) | (9.17) | (9.17) | (9.17) |
| Temp. range C [3] | Characteristic bond stress in cracked concrete [4,5] | $T_{cr}$ | psi | 305 | 305 | 305 | 305 |
| | | | (MPa) | (2.11) | (2.11) | (2.11) | (2.11) |
| | Characteristic bond stress in uncracked concrete [4,5] | $T_{uncr}$ | psi | 855 | 855 | 855 | 855 |
| | | | (MPa) | (5.89) | (5.89) | (5.89) | (5.89) |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | - | 1.0 | | | |

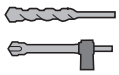
1 Design information in this table is based on testing in accordance with ACI 355.4.
2 Items from Table 12 ($d_a$, $h_{ef}$, $h_{min}$, $c_{ac}$, $c_{min}$, $s_{min}$, $k_{c,uncr}$, $k_{c,cr}$, and Φ factors) are applicable to this table for diamond core drilling.
3 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
4 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi
(55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^n$ [for SI: $(f'_c / 17.2)^n$], where n is as follows:
n = 0 for uncracked concrete, all drilling methods
n = 0.18 for cracked concrete, diamond core drill bit
5 Characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.

## Table 14 — Steel design strength for steel bolt and cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

| Thread size | ASTM A193 B7 | | | ASTM A193 Grade B8M stainless steel | | |
|---|---|---|---|---|---|---|
| | Tensile[4] $\phi N_{sa}$ lb (kN) | Shear[5] $\phi V_{sa}$ lb (kN) | Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN) | Tensile[4] $\phi N_{sa}$ lb (kN) | Shear[5] $\phi V_{sa}$ lb (kN) | Seismic Shear[6] $\phi V_{sa,eq}$ lb (kN) |
| 3/8-16 UNC | 6,300 | 3,490 | 2,445 | 5,540 | 3,070 | 2,150 |
| | (28.0) | (15.5) | (10.9) | (24.6) | (13.7) | (9.6) |
| 1/2-13 UNC | 11,530 | 6,385 | 4,470 | 10,145 | 5,620 | 3,935 |
| | (51.3) | (28.4) | (19.9) | (45.1) | (25.0) | (17.5) |
| 5/8-11 UNC | 18,365 | 10,170 | 7,120 | 16,160 | 8,950 | 6,265 |
| | (81.7) | (45.2) | (31.6) | (71.9) | (39.8) | (27.9) |
| 3/4-10 UNC | 27,180 | 15,055 | 10,540 | 23,915 | 13,245 | 9,270 |
| | (120.9) | (67.0) | (46.9) | (106.4) | (58.9) | (41.2) |

1 See section 3.1.8 to convert design strength (factored resistance) value to ASD value.
2 Hilti HIS-N and HIS-RN inserts with steel bolts are to be considered brittle steel elements.
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.
4 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
5 Shear values determined by static shear tests with $\phi V_{sa} \le \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.
6 Seismic Shear = $\alpha_{V,seis}\ \phi_{Vsa}$ : Reduction for seismic shear only. See section 3.1.8 for additional information on seismic applications.

## Table 15 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2,3,4,5,6,7,8,9]

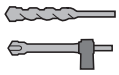


Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) |
| 3/8-16 UNC | 4-3/8 | 7,140 | 7,820 | 8,650 | 8,650 | 15,375 | 16,840 | 18,635 | 18,635 |
| | (110) | (31.8) | (34.8) | (38.5) | (38.5) | (68.4) | (74.9) | (82.9) | (82.9) |
| 1/2-13 UNC | 5 | 8,720 | 9,555 | 11,030 | 12,325 | 18,785 | 20,575 | 23,760 | 26,540 |
| | (125) | (38.8) | (42.5) | (49.1) | (54.8) | (83.6) | (91.5) | (105.7) | (118.1) |
| 5/8-11 UNC | 6-3/4 | 13,680 | 14,985 | 17,305 | 20,540 | 29,460 | 32,275 | 37,265 | 44,235 |
| | (170) | (60.9) | (66.7) | (77.0) | (91.4) | (131.0) | (143.6) | (165.8) | (196.8) |
| 3/4-10 UNC | 8-1/8 | 18,065 | 19,790 | 22,850 | 26,945 | 38,910 | 42,620 | 49,215 | 58,040 |
| | (205) | (80.4) | (88.0) | (101.6) | (119.9) | (173.1) | (189.6) | (218.9) | (258.2) |

3.2.6

## Table 16 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2,3,4,5,6,7,8,9,10]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) |
| 3/8-16 UNC | 4-3/8 | 4,210 | 4,415 | 4,755 | 5,285 | 9,070 | 9,510 | 10,245 | 11,385 |
| | (110) | (18.7) | (19.6) | (21.2) | (23.5) | (40.3) | (42.3) | (45.6) | (50.6) |
| 1/2-13 UNC | 5 | 5,995 | 6,285 | 6,775 | 7,530 | 12,915 | 13,540 | 14,595 | 16,215 |
| | (125) | (26.7) | (28.0) | (30.1) | (33.5) | (57.4) | (60.2) | (64.9) | (72.1) |
| 5/8-11 UNC | 6-3/4 | 9,690 | 10,480 | 11,290 | 12,550 | 20,870 | 22,570 | 24,320 | 27,025 |
| | (170) | (43.1) | (46.6) | (50.2) | (55.8) | (92.8) | (100.4) | (108.2) | (120.2) |
| 3/4-10 UNC | 8-1/8 | 12,795 | 13,750 | 14,815 | 16,465 | 27,560 | 29,610 | 31,910 | 35,460 |
| | (205) | (56.9) | (61.2) | (65.9) | (73.2) | (122.6) | (131.7) | (141.9) | (157.7) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 19 – 20 as necessary to the above values. Compare to the steel values in table 14. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.75.
See section 3.1.8 for additional information on seismic applications.

## Table 17 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2,3,4,5,6,7,8,9]


Diamond core drilling

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) |
| 3/8-16 UNC | 4-3/8 | 7,140 | 7,820 | 8,215 | 8,215 | 15,375 | 16,840 | 17,700 | 17,700 |
| | (111) | (31.8) | (34.8) | (36.5) | (36.5) | (68.4) | (74.9) | (78.7) | (78.7) |
| 1/2-13 UNC | 5 | 8,720 | 9,555 | 11,030 | 11,700 | 18,785 | 20,575 | 23,760 | 25,205 |
| | (127) | (38.8) | (42.5) | (49.1) | (52.0) | (83.6) | (91.5) | (105.7) | (112.1) |
| 5/8-11 UNC | 6-3/4 | 13,680 | 14,985 | 17,305 | 19,505 | 29,460 | 32,275 | 37,265 | 42,010 |
| | (171) | (60.9) | (66.7) | (77.0) | (86.8) | (131.0) | (143.6) | (165.8) | (186.9) |
| 3/4-10 UNC | 8-1/8 | 18,065 | 19,790 | 22,850 | 25,590 | 38,910 | 42,620 | 49,215 | 55,115 |
| | (206) | (80.4) | (88.0) | (101.6) | (113.8) | (173.1) | (189.6) | (218.9) | (245.2) |

## Table 18 — Hilti HVU2 adhesive design strength with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2,3,4,5,6,7,8,9,10]


Diamond core drilling

| Thread size | Effective embedment in. (mm) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) | $f'_c$ = 2500 psi (17.2 Mpa) lb (kN) | $f'_c$ = 3000 psi (20.7 Mpa) lb (kN) | $f'_c$ = 4000 psi (27.6 Mpa) lb (kN) | $f'_c$ = 6000 psi (41.4 Mpa) lb (kN) |
| 3/8-16 UNC | 4-3/8 | 2,935 | 3,030 | 3,190 | 3,435 | 6,315 | 6,525 | 6,875 | 7,395 |
| | (111) | (13.1) | (13.5) | (14.2) | (15.3) | (28.1) | (29.0) | (30.6) | (32.9) |
| 1/2-13 UNC | 5 | 4,175 | 4,315 | 4,545 | 4,890 | 8,995 | 9,295 | 9,790 | 10,530 |
| | (127) | (18.6) | (19.2) | (20.2) | (21.8) | (40.0) | (41.3) | (43.5) | (46.8) |
| 5/8-11 UNC | 6-3/4 | 6,960 | 7,195 | 7,575 | 8,150 | 14,990 | 15,495 | 16,315 | 17,550 |
| | (171) | (31.0) | (32.0) | (33.7) | (36.3) | (66.7) | (68.9) | (72.6) | (78.1) |
| 3/4-10 UNC | 8-1/8 | 9,135 | 9,440 | 9,940 | 10,690 | 19,670 | 20,325 | 21,405 | 23,030 |
| | (206) | (40.6) | (42.0) | (44.2) | (47.6) | (87.5) | (90.4) | (95.2) | (102.4) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 19 – 20 as necessary to the above values. Compare to the steel values in table 14. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.94.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.60.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.75.
See section 3.1.8 for additional information on seismic applications.

## Table 19 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2]

| HIS-N and HIS-RN all diameters cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear [3] $f_{AV}$ | | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | | Concrete thickness factor in shear [4] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thread size, in. | | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 |
| Embedment $h_{ef}$ | in. | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 |
| | (mm) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in (mm) | 3-1/4 (83) | 0.61 | n/a | n/a | n/a | 0.40 | n/a | n/a | n/a | 0.55 | n/a | n/a | n/a | 0.15 | n/a | n/a | n/a | 0.31 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.63 | 0.61 | n/a | n/a | 0.45 | 0.42 | n/a | n/a | 0.56 | 0.55 | n/a | n/a | 0.21 | 0.19 | n/a | n/a | 0.42 | 0.38 | n/a | n/a | n/a | n/a | n/a | n/a |
| | 5 (127) | 0.67 | 0.63 | 0.61 | n/a | 0.51 | 0.47 | 0.40 | n/a | 0.57 | 0.57 | 0.55 | n/a | 0.29 | 0.26 | 0.17 | n/a | 0.51 | 0.47 | 0.33 | n/a | n/a | n/a | n/a | n/a |
| | 5-1/2 (140) | 0.68 | 0.65 | 0.62 | 0.61 | 0.55 | 0.50 | 0.42 | 0.38 | 0.58 | 0.58 | 0.56 | 0.55 | 0.34 | 0.30 | 0.19 | 0.15 | 0.55 | 0.50 | 0.39 | 0.29 | n/a | n/a | n/a | n/a |
| | 6 (152) | 0.70 | 0.66 | 0.63 | 0.62 | 0.59 | 0.53 | 0.44 | 0.39 | 0.59 | 0.58 | 0.56 | 0.55 | 0.39 | 0.35 | 0.22 | 0.17 | 0.59 | 0.53 | 0.44 | 0.33 | 0.60 | n/a | n/a | n/a |
| | 7 (178) | 0.73 | 0.69 | 0.65 | 0.64 | 0.67 | 0.60 | 0.48 | 0.43 | 0.60 | 0.60 | 0.57 | 0.56 | 0.49 | 0.43 | 0.28 | 0.21 | 0.67 | 0.60 | 0.48 | 0.42 | 0.64 | 0.62 | n/a | n/a |
| | 8 (203) | 0.76 | 0.71 | 0.67 | 0.66 | 0.77 | 0.67 | 0.53 | 0.46 | 0.62 | 0.61 | 0.58 | 0.57 | 0.60 | 0.53 | 0.34 | 0.26 | 0.77 | 0.67 | 0.53 | 0.46 | 0.69 | 0.66 | n/a | n/a |
| | 9 (229) | 0.80 | 0.74 | 0.69 | 0.68 | 0.86 | 0.76 | 0.57 | 0.50 | 0.63 | 0.62 | 0.59 | 0.58 | 0.71 | 0.63 | 0.40 | 0.31 | 0.86 | 0.76 | 0.57 | 0.50 | 0.73 | 0.70 | 0.60 | n/a |
| | 10 (254) | 0.83 | 0.77 | 0.71 | 0.70 | 0.96 | 0.84 | 0.62 | 0.53 | 0.65 | 0.64 | 0.60 | 0.58 | 0.83 | 0.74 | 0.47 | 0.36 | 0.96 | 0.84 | 0.62 | 0.53 | 0.77 | 0.74 | 0.64 | n/a |
| | 11 (279) | 0.86 | 0.79 | 0.74 | 0.72 | 1.00 | 0.92 | 0.68 | 0.57 | 0.66 | 0.65 | 0.61 | 0.59 | 0.96 | 0.86 | 0.55 | 0.41 | 1.00 | 0.92 | 0.68 | 0.57 | 0.81 | 0.78 | 0.67 | 0.61 |
| | 12 (305) | 0.90 | 0.82 | 0.76 | 0.74 | | 1.00 | 0.74 | 0.61 | 0.68 | 0.66 | 0.62 | 0.60 | 1.00 | 0.98 | 0.62 | 0.47 | | 1.00 | 0.74 | 0.61 | 0.84 | 0.81 | 0.70 | 0.64 |
| | 14 (356) | 0.96 | 0.87 | 0.80 | 0.78 | | | 0.87 | 0.71 | 0.71 | 0.69 | 0.64 | 0.62 | | 1.00 | 0.78 | 0.59 | | | 0.87 | 0.71 | 0.91 | 0.87 | 0.75 | 0.69 |
| | 16 (406) | 1.00 | 0.92 | 0.84 | 0.82 | | | 0.99 | 0.82 | 0.74 | 0.72 | 0.66 | 0.63 | | | 0.96 | 0.73 | | | 0.99 | 0.82 | 0.97 | 0.94 | 0.80 | 0.73 |
| | 18 (457) | | 0.98 | 0.89 | 0.85 | | | 1.00 | 0.92 | 0.77 | 0.75 | 0.68 | 0.65 | | | 1.00 | 0.87 | | | 1.00 | 0.92 | 1.00 | 0.99 | 0.85 | 0.78 |
| | 24 (610) | | 1.00 | 1.00 | 0.97 | | | | 1.00 | 0.85 | 0.83 | 0.74 | 0.70 | | | | 1.00 | | | | 1.00 | | 1.00 | 0.99 | 0.90 |
| | 30 (762) | | | | 1.00 | | | | | 0.94 | 0.91 | 0.80 | 0.75 | | | | | | | | | | | 1.00 | 1.00 |
| | 36 (914) | | | | | | | | | 1.00 | 0.99 | 0.86 | 0.80 | | | | | | | | | | | | |
| | > 48 (1219) | | | | | | | | | | 1.00 | 0.99 | 0.90 | | | | | | | | | | | | |

## Table 20 — Load adjustment factors for Hilti HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2]

| HIS-N and HIS-RN all diameters cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear [3] $f_{AV}$ | | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | | Concrete thickness factor in shear [4] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thread size, in. | | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 | 3/8 | 1/2 | 5/8 | 3/4 |
| Embedment $h_{ef}$ | in. | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 | 4-3/8 | 5 | 6-3/4 | 8-1/8 |
| | (mm) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) | (111) | (127) | (171) | (206) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in (mm) | 3-1/4 (83) | 0.61 | n/a | n/a | n/a | 0.59 | n/a | n/a | n/a | 0.55 | n/a | n/a | n/a | 0.19 | n/a | n/a | n/a | 0.37 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4 (102) | 0.63 | 0.61 | n/a | n/a | 0.66 | 0.59 | n/a | n/a | 0.57 | 0.56 | n/a | n/a | 0.26 | 0.20 | n/a | n/a | 0.51 | 0.39 | n/a | n/a | n/a | n/a | n/a | n/a |
| | 5 (127) | 0.67 | 0.63 | 0.61 | n/a | 0.75 | 0.66 | 0.59 | n/a | 0.58 | 0.57 | 0.55 | n/a | 0.36 | 0.27 | 0.17 | n/a | 0.71 | 0.55 | 0.34 | n/a | n/a | n/a | n/a | n/a |
| | 5-1/2 (140) | 0.68 | 0.65 | 0.62 | 0.61 | 0.79 | 0.69 | 0.62 | 0.59 | 0.59 | 0.58 | 0.56 | 0.55 | 0.41 | 0.31 | 0.19 | 0.15 | 0.79 | 0.63 | 0.39 | 0.29 | n/a | n/a | n/a | n/a |
| | 6 (152) | 0.70 | 0.66 | 0.63 | 0.62 | 0.84 | 0.73 | 0.65 | 0.62 | 0.60 | 0.58 | 0.56 | 0.55 | 0.47 | 0.36 | 0.22 | 0.17 | 0.84 | 0.72 | 0.44 | 0.34 | 0.63 | n/a | n/a | n/a |
| | 7 (178) | 0.73 | 0.69 | 0.65 | 0.64 | 0.94 | 0.80 | 0.70 | 0.67 | 0.62 | 0.60 | 0.57 | 0.56 | 0.59 | 0.45 | 0.28 | 0.21 | 0.94 | 0.80 | 0.56 | 0.42 | 0.69 | 0.63 | n/a | n/a |
| | 8 (203) | 0.76 | 0.71 | 0.67 | 0.66 | 1.00 | 0.88 | 0.76 | 0.72 | 0.63 | 0.61 | 0.58 | 0.57 | 0.72 | 0.55 | 0.34 | 0.26 | 1.00 | 0.88 | 0.68 | 0.52 | 0.73 | 0.67 | n/a | n/a |
| | 9 (229) | 0.80 | 0.74 | 0.69 | 0.68 | | 0.96 | 0.83 | 0.78 | 0.65 | 0.63 | 0.59 | 0.58 | 0.86 | 0.66 | 0.41 | 0.31 | | 0.96 | 0.82 | 0.62 | 0.78 | 0.71 | 0.61 | n/a |
| | 10 (254) | 0.83 | 0.77 | 0.71 | 0.70 | | 1.00 | 0.89 | 0.84 | 0.67 | 0.64 | 0.60 | 0.58 | 1.00 | 0.77 | 0.48 | 0.36 | | 1.00 | 0.89 | 0.72 | 0.82 | 0.75 | 0.64 | n/a |
| | 11 (279) | 0.86 | 0.79 | 0.74 | 0.72 | | | 0.96 | 0.90 | 0.68 | 0.65 | 0.61 | 0.59 | | 0.89 | 0.55 | 0.42 | | | 0.96 | 0.83 | 0.86 | 0.79 | 0.67 | 0.61 |
| | 12 (305) | 0.90 | 0.82 | 0.76 | 0.74 | | | 1.00 | 0.96 | 0.70 | 0.67 | 0.62 | 0.60 | | 1.00 | 0.63 | 0.48 | | | 1.00 | 0.95 | 0.90 | 0.82 | 0.70 | 0.64 |
| | 14 (356) | 0.96 | 0.87 | 0.80 | 0.78 | | | | 1.00 | 0.73 | 0.70 | 0.64 | 0.62 | | | 0.79 | 0.60 | | | | 1.00 | 0.97 | 0.89 | 0.76 | 0.69 |
| | 16 (406) | 1.00 | 0.92 | 0.84 | 0.82 | | | | | 0.77 | 0.72 | 0.66 | 0.64 | | | 0.97 | 0.73 | | | | | 1.00 | 0.95 | 0.81 | 0.74 |
| | 18 (457) | | 0.98 | 0.89 | 0.85 | | | | | 0.80 | 0.75 | 0.68 | 0.65 | | | 1.00 | 0.87 | | | | | | 1.00 | 0.86 | 0.78 |
| | 24 (610) | | 1.00 | 1.00 | 0.97 | | | | | 0.90 | 0.84 | 0.74 | 0.70 | | | | 1.00 | | | | | | | 0.99 | 0.90 |
| | 30 (762) | | | | 1.00 | | | | | 1.00 | 0.92 | 0.81 | 0.75 | | | | | | | | | | | 1.00 | 1.00 |
| | 36 (914) | | | | | | | | | | 1.00 | 0.87 | 0.80 | | | | | | | | | | | | |
| | > 48 (1219) | | | | | | | | | | | 0.99 | 0.91 | | | | | | | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a four-anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3*h_{ef}$. If $c \geq 3*h_{ef}$, then $f_{HV} = 1.0$.

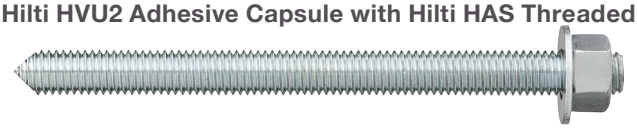
# DESIGN DATA IN CONCRETE PER CSA A23.3

## CSA A23.3 Annex D design

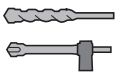
This section contains the Limit State Design tables with un-factored characteristic loads and pre-calculated factored resistance tables based on the published loads in ICC Evaluation Services ESR-4372 and testing per ACI 355.4.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

### Hilti HVU2 Adhesive Capsule with Hilti HAS Threaded Rod



Hilti HAS threaded rod with setting tip — See Table 1 and Figures 1 and 2 of this document for installation parameters



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

### Table 21 — Hilti HVU2 adhesive capsule design information with HAS threaded rods per CSA A23.3 Annex D [1]

| Setting information | | Symbol | Units | Nominal rod diameter (in.) | | | | | | | Ref A23.3-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 [8] | |
| Nominal anchor diameter | | $d_a$ | mm | 9.5 | 12.7 | 15.9 | 19.1 | 22.2 | 25.4 | 31.8 | |
| Effective embedment [2] | | $h_{ef}$ | mm | 89 | 108 | 127 | 168 | 168 | 210 | 279 | |
| Min. concrete thickness [2] | | $h_{min}$ | mm | 121 | 140 | 162 | 213 | 219 | 267 | 349 | |
| Critical edge distance | | $c_{ac}$ | - | See footnote 9 below | | | | | | | |
| Minimum edge distance | | $c_{min}$ | mm | 48 | 64 | 79 | 95 | 111 | 127 | 159 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 48 | 64 | 79 | 95 | 111 | 127 | 159 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete [3] | | $k_{c,uncr}$ | - | 10 | | | | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete [3] | | $k_{c,cr}$ | - | 7 | | | | | | | D.6.2.2 |
| Concrete material resistance factor | | $\Phi_c$ | - | 0.65 | | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B [4] | | $R_{conc}$ | - | 1.00 | | | | | | | D.5.3 (c ) |
| Temp. range A [5] | Characteristic bond stress in cracked concrete [6,7] | $\tau_{cr}$ | psi (MPa) | - - | 1,055 (7.3) | 1,055 (7.3) | 1,055 (7.3) | 1,055 (7.3) | 1,055 (7.3) | 1,055 (7.3) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [6,7] | $\tau_{uncr}$ | psi (MPa) | 1,475 (10.2) | 1,950 (13.5) | 1,950 (13.5) | 1,950 (13.5) | 1,950 (13.5) | 1,950 (13.5) | 2,015 (13.9) | D.6.5.2 |
| Temp. range B [5] | Characteristic bond stress in cracked concrete [6,7] | $\tau_{cr}$ | psi (MPa) | - - | 980 (6.8) | 980 (6.8) | 980 (6.8) | 980 (6.8) | 980 (6.8) | 980 (6.8) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [6,7] | $\tau_{uncr}$ | psi (MPa) | 1,370 (9.5) | 1,815 (12.5) | 1,815 (12.5) | 1,815 (12.5) | 1,815 (12.5) | 1,815 (12.5) | 1,870 (12.9) | D.6.5.2 |
| Temp. range C [5] | Characteristic bond stress in cracked concrete [6,7] | $\tau_{cr}$ | psi (MPa) | - - | 615 (4.2) | 615 (4.2) | 615 (4.2) | 615 (4.2) | 615 (4.2) | 615 (4.2) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [6,7] | $\tau_{uncr}$ | psi (MPa) | 860 (5.9) | 1,135 (7.8) | 1,135 (7.8) | 1,135 (7.8) | 1,135 (7.8) | 1,135 (7.8) | 1,170 (8.1) | D.6.5.2 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | - | - | 1.0 | | | | | | |
| Permissible installation conditions | Strength reduction factor for bond failure, dry concrete | Anchor category | - | 1 | | | | | | | D.5.3 (c ) |
| | | $R_{dry}$ | - | 1.00 | | | | | | | |
| | Strength reduction factor for bond failure, water-saturated concrete | Anchor category | - | 1 | | | | | | | D.5.3 (c ) |
| | | $R_{ws}$ | - | 1.00 | | | | | | | |

1 Design information in this table is taken from ICC-ES ESR-4372, dated May, 2019, Tables 4 and 5, and converted for use with CSA A23.3 Annex D.

2 See Figure 2.

3 For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

6 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^n$ [for SI: $(f'_c / 17.2)^n$].
where n is as follows:
n = 0.26 for uncracked concrete
n = 0.14 for cracked concrete

7 For 3/8-in. to 1-in. rods, characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.

8 1-1/4-in. diameter rods to be installed in generally vertically downward direction only.

9 $c_{ac} = h_{ef} \cdot \left(\frac{\tau_{k,uncr}}{1{,}160}\right)^{0.4} \cdot \left[3.1 - 0.7 \cdot \frac{h}{h_{ef}}\right]$, where

$\frac{h}{h_{ef}}$ need not be greater than 2.4, and

$\tau_{k,uncr}$ need not be greater than $\tau_{k,uncr} = \frac{\tau_{k,uncr}\sqrt{h_{ef} \cdot f'_c}}{\pi \cdot d_a}$ (use imperial units in all equations)

## Table 22 — Hilti HVU2 design information with HAS threaded rods per CSA A23.3 Annex D [1,2]


Diamond core drilling

| Design parameter | | Symbol | Units | Nominal rod diameter (in.) | | | | | | Ref A23.3-14 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/4 [6] | |
| Temp. range A [3] | Characteristic bond stress in cracked concrete [4,5] | $\tau_{cr}$ | psi (MPa) | 1,075 (7.4) | 1,075 (7.4) | 1,075 (7.4) | 1,075 (7.4) | 1,075 (7.4) | 1,075 (7.4) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [4,5] | $\tau_{uncr}$ | psi (MPa) | 1,830 (12.6) | 1,830 (12.6) | 1,830 (12.6) | 1,830 (12.6) | 1,830 (12.6) | 1,885 (13.0) | D.6.5.2 |
| Temp. range B [3] | Characteristic bond stress in cracked concrete [4,5] | $\tau_{cr}$ | psi (MPa) | 1,010 (7.0) | 1,010 (7.0) | 1,010 (7.0) | 1,010 (7.0) | 1,010 (7.0) | 1,010 (7.0) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [4,5] | $\tau_{uncr}$ | psi (MPa) | 1,720 (11.9) | 1,720 (11.9) | 1,720 (11.9) | 1,720 (11.9) | 1,720 (11.9) | 1,770 (12.2) | D.6.5.2 |
| Temp. range C [3] | Characteristic bond stress in cracked concrete [4,5] | $\tau_{cr}$ | psi (MPa) | 650 (4.5) | 650 (4.5) | 650 (4.5) | 650 (4.5) | 650 (4.5) | 650 (4.5) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [4,5] | $\tau_{uncr}$ | psi (MPa) | 1,105 (7.6) | 1,105 (7.6) | 1,105 (7.6) | 1,105 (7.6) | 1,105 (7.6) | 1,135 (7.8) | D.6.5.2 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | - | 1.0 | | | | | | |

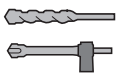
1 Design information in this table is taken from ICC-ES ESR-4372, dated May, 2019, Tables 4 and 5, and converted for use with CSA A23.3Annex D.
2 Items from Table 21 ($d_a$, $h_{ef}$, $h_{min}$, $c_{ac}$, $c_{min}$, $s_{min}$, $k_{c,uncr}$, $k_{c,cr}$, and Φ factors) are applicable to this table for diamond core drilling.
3 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
4 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^n$ [for SI: $(f'_c / 17.2)^n$].
where n is as follows:
n = 0.26 for uncracked concrete
n = 0 for cracked concrete
5 For 1/2-in. to 1-in. rods, characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.
6 1-1/4-in. diameter rods to be installed in generally vertically downward direction only.

## Table 23 — Steel factored resistance for Hilti HAS threaded rods for use with CSA A23.3 Annex D

| Nominal anchor diameter in. | HAS-E-55 / HAS-E-55 HDG ASTM F1554 Gr. 55[4,6] | | | HAS-B-105 / HAS-B-105 HDG ASTM A193 B7 and ASTM F 1554 Gr.105[4,6] | | | HAS-R stainless steel ASTM F593 (3/8-in to 1-in)[5] ASTM A193 (1-1/8-in to 2-in)[4] | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[1] $\Phi N_{sar}$ lb (kN) | Shear[2] $\Phi V_{sar}$ lb (kN) | Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN) | Tensile[1] $\Phi N_{sar}$ lb (kN) | Shear[2] $\Phi V_{sar}$ lb (kN) | Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN) | Tensile[1] $\Phi N_{sar}$ lb (kN) | Shear[2] $\Phi V_{sar}$ lb (kN) | Seismic Shear[3] $\Phi V_{sar,eq}$ lb (kN) |
| 3/8 | 3,955 (17.6) | 2,225 (9.9) | 1,560 (6.9) | 6,570 (29.2) | 3,695 (16.4) | 2,585 (11.5) | 4,610 (20.5) | 2,570 (11.4) | 1,800 (8.0) |
| 1/2 | 7,240 (32.2) | 4,070 (18.1) | 2,850 (12.7) | 12,035 (53.5) | 6,765 (30.1) | 4,735 (21.1) | 8,445 (37.6) | 4,705 (20.9) | 3,295 (14.7) |
| 5/8 | 11,525 (51.3) | 6,485 (28.8) | 4,540 (20.2) | 19,160 (85.2) | 10,780 (48.0) | 7,545 (33.6) | 13,445 (59.8) | 7,490 (33.3) | 5,245 (23.3) |
| 3/4 | 17,060 (75.9) | 9,600 (42.7) | 6,720 (29.9) | 28,365 (126.2) | 15,955 (71.0) | 11,170 (49.7) | 16,920 (75.3) | 9,425 (41.9) | 6,600 (29.4) |
| 7/8 | 23,550 (104.8) | 13,245 (58.9) | 9,270 (41.2) | 39,150 (174.1) | 22,020 (97.9) | 15,415 (68.6) | 23,350 (103.9) | 13,010 (57.9) | 9,105 (40.5) |
| 1 | 30,890 (137.4) | 17,380 (77.3) | 12,165 (54.1) | 51,360 (228.5) | 28,890 (128.5) | 20,225 (90.0) | 30,635 (136.3) | 17,065 (75.9) | 11,945 (53.1) |
| 1-1/4 | 49,425 (219.9) | 27,800 (123.7) | 19,460 (86.6) | 82,175 (365.5) | 46,220 (205.6) | 32,355 (143.9) | 37,565 (167.1) | 21,130 (94.0) | 12,680 (56.4) |

1 Tensile = $A_{se,N}$ ϕ $f_{uta}$ R as noted in CSA A23.3Eq. D.2.
2 Shear = $A_{se,V}$ ϕ 0.60 $f_{uta}$ R as noted in CSA A23.3 Eq. D.31.
3 Seismic Shear = $\alpha_{V,seis}$ $V_{sar}$ : Reduction factor for seismic shear only. See CSA A23.3 Annex D for additional information on seismic applications. Seismic shear for HIT-RE 500 V3
4 HAS-E (3/8-in to 1-1/4-in), HAS-B, and HAS-R (Class 1; 1-1/4-in) threaded rods are considered ductile steel elements (including HDG rods).
5 HAS-R (CW1 and CW2; 3/8-in to 1-in) threaded rods are considered brittle steel elements.
6 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-E-55, and HAS-B-105 (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

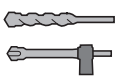
## Table 24 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for threaded rod in uncracked concrete [1,2,3,4,5,6,7,8,9]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $N_r$ | | | | Shear — $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 3-1/2 | 4,110 | 4,360 | 4,570 | 4,925 | 8,225 | 8,715 | 9,140 | 9,850 |
| | (89) | (18.3) | (19.4) | (20.3) | (21.9) | (36.6) | (38.8) | (40.7) | (43.8) |
| 1/2 | 4-1/4 | 7,330 | 8,195 | 8,975 | 10,365 | 14,660 | 16,390 | 17,955 | 20,730 |
| | (108) | (32.6) | (36.5) | (39.9) | (46.1) | (65.2) | (72.9) | (79.9) | (92.2) |
| 5/8 | 5 | 9,355 | 10,455 | 11,455 | 13,225 | 18,705 | 20,915 | 22,910 | 26,455 |
| | (127) | (41.6) | (46.5) | (51.0) | (58.8) | (83.2) | (93.0) | (101.9) | (117.7) |
| 3/4 | 6-5/8 | 14,265 | 15,950 | 17,470 | 20,175 | 28,530 | 31,900 | 34,940 | 40,350 |
| | (168) | (63.5) | (70.9) | (77.7) | (89.7) | (126.9) | (141.9) | (155.4) | (179.5) |
| 7/8 | 6-5/8 | 14,265 | 15,950 | 17,470 | 20,175 | 28,530 | 31,900 | 34,940 | 40,350 |
| | (168) | (63.5) | (70.9) | (77.7) | (89.7) | (126.9) | (141.9) | (155.4) | (179.5) |
| 1 | 8-1/4 | 19,825 | 22,165 | 24,280 | 28,035 | 39,645 | 44,325 | 48,555 | 56,070 |
| | (210) | (88.2) | (98.6) | (108.0) | (124.7) | (176.4) | (197.2) | (216.0) | (249.4) |
| 1-1/4 [10] | 11 | 30,520 | 34,120 | 37,380 | 43,160 | 61,040 | 68,245 | 74,760 | 86,325 |
| | (279) | (135.8) | (151.8) | (166.3) | (192.0) | (271.5) | (303.6) | (332.5) | (384.0) |

## Table 25 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9,11]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $N_r$ | | | | Shear — $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/2 | 4-1/4 | 4,675 | 4,825 | 4,950 | 5,155 | 9,355 | 9,650 | 9,900 | 10,305 |
| | (108) | (20.8) | (21.5) | (22.0) | (22.9) | (41.6) | (42.9) | (44.0) | (45.8) |
| 5/8 | 5 | 6,545 | 7,095 | 7,280 | 7,580 | 13,095 | 14,190 | 14,560 | 15,155 |
| | (127) | (29.1) | (31.6) | (32.4) | (33.7) | (58.2) | (63.1) | (64.8) | (67.4) |
| 3/4 | 6-5/8 | 9,985 | 11,165 | 11,575 | 12,050 | 19,970 | 22,330 | 23,150 | 24,100 |
| | (168) | (44.4) | (49.7) | (51.5) | (53.6) | (88.8) | (99.3) | (103.0) | (107.2) |
| 7/8 | 6-5/8 | 9,985 | 11,165 | 12,230 | 14,060 | 19,970 | 22,330 | 24,460 | 28,115 |
| | (168) | (44.4) | (49.7) | (54.4) | (62.5) | (88.8) | (99.3) | (108.8) | (125.1) |
| 1 | 8-1/4 | 13,875 | 15,515 | 16,995 | 19,625 | 27,755 | 31,030 | 33,990 | 39,250 |
| | (210) | (61.7) | (69.0) | (75.6) | (87.3) | (123.4) | (138.0) | (151.2) | (174.6) |
| 1-1/4 [10] | 11 | 21,365 | 23,885 | 26,165 | 30,215 | 42,730 | 47,770 | 52,330 | 60,425 |
| | (279) | (95.0) | (106.2) | (116.4) | (134.4) | (190.1) | (212.5) | (232.8) | (268.8) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7 – 10 as necessary. Compare to the steel values in table 23. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 For 3/8-in to 1-in dia. threaded rods, tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 1-1/4-in diameter rods to be installed in generally vertically downward direction only.
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.75.
See section 3.1.8 for additional information on seismic applications.

## Table 26 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for threaded rod in uncracked concrete [1,2,3,4,5,6,7,8]


Diamond core drilling

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $N_r$ | | | | Shear — $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/2 | 4-1/4 (108) | 7,330 (32.6) | 8,195 (36.5) | 8,975 (39.9) | 9,890 (44.0) | 14,660 (65.2) | 16,390 (72.9) | 17,955 (79.9) | 19,785 (88.0) |
| 5/8 | 5 (127) | 9,355 (41.6) | 10,455 (46.5) | 11,455 (51.0) | 13,225 (58.8) | 18,705 (83.2) | 20,915 (93.0) | 22,910 (101.9) | 26,455 (117.7) |
| 3/4 | 6-5/8 (168) | 14,265 (63.5) | 15,950 (70.9) | 17,470 (77.7) | 20,175 (89.7) | 28,530 (126.9) | 31,900 (141.9) | 34,940 (155.4) | 40,350 (179.5) |
| 7/8 | 6-5/8 (168) | 14,265 (63.5) | 15,950 (70.9) | 17,470 (77.7) | 20,175 (89.7) | 28,530 (126.9) | 31,900 (141.9) | 34,940 (155.4) | 40,350 (179.5) |
| 1 | 8-1/4 (210) | 19,825 (88.2) | 22,165 (98.6) | 24,280 (108.0) | 28,035 (124.7) | 39,645 (176.4) | 44,325 (197.2) | 48,555 (216.0) | 56,070 (249.4) |
| 1-1/4 [10] | 11 (279) | 30,520 (135.8) | 34,120 (151.8) | 37,380 (166.3) | 43,160 (192.0) | 61,040 (271.5) | 68,245 (303.6) | 74,760 (332.5) | 86,325 (384.0) |

## Table 27 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for threaded rod in cracked concrete [1,2,3,4,5,6,7,8,9]


Diamond core drilling

| Nominal anchor diameter in. | Effective embedment in. (mm) | Tension — $N_r$ | | | | Shear — $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/2 | 4-1/4 (108) | 4,665 (20.8) | 4,665 (20.8) | 4,665 (20.8) | 4,665 (20.8) | 9,330 (41.5) | 9,330 (41.5) | 9,330 (41.5) | 9,330 (41.5) |
| 5/8 | 5 (127) | 6,545 (29.1) | 6,860 (30.5) | 6,860 (30.5) | 6,860 (30.5) | 13,095 (58.2) | 13,725 (61.0) | 13,725 (61.0) | 13,725 (61.0) |
| 3/4 | 6-5/8 (168) | 9,985 (44.4) | 10,910 (48.5) | 10,910 (48.5) | 10,910 (48.5) | 19,970 (88.8) | 21,820 (97.1) | 21,820 (97.1) | 21,820 (97.1) |
| 7/8 | 6-5/8 (168) | 9,985 (44.4) | 11,165 (49.7) | 12,230 (54.4) | 12,730 (56.6) | 19,970 (88.8) | 22,330 (99.3) | 24,460 (108.8) | 25,455 (113.2) |
| 1 | 8-1/4 (210) | 13,875 (61.7) | 15,515 (69.0) | 16,995 (75.6) | 18,115 (80.6) | 27,755 (123.4) | 31,030 (138.0) | 33,990 (151.2) | 36,230 (161.2) |
| 1-1/4 [10] | 11 (279) | 21,365 (95.0) | 23,885 (106.2) | 26,165 (116.4) | 30,190 (134.3) | 42,730 (190.1) | 47,770 (212.5) | 52,330 (232.8) | 60,385 (268.6) |

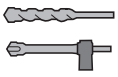
1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 7 – 10 as necessary. Compare to the steel values in table 23. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 For 1/2-in to 1-in dia. threaded rods, tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 1-1/4-in diameter rods to be installed in generally vertically downward direction only.
11 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.75.
See section 3.1.8 for additional information on seismic applications.

## Hilti HVU2 with Hilti HIS-N Inserts



Hilti HIS-N and HIS-RN internally threaded insert – See Table 11 and Figures 3 and 4 for installation parameters

### Table 28 — HVU2 adhesive capsule design information with Hilti HIS-N and HIS-RN internally threaded inserts per CSA A23.3 Annex D [1]



Hammer drilling with carbide tipped drill bit, orHilti TE-CD or TE-YD Hollow Drill Bit

| Design parameter | | Symbol | Units | Nominal bolt/cap screw diameter (in.) | | | | Ref A23.3-14 |
|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | |
| HIS insert outside diameter | | $d_a$ | mm | 16.5 | 20.5 | 25.4 | 27.6 | |
| Effective embedment [2] | | $h_{ef}$ | mm | 110 | 125 | 170 | 205 | |
| Min. concrete thickness [2] | | $h_{min}$ | mm | 150 | 170 | 230 | 270 | |
| Critical edge distance | | $c_{ac}$ | - | See footnote 8 below | | | | |
| Minimum edge distance | | $c_{min}$ | mm | 83 | 102 | 127 | 140 | |
| Minimum anchor spacing | | $s_{min}$ | mm | 83 | 102 | 127 | 140 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete [3] | | $k_{c,uncr}$ | - | 10 | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete [3] | | $k_{c,cr}$ | - | 7 | | | | D.6.2.2 |
| Concrete material resistance factor | | $\Phi_c$ | - | 0.65 | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B [4] | | $R_{conc}$ | - | 1.00 | | | | D.5.3 (c ) |
| Temp. range A [5] | Characteristic bond stress in cracked concrete [6,7] | $\tau_{cr}$ | psi (MPa) | 725 (4.99) | 725 (4.99) | 725 (4.99) | 725 (4.99) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [6,7] | $\tau_{uncr}$ | psi (MPa) | 1,490 (10.26) | 1,490 (10.26) | 1,490 (10.26) | 1,490 (10.26) | D.6.5.2 |
| Temp. range B [5] | Characteristic bond stress in cracked concrete [6,7] | $\tau_{cr}$ | psi (MPa) | 670 (4.63) | 670 (4.63) | 670 (4.63) | 670 (4.63) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [6,7] | $\tau_{uncr}$ | psi (MPa) | 1,380 (9.53) | 1,380 (9.53) | 1,380 (9.53) | 1,380 (9.53) | D.6.5.2 |
| Temp. range C [5] | Characteristic bond stress in cracked concrete [6,7] | $\tau_{cr}$ | psi (MPa) | 420 (2.90) | 420 (2.90) | 420 (2.90) | 420 (2.90) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [6,7] | $\tau_{uncr}$ | psi (MPa) | 865 (5.97) | 865 (5.97) | 865 (5.97) | 865 (5.97) | D.6.5.2 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | - | 1.0 | | | | |
| Permissible installation conditions | Strength reduction factor for bond failure, dry concrete | Anchor category | - | 1 | | | | D.5.3 (c ) |
| | | $R_{dry}$ | - | 1.00 | | | | |
| | Strength reduction factor for bond failure, water-saturated concrete | Anchor category | - | 1 | | | | D.5.3 (c ) |
| | | $R_{ws}$ | - | 1.00 | | | | |

1 Design information in this table is based on testing in accordance with ACI 355.4.
2 See Figure 4.
3 For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
4 Values provided for post-installed anchors under Condition B without supplementary reinforcement as defined in CSA A23.3 Section D.5.3.
For cases where the presence of supplementary reinforcement can be verified, the reduction factors associated with Condition A may be used.
5 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., over significant periods of time.
6 Bond strength values corresponding to concrete compressive strength $f'_c$ = 2,500 psi (17.2 MPa). For concrete compressive strength, $f'_c$, between
7 Characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.

8 $c_{ac} = h_{ef} \cdot \left(\frac{\tau_{k,uncr}}{1,160}\right)^{0.4} \cdot \left[3.1 - 0.7 \cdot \frac{h}{h_{ef}}\right]$, where

$\frac{h}{h_{ef}}$ need not be greater than 2.4, and

$\tau_{k,uncr}$ need not be greater than $\tau_{k,uncr} = \frac{\tau_{k,uncr}\sqrt{h_{ef} \cdot f'_c}}{\pi \cdot d_a}$ (use metric units in all equations)

## Table 29 — HVU2 adhesive capsule design information with Hilti HIS-N and HIS-RN internally threaded inserts per CSA A23.3 Annex D [1,2]


Diamond core drilling

| Design parameter | | Symbol | Units | Nominal rod diameter (in.) | | | | Ref A23.3-14 |
|---|---|---|---|---|---|---|---|---|
| | | | | 3/8 | 1/2 | 5/8 | 3/4 | |
| Temp. range A [3] | Characteristic bond stress in cracked concrete [4,5] | $\tau_{cr}$ | psi (MPa) | 505 (3.49) | 505 (3.49) | 505 (3.49) | 505 (3.49) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [4,5] | $\tau_{uncr}$ | psi (MPa) | 1,415 (9.77) | 1,415 (9.77) | 1,415 (9.77) | 1,415 (9.77) | D.6.5.2 |
| Temp. range B [3] | Characteristic bond stress in cracked concrete [4,5] | $\tau_{cr}$ | psi (MPa) | 475 (3.28) | 475 (3.28) | 475 (3.28) | 475 (3.28) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [4,5] | $\tau_{uncr}$ | psi (MPa) | 1,330 (9.17) | 1,330 (9.17) | 1,330 (9.17) | 1,330 (9.17) | D.6.5.2 |
| Temp. range C [3] | Characteristic bond stress in cracked concrete [4,5] | $\tau_{cr}$ | psi (MPa) | 305 (2.11) | 305 (2.11) | 305 (2.11) | 305 (2.11) | D.6.5.2 |
| | Characteristic bond stress in uncracked concrete [4,5] | $\tau_{uncr}$ | psi (MPa) | 855 (5.89) | 855 (5.89) | 855 (5.89) | 855 (5.89) | D.6.5.2 |
| Reduction for seismic tension | | $\alpha_{N,seis}$ | - | 1.0 | | | | |

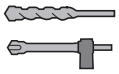
1 Design information in this table is based on testing in accordance with ACI 355.4.
2 Items from Table 28 ($d_a$, $h_{ef}$, $h_{min}$, $c_{ac}$, $c_{min}$, $s_{min}$, $k_{c,uncr}$, $k_{c,cr}$, R and Φ factors) are applicable to this table for diamond core drilling.
3 Temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
Temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C).
Temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C).
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
4 Bond strength values corresponding to concrete compressive strength f'c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'c, between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^n$ [for SI: $(f'_c / 17.2)^n$], where n is as follows:
n = 0 for uncracked concrete, all drilling methods
n = 0.18 for cracked concrete, diamond core drill bit
5 Characteristic bond strengths are for horizontal and vertical downward direction only. For overhead (vertical up) installation, bond strengths must be multiplied by 0.70.

## Table 30 — Steel factored resistance for steel bolt/cap screw for Hilti HIS-N and HIS-RN internally threaded inserts[1,2,3]

| Thread size | ASTM A193 B7 | | | ASTM A193 Grade B8M Stainless Steel | | |
|---|---|---|---|---|---|---|
| | Tensile[4] $N_{sar}$ lb (kN) | Shear[5] $V_{sar}$ lb (kN) | Seismic Shear[6] $V_{sar,eq}$ lb (kN) | Tensile[4] $N_{sar}$ lb (kN) | Shear[5] $V_{sar}$ lb (kN) | Seismic Shear[6] $V_{sar,eq}$ lb (kN) |
| 3/8-16 UNC | 5,765 (25.6) | 3,215 (14.3) | 2,250 (10.0) | 5,070 (22.6) | 2,825 (12.6) | 1,975 (8.8) |
| 1/2-13 UNC | 9,635 (42.9) | 5,880 (26.2) | 4,115 (18.3) | 9,290 (41.3) | 5,175 (23.0) | 3,620 (16.1) |
| 5/8-11 UNC | 16,020 (71.3) | 9,365 (41.7) | 6,555 (29.2) | 14,790 (65.8) | 8,240 (36.7) | 5,770 (25.7) |
| 3/4-10 UNC | 16,280 (72.4) | 13,860 (61.7) | 9,700 (43.1) | 21,895 (97.4) | 12,195 (54.2) | 8,535 (38.0) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Hilti HIS-N and HIS-RN inserts with steel bolts are considered brittle steel elements.
3 Table values are the lesser of steel failure in the HIS-N insert or inserted steel bolt.
4 Tensile = $A_{se,N}$ $\phi_s$ $f_{uta}$ R as noted in CSA A23.3 Annex D.
5 Shear = $A_{se,V}$ $\phi_s$ 0.60 $f_{uta}$ R as noted in CSA A23.3 Annex D. For 3/8-in diameter insert, shear = $A_{se,V}$ $\phi_s$ 0.50 $f_{uta}$ R.
6 Seismic Shear = $\alpha_{V,seis}$ $V_{sar}$ : Reduction factor for seismic shear only. See section 3.1.8 for additional information on seismic applications.

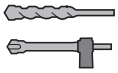
## Table 31 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2,3,4,5,6,7,8,9]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

| Thread size | Effective embedment in. (mm) | Tension — $N_r$ | | | | Shear — $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8-16 UNC | 4-3/8 (110) | 7,540 (33.5) | 8,430 (37.5) | 8,555 (38.0) | 8,555 (38.0) | 15,080 (67.1) | 16,860 (75.0) | 17,110 (76.1) | 17,110 (76.1) |
| 1/2-13 UNC | 5 (125) | 9,135 (40.6) | 10,210 (45.4) | 11,185 (49.8) | 12,115 (53.9) | 18,265 (81.3) | 20,420 (90.8) | 22,370 (99.5) | 24,225 (107.8) |
| 5/8-11 UNC | 6-3/4 (170) | 14,485 (64.4) | 16,195 (72.0) | 17,740 (78.9) | 20,340 (90.5) | 28,970 (128.9) | 32,390 (144.1) | 35,480 (157.8) | 40,675 (180.9) |
| 3/4-10 UNC | 8-1/8 (205) | 19,180 (85.3) | 21,445 (95.4) | 23,490 (104.5) | 26,735 (118.9) | 38,360 (170.6) | 42,890 (190.8) | 46,985 (209.0) | 53,465 (237.8) |

## Table 32 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2,3,4,5,6,7,8,9,10]



Hammer drilling with carbide tipped drill bit, or Hilti TE-CD or TE-YD Hollow Drill Bit

| Thread size | Effective embedment in. (mm) | Tension — $N_r$ | | | | Shear — $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8-16 UNC | 4-3/8 (110) | 4,325 (19.2) | 4,585 (20.4) | 4,810 (21.4) | 5,180 (23.0) | 8,655 (38.5) | 9,170 (40.8) | 9,615 (42.8) | 10,360 (46.1) |
| 1/2-13 UNC | 5 (125) | 6,125 (27.3) | 6,495 (28.9) | 6,810 (30.3) | 7,335 (32.6) | 12,255 (54.5) | 12,985 (57.8) | 13,615 (60.6) | 14,675 (65.3) |
| 5/8-11 UNC | 6-3/4 (170) | 10,140 (45.1) | 10,900 (48.5) | 11,430 (50.8) | 12,320 (54.8) | 20,280 (90.2) | 21,805 (97.0) | 22,860 (101.7) | 24,635 (109.6) |
| 3/4-10 UNC | 8-1/8 (205) | 13,425 (59.7) | 14,330 (63.7) | 15,025 (66.8) | 16,190 (72.0) | 26,855 (119.5) | 28,660 (127.5) | 30,050 (133.7) | 32,385 (144.0) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 19 – 20 as necessary to the above values. Compare to the steel values in table 30. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.93.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.58.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.75.
See section 3.1.8 for additional information on seismic applications.

## Table 33 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in uncracked concrete [1,2,3,4,5,6,7,8,9]



Diamond core drilling

| Thread size | Effective embedment in. (mm) | Tension — $N_r$ | | | | Shear — $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8-16 UNC | 4-3/8 (110) | 7,540 (33.5) | 8,145 (36.2) | 8,145 (36.2) | 8,145 (36.2) | 15,080 (67.1) | 16,290 (72.5) | 16,290 (72.5) | 16,290 (72.5) |
| 1/2-13 UNC | 5 (125) | 9,135 (40.6) | 10,210 (45.4) | 11,185 (49.8) | 11,535 (51.3) | 18,265 (81.3) | 20,420 (90.8) | 22,370 (99.5) | 23,070 (102.6) |
| 5/8-11 UNC | 6-3/4 (170) | 14,485 (64.4) | 16,195 (72.0) | 17,740 (78.9) | 19,365 (86.1) | 28,970 (128.9) | 32,390 (144.1) | 35,480 (157.8) | 38,735 (172.3) |
| 3/4-10 UNC | 8-1/8 (205) | 19,180 (85.3) | 21,445 (95.4) | 23,490 (104.5) | 25,455 (113.2) | 38,360 (170.6) | 42,890 (190.8) | 46,985 (209.0) | 50,910 (226.5) |



## Table 34 — Hilti HVU2 adhesive factored resistance with lesser of concrete or bond failure for HIS-N and HIS-RN internally threaded inserts in cracked concrete [1,2,3,4,5,6,7,8,9,10]



Diamond core drilling

| Thread size | Effective embedment in. (mm) | Tension — $N_r$ | | | | Shear — $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8-16 UNC | 4-3/8 (110) | 2,990 (13.3) | 3,110 (13.8) | 3,215 (14.3) | 3,385 (15.1) | 5,980 (26.6) | 6,225 (27.7) | 6,430 (28.6) | 6,775 (30.1) |
| 1/2-13 UNC | 5 (125) | 4,235 (18.8) | 4,405 (19.6) | 4,555 (20.3) | 4,795 (21.3) | 8,465 (37.7) | 8,815 (39.2) | 9,110 (40.5) | 9,595 (42.7) |
| 5/8-11 UNC | 6-3/4 (170) | 7,110 (31.6) | 7,400 (32.9) | 7,645 (34.0) | 8,055 (35.8) | 14,215 (63.2) | 14,800 (65.8) | 15,295 (68.0) | 16,105 (71.6) |
| 3/4-10 UNC | 8-1/8 (205) | 9,345 (41.6) | 9,725 (43.3) | 10,050 (44.7) | 10,585 (47.1) | 18,685 (83.1) | 19,455 (86.5) | 20,100 (89.4) | 21,170 (94.2) |

1 See Section 3.1.8 for explanation on development of load values.
2 See Section 3.1.8 to convert design strength value to ASD value.
3 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 19 – 20 as necessary to the above values. Compare to the steel values in table 30. The lesser of the values is to be used for the design.
5 Data is for temperature range A: Max. short term temperature = 130°F (55°C), max. long term temperature = 110°F (43°C).
For temperature range B: Max. short term temperature = 176°F (80°C), max. long term temperature = 110°F (43°C) multiply above value by 0.94.
For temperature range C: Max. short term temperature = 248°F (120°C), max. long term temperature = 162°F (72°C) multiply above value by 0.60.
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
6 Tabular values are for dry or water saturated concrete conditions.
7 Tabular values are for short term loads only. For sustained loads including overhead use, see Section 3.1.8.
8 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.51. For all-lightweight, $\lambda_a$ = 0.45.
9 Tabular values are for horizontal and vertical downward direction only. For overhead (vertical up) installation, tabular values must be multiplied by 0.70.
10 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic loads, multiply cracked concrete tabular values in tension and shear by $\alpha_{seis}$ = 0.75.
See section 3.1.8 for additional information on seismic applications.

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com and www.hilti.ca. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## MATERIAL SPECIFICATIONS

**Figure 5 — Hilti HVU2 adhesive cure time (approx.)**

| [°C] | [°F] | $t_{cure}$ |
|---|---|---|
| -10…-6 | 14…22 | 5 h |
| -5…-1 | 23…31 | 3 h |
| 0…4 | 32…40 | 40 min |
| 5…9 | 41…49 | 20 min |
| 10…19 | 50…67 | 10 min |
| 20…40 | 68…104 | 5 min |

**Table 35 — Material properties of fully cured Hilti HVU2 adhesive**

| | | |
|---|---|---|
| Compressive strength @ 73°F (23°C) / 50% humidity | 11,200 psi | 77.30 N/mm² |
| Tensile strength | 1,241 psi | 8.56 N/mm² |
| Water absorption after 24h | 0.26% | |

**Key for Table 36 Behavior:**

- non-resistant
+ resistant

Samples of cured HVU2 adhesive were immersed in the various chemical compounds at room temperature (77°F / 25°C) for 90 days. Samples that showed weight increase less than 4% were evaluated as Resistant" and samples that showed a weight increase greater than 6% were evaluated as Non-resistant".

Note: In actual use, the majority of the adhesive is encased in the base material, leaving very little surface area exposed.

**Table 36 — Resistance of fully cured Hilti HVU2 adhesive to chemicals**

| Chemical substance | Components | Content [Vol. %] | Behavior |
|---|---|---|---|
| Diesel-Fuel | Test mixture A 20/NP 2<br>Biodiesel | 95.0<br>5.0 | + |
| Alcohol | Methanol | 100.0 | - |
| Aliphatic halogenated hydrocarbons | Dichlormethane (Methylene chloride) | 100.0 | - |
| Aqueous organic surfactants/Tensides | Texapon N 28<br>Marlipal O 13/8<br>Water | 3.0<br>2.0<br>95.0 | + |
| Organic esters and ketones | Ethylacetate<br>Methylisobutylketone | 50.0<br>50.0 | + |
| Aqueous organic acids | Acqueous acetic acid (10%) | 100.0 | + |
| Organic acids | Acetic acid<br>Propionic acid | 50.0<br>50.0 | - |
| Inorganic acids | Sulfuric acid (20%) | 100.0 | + |
| Aliphatic Aldehydes | n-Butyraldehyde (Butanal)<br>n-Heptaldehyde (Heptanal) | 50.0<br>50.0 | + |
| Cyclic and acyclic ether | Tetrahydrofuran (THF) | 100.0 | - |
| Hydrocarbons | Toluene<br>Xylene<br>Methylnaphthalene | 60.0<br>30.0<br>10.0 | + |
| Benzene and benzene mixtures | Benzene<br>Toluene<br>Xylene<br>Methylnaphthalene | 30.0<br>30.0<br>30.0<br>10.0 | + |
| Inorganic bases | Sodium hydroxide (20%) | 100.0 | + |
| Amine | Triethanolamine<br>n-Butylamine<br>N,N-Dimethylaniline | 35.0<br>30.0<br>35.0 | - |

## ORDERING INFORMATION

| Order information |
|---|
| **Description** |
| Adhesive capsule HVU2 3/8" x 3 1/2" |
| Adhesive capsule HVU2 1/2" x 4 1/4" |
| Adhesive capsule HVU2 5/8" x 5" |
| Adhesive capsule HVU2 3/4" x 6 5/8" |
| Adhesive capsule HVU2 7/8" x 6 5/8" |
| Adhesive capsule HVU2 1" x 8 1/4" |
| Adhesive capsule HVU2 1 1/4" x 11" |

**Accessories**

① HAS anchor rods with setting tip



② HIS-N / HIS-RN internally threaded inserts

③ SF 6H-A22 cordless drill driver

④ SID 4-122 cordless impact driver



⑤ Hamer drill / combihammer

⑥ Tool shaft / sockets



# 3.2.7 HAS THREADED RODS AND HIT-Z ANCHOR RODS

Hilti has a full line of threaded rods available in 8 different material and coating types. Our new enhanced carbon steel rods now all meet the requirements of ASTM F1554, which allows engineers to design ductile fastening points with predictable steel failure for seismic applications in the three most common and relevant steel grades 36, 55 and 105.

Hilti still continues to provide the innovative HIT-Z anchor rods with HIT-HY 200 V3. This Hilti SafeSet system provides the ultimate in safety and load capacity combined with 60% faster installation due to zero-cleaning.

The following is the technical data and ordering information for diameters up to 1-1/4" and pre-cut lengths. Contact Hilti for additional information on HAS rod diameters up to 2-1/2" and custom lengths.

**Specifications and physical properties of Hilti HAS threaded rods and Hilti HIT-Z anchor rods**



| | Threaded Rod Specification | Units | Specified Ultimate Strength, $f_{uta}$ | | Minimum Specified Yield Strength 0.2% Offset, $f_{ya}$ | $f_{uta}$ / $f_{ya}$ | Elongation, Min. % | Reduction of Area, Min. % | Specification for Nuts and Washers |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min. | Max[6] | | | | | |
| CARBON STEEL | **HAS-V-A307**<br>1/4-in. to 5/16-in.<br>ASTM A307 Grade A[1,2] | psi<br>(MPa) | 60,000<br>(414) | NA | 37,500<br>(259) | 1.60 | 10 | - | **Nuts:**<br>SAE J995 Grade 5<br>**Washers:**<br>ASTM F884, HV and ANSI B18.22.1 Type A Plain |
| CARBON STEEL | **HAS-V / HAS-V-36 / HAS-V-36 HDG**<br>ASTM F1554, Grade 36 [1,3,9]<br>ASTM F1554 Compliant | psi<br>(MPa) | 58,000<br>(400) | 80,000<br>(552) | 36,000<br>(248) | 1.61 | 23 | 40 | **Nuts:**<br>ASTM A194/194M, Grade 2H, Heavy or ASTM A563-15 Grade A, Heavy<br>**Washers:**<br>ASTM F436 Type 1 and ANSI B18.22.1 Type A Plain |
| CARBON STEEL | **HAS-E-55 / HAS-E-55 HDG**<br>ASTM F1554, Grade 55[1,3,9]<br>ASTM F1554 Compliant | psi<br>(MPa) | 75,000<br>(517) | 95,000<br>(655) | 55,000<br>(379) | 1.36 | 21 | 30 (3/8" - 2")<br>22 (2-1/4" - 2-1/2") | |
| CARBON STEEL | **HAS-B 105 / HAS-B-105 HDG**<br>ASTM A193, Grade B7[1,4]<br>ASTM F1554, Grade 105[1,3,9]<br>ASTM F1554 Compliant | psi<br>(MPa) | 125,000[7]<br>(862)[7] | 150,000<br>(1,034) | 105,000<br>(724) | 1.19 | 16 (B7)<br>15 (Gr. 105) | 50 (B7)<br>45 (Gr. 105) | **Nuts:**<br>ASTM A194/194M, Grade 2H, Heavy or ASTM A563-15 Grade C<br>**Washers:**<br>ASTM F436 Type 1 and ANSI B18.22.1 Type A Plain |
| CARBON STEEL | **HIT-Z Anchor rod**<br>(HIT-HY 200 V3 only)<br>Unalloyed carbon steel [1] | psi<br>(MPa) | 94,200<br>(650) | NA | 75,300<br>(519) | 1.25 | 8 | 20 | **Nuts:**<br>ASTM A563 Gr. A<br>**Washers:**<br>ASTM F844, HV and ANSI B18.22.1 Type A Plain |
| STAINLESS STEEL | **HAS-R 304 / 316**<br>3/8-in. 5/8-in. AISI Type 304 / 316 ASTM F 593 CW1[5] | psi<br>(MPa) | 100,000<br>(690) | 150,000<br>(1,034) | 65,000<br>(448) | 1.54 | 20 | - | **Nuts:**<br>ASTM F594<br>**Washers:**<br>ASTM A240 and ANSI B18.22.1 Type A Plain |
| STAINLESS STEEL | **HAS-R 304 / 316**<br>3/4-in. to 1-in. AISI Type 304 / 316 ASTM F 593 CW2[5] | psi<br>(MPa) | 85,000<br>(586) | 140,000<br>(966) | 45,000<br>(310) | 1.89 | 25 | - | |
| STAINLESS STEEL | **HAS-R 304 / 316**<br>1/4-in. to 5/16-in. and 1-1/8" to 2-in.<br>ASTM A193 Grade8(M), Class 1[4] | psi<br>(MPa) | 75,000[8]<br>(517)[8] | NA | 30,000<br>(207) | 2.50[7] | 30 | 50 | |
| STAINLESS STEEL | **HIT-Z Anchor rod**<br>(HIT-HY 200 V3 only)<br>Grade 316 | psi<br>(MPa) | 94,200<br>(650) | NA | 75,300<br>(519) | 1.25 | 8 | 20 | |

1 All electroplated carbon steel threaded rods are zinc plated in accordance with ASTM F1941 Fe/Zn 5 AN, with nuts and washers zinc plated in accordance with ASTM B633 SC 1 Type III. All hot-dipped galvanized threaded rods, nuts, and washers are zinc plated in accordance with ASTM F2329.
2 Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
3 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
4 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
5 Standard Steel Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
6 Maximum specified steel strength according to ASTM standard. NA indicates that ASTM standard does not publish a maximum value.
7 For designs according to CSA A23.3 Annex D, the maximum value of $f_{uta}$ is 860 MPa (124,700 psi) per clause D.6.1.2.
8 For calculating steel strength, ACI 318 section 17.4.1.2 and CSA A23.3 clause D.6.1.2 limit the ultimate strength to 1.9 $f_{ya}$. Thus, $f_{uta}$ = 57,000 psi (393 MPa) for calculation purposes when determining steel strength in tension ($N_{sa}$) and shear ($V_{sa}$).
9 3/8-inch dia. threaded rods are not included in the ASTM F1554 standard. Hilti 3/8-inch dia. HAS-V-36, HAS-E-55, and HAS-B-105 (incl. HDG) threaded rods meet the chemical composition and mechanical property requirements of ASTM F1554.

## ORDERING INFORMATION

**Hilti HIT-Z Anchor rods for Hilti HIT-HY 200 V3 Anchoring system**

| HIT-Z Carbon Steel | | HIT-Z-R 316 Stainless Steel | | HIT-Z (-R) Length Code |
|---|---|---|---|---|
| Description | Qty | Description | Qty | |
| 3/8" x 3-3/8" | 40 | 3/8" x 3-3/8" | 40 | D |
| 3/8" x 4-3/8" | 40 | 3/8" x 4-3/8" | 40 | F |
| 3/8"x 5-1/8" | 40 | 3/8"x 5-1/8" | 40 | H |
| 3/8" x 6-3/8" | 40 | 3/8" x 6-3/8" | 40 | J |
| 1/2" x 4-1/2" | 20 | 1/2" x 4-1/2" | 20 | F |
| 1/2" x 6-1/2" | 20 | 1/2" x 6-1/2" | 20 | J |
| 1/2" x 7-3/4" | 20 | 1/2" x 7-3/4" | 20 | M |
| 5/8" x 6" | 12 | 5/8" x 6" | 12 | I |
| 5/8" x 8" | 12 | 5/8" x 8" | 12 | M |
| 5/8" x 9-1/2" | 12 | 5/8" x 9-1/2" | 12 | P |
| 3/4" x 6-1/2" | 6 | 3/4" x 6-1/2" | 6 | K |
| 3/4" x 8-1/2" | 6 | 3/4" x 8-1/2" | 6 | N |
| 3/4" x 9-3/4" | 6 | 3/4" x 9-3/4" | 6 | Q |





**Hilti Rods are now stamped on the end to show grade of steel and overall anchor length!**




"/_\" = HIT-Z
"J" = Length Code




"HV" = HAS-V-36
"6 1/2" = Length



✕ = 1/4" & 5/16" HAS-V
Carbon steel
No length identification




"HE" = HAS-E-55
"6 1/2" = Length




"HB" = HAS-B-105
"6 1/2" = Length



● = 1/4" & 5/16" HAS-R
Stainless steel 304
No length identification




"R1" = 304 SS
"6 1/2" = Length

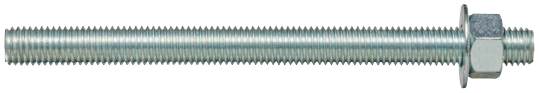



"R2" = 316 SS
"6 1/2" = Length

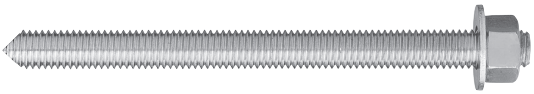


— = 1/4" & 5/16" HAS-R
Stainless steel 316
No length identification

## Overview of the Hilti HAS standard off-the-shelf anchor rods for Hilti chemical anchoring systems[1]



HAS-V does not come with chisel point



HAS-E, HAS-B, and HAS-R all come with chisel point

| HAS-V | | HAS-V-36/ HAS-V-36 HDG | | HAS-E-55 | | HAS-B-105 | | HAS-B-105 HDG Hot-dipped galvanized | | HAS-R 304 Stainless Steel | | HAS-R 316 Stainless Steel | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description | Qty | Description | Qty | Description | Qty | Description | Qty | Description | Qty | Description | Qty | Description | Qty |
| **1/4" x 3"** | 20 | **-** | - | **-** | - | **-** | - | **-** | - | **-** | - | **-** | - |
| **1/4" x 4-1/2"** | 20 | **-** | - | **-** | - | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **-** | - | **3/8" x 3"** | 20 | **-** | - | **-** | - | **-** | - | **-** | - |
| **5/16" x 3"** | 20 | **-** | - | **-** | - | **-** | - | **-** | - | **-** | - | **-** | - |
| **5/16" x 4-1/2"** | 20 | **-** | - | **-** | - | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **3/8" x 4-3/8"[2]** | 20 | **3/8" x 4-3/8"** | 20 | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **3/8" x 5-1/8"[2]** | 20 | **3/8" x 5-1/8"** | 20 | **3/8" x 5-1/8"** | 20 | **-** | - | **3/8" x 5-1/8"** | 20 | **3/8" x 5-1/8"** | 20 |
| **-** | - | **3/8" x 8"[2]** | 10 | **3/8" x 8"** | 10 | **-** | - | **-** | - | **3/8" x 8"** | 10 | **3/8" x 8"** | 10 |
| **-** | - | **-** | - | **3/8" x 12"** | 10 | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **-** | - | **1/2" x 3-1/8"** | 20 | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **1/2" x 4-1/2"** | 20 | **1/2" x 4-1/2"** | 20 | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **1/2" x 6-1/2"** | 20 | **1/2" x 6-1/2"** | 20 | **1/2" x 6-1/2"** | 20 | **-** | - | **1/2" x 6-1/2"** | 20 | **1/2" x 6-1/2"** | 20 |
| **-** | - | **1/2" x 8"[2]** | 10 | **1/2" x 8"** | 10 | **-** | - | **1/2" x 8"** | 10 | **1/2" x 8"** | 10 | **1/2" x 8"** | 10 |
| **-** | - | **-** | - | **1/2" x 10"** | 10 | **-** | - | **-** | - | **1/2" x 10"** | 10 | **1/2" x 11"** | 10 |
| **-** | - | **-** | - | **1/2" x 12"** | 10 | **-** | - | **-** | - | **-** | - | **1/2" x 12"** | 10 |
| **-** | - | **5/8" x 6"** | 10 | **5/8" x 6"** | 10 | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **5/8" x 8"** | 10 | **5/8" x 8"** | 10 | **5/8" x 8"** | 10 | **5/8" x 8"** | 10 | **5/8" x 7-5/8"** | 20 | **5/8" x 7-5/8"** | 20 |
| **-** | - | **5/8" x 10"[2]** | 10 | **5/8" x 9"** | 10 | **-** | - | **-** | - | **5/8" x 10"** | 10 | **5/8" x 9"** | 10 |
| **-** | - | **5/8" x 12"[2]** | 10 | **5/8" x 12"** | 10 | **-** | - | **5/8" x 12"** | 10 | **-** | - | **5/8" x 12"** | 10 |
| **-** | - | **-** | - | **5/8" x 17"** | 10 | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **3/4" x 6"[2]** | 10 | **3/4" x 6"** | 10 | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **3/4" x 8"** | 10 | **3/4" x 8"** | 10 | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **3/4" x 10"** | 10 | **3/4" x 10"** | 10 | **3/4" x 10"** | 10 | **3/4" x 10"** | 10 | **3/4" x 9-5/8"** | 10 | **3/4" x 9-5/8"** | 10 |
| **-** | - | **-** | - | **3/4" x 11"** | 10 | **-** | - | **-** | - | **-** | - | **3/4" x 10"** | 10 |
| **-** | - | **3/4" x 12"[2]** | 10 | **3/4" x 12"** | 10 | **-** | - | **-** | - | **3/4" x 12"** | 10 | **-** | - |
| **-** | - | **-** | - | **3/4" x 14"** | 10 | **3/4" x 14"** | 10 | **3/4" x 14"** | 10 | **3/4" x 14"** | 10 | **-** | - |
| **-** | - | **3/4" x 16"[2]** | 10 | **3/4" x 17"** | 10 | **-** | - | **-** | - | **3/4" x 16"** | 10 | **3/4" x 16"** | 10 |
| **-** | - | **-** | - | **3/4" x 19"** | 8 | **-** | - | **3/4"x20"** | 8 | **-** | - | **-** | - |
| **-** | - | **-** | - | **3/4" x 21"** | 8 | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **-** | - | **3/4" x 25"** | 4 | **-** | - | **-** | - | **-** | - | **-** | - |
| **-** | - | **-** | - | **7/8" x 10"** | 10 | **-** | - | **7/8" x 10"** | 10 | **7/8" x 10"** | 10 | **7/8" x 10"** | 10 |
| **-** | - | **-** | - | **7/8" x 13"** | 8 | **-** | - | **7/8" x 12"** | 10 | **-** | - | **-** | - |
| **-** | - | **-** | - | **-** | - | **-** | - | **7/8" x 16"** | 10 | **-** | - | **7/8" x 16"** | 10 |
| **-** | - | **1" x 12"** | 4 | **1" x 12"** | 4 | **1" x 12"** | 4 | **-** | - | **1" x 12"** | 4 | **1" x 12"** | 4 |
| **-** | - | **-** | - | **1" x 14"** | 4 | **1" x 14"** | 4 | **-** | - | **-** | - | **-** | - |
| **-** | - | **-** | - | **1" x 16"** | 2 | **1" x 16"** | 2 | **1" x 16"** | 2 | **-** | - | **1" x 16"** | 2 |
| **-** | - | **-** | - | **1" x 20"** | 2 | **1" x 21"** | 2 | **1" x 21"** | 2 | **-** | - | **1" x 20"** | 2 |
| **-** | - | **-** | - | **1-1/4" x 16"** | 2 | **1-1/4" x 16"** | 2 | **1-1/4" x 16"** | 2 | **-** | - | **-** | - |
| **-** | - | **-** | - | **1-1/4" x 22"** | 2 | **1-1/4" x 23"** | 2 | **-** | - | **-** | - | **-** | - |

1 Additional diameters (up to 2-1/2") and lengths are available upon request. Contact Hilti for the full portfolio.
2 Not available in hot dipped galvanized.

# 3.2.8 ADHESIVE ANCHOR ACCESSORIES

## Accessories — dispensers

### Battery powered

| Description |
|---|
| **HDE 500-A18/A22 compact battery dispenser kit**[1]<br>Includes dispenser, (2) compact B 18/22 1.6-Ah Li-Ion batteries, C 4/36 battery charger, black and red cartridge holders in a soft bag. |
| **HDE 500-A18/A22 industrial battery dispenser kit**[1]<br>Includes dispenser, (2) industrial B 18/22 3.3-Ah Li-Ion batteries, C 4/36 battery charger, black and red cartridge holders in a soft bag. |
| **HDE 500-A18/A22 battery dispenser tool body**[1]<br>Includes black and red cartridge holders |
| **Battery charger C 4/36 Li-Ion 115V**<br>Use with all B 14.4, B 18/22 batteries or B 36 batteries |
| **Battery compact 18/22 1.6-Ah Li-Ion** |
| **Battery industrial B 18/22 3.3-Ah Li-Ion** |
| **HDE 500-A18/22 hard case** |

### Manual

| Description |
|---|
| **MD 1000 manual dispenser**[1]<br>For HIT ICE |
| **HDM 500 manual dispenser with black foil pack holder**<br>For use with 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil packs of HIT-RE 500-V3, HIT-HY 10 PLUS, HIT-HY 270 |
| **HDM 500 manual dispenser with red foil pack holder**<br>For use with 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil pack adhesives HIT-HY 200-A V3 and HIT-HY 200-R V3 |
| **HDM 500 manual dispenser with black and red foil pack holder**<br>For use with 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil pack adhesives HIT-HY 200-A V3, HIT-HY 200-R V3, HIT-RE 500-V3, HIT-HY 10 PLUS and HIT-HY 270 |
| **HIT-CB 500 black cartridge (foil pack) holder replacement**<br>For use with 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil packs or HIT-RE 500V-3, HIT-HY 10 PLUS and HIT-HY 270 |
| **HIT-CR 500 red cartridge (foil pack) holder replacement**<br>For use with 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil pack adhesives HIT-HY 200-A V3 and HIT-HY 200-R V3 |
| **HDM 500 hard case only, no tool** |

### **Pneumatic** with 1/4 female compressed air coupling

| Description |
|---|
| **P 3500 pneumatic dispenser**[1]<br>For use with HIT 11.1 fl oz/330 ml and 16.9 fl oz/500 ml foil pack |
| **HIT-P 8000D pneumatic dispenser**[1]<br>For use with HIT 47.3 fl oz/1400 ml jumbo foil pack |
| **P 3500 Cartridge (black foil pack) holder replacement**<br>For use with the P 3500 Pneumatic Dispenser and HIT-RE 500-V3, HIT-HY 270 and HIT-HY 10 PLUS |

1 Dispensers not compatible with HIT-HY 200 V3 Adhesive Anchor System.

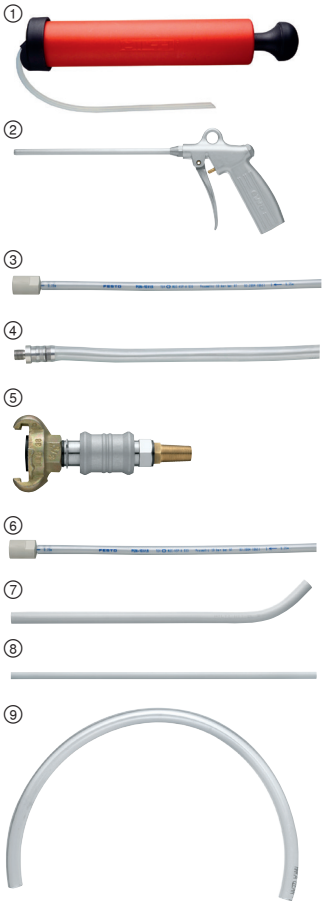
### Color coded cartridge holders with the same quality dispenser

With the introduction of HIT-HY 200 V3 and Safe Set™ Technology, Hilti has introduced a new chemistry with a 5:1 ratio. **All other Hilti adhesive anchor system have a 3:1 mix ratio.** The new technology allows for better performance and both the HDM 500 Manual Dispensers and HDE 500-A18/A22 Battery Dispenser can accept both cartridge ratios. Simply change out the cartridge holder and you can use the dispenser on any jobsite with any Hilti foil pack adhesive.

| Red | | Black | |
|---|---|---|---|
|  |  |  |  |

## Hilti HIT Profi accessories for blowing out drilled holes

| Description | | Diameter in. | Length ft | Qty |
|---|---|---|---|---|
| **Blow-Out Pump**<br>For use in holes up to 10 in. deep | ① | | | 1 |
| **Blow-Out Tool G 1/4 NPT Inlet**<br>For use in holes up to 11 in. deep.<br>For holes deeper than 11 in., use Blow-Out Tool plus the following extensions | ② | | | 1 |
| **Extension hose for blow-out tool HIT-DL 10/0.8** | ③ | 0.39 | 2.6 | 1 |
| **Extension hose for blow-out tool HIT-DL 16/0.8** | ④ | 0.71 | 2.6 | 1 |
| **3/8 Claw-type Quick Connect HIT-DL A** | ⑤ | | | 1 |
| **Extension hose for HIT-DL A HIT-DL V10/1** | ⑥ | 0.39 | 3.3 | 1 |
| **Extension tube HIT-DL B (Rigid/bent)** | ⑦ | 0.63 | | 5 |
| **Extension tube HIT-VL 16/0.7 (Rigid/straight)** | ⑧ | 0.63 | 2.3 | 10 |
| **Coupler for blowing extensions HIT-DL K**<br>Metal coupler for splicing 16 mm extension hose | | 0.63 | | 10 |
| **Extension hose HIT-VL 16 (Flexible)** | ⑨ | 0.63 | 33 | 1 |
| **HIT-DRS**<br>Dust Removal System with one hole for vacuum attachment and another hole for the Blow-Out Tool. For use with compressed air | | | | 1 |




## Air nozzles

Attach to extension end for proper hole cleaning[1]

| Description | Qty |
|---|---|
| **HIT-DL 1/2**<br>Use with 10 mm diameter hose | 1 |
| **HIT-DL 9/16**<br>Use with 10 mm diameter hose | 1 |
| **HIT-DL 11/16**<br>Use with 10 mm diameter hose | 1 |
| **HIT-DL 3/4**<br>Use with 16 mm diameter hose/tube | 1 |
| **HIT-DL 7/8**<br>Use with 16 mm diameter hose/tube | 1 |
| **HIT-DL 1**<br>Use with 16 mm diameter hose/tube | 1 |
| **HIT-DL 1-3/8**<br>Use with 16 mm diameter hose/tube | 1 |

1 HIT-DL size determined by the diameter of drilled hole; see Accessory Selection Table below for proper sizing

**Also avaliable in metric!**

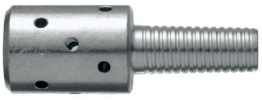
Round brush[2]



Piston plug (10 pack)[3]



Air nozzle



| Hole diameter[1] | Description | Description | Use with hose dia. | Description |
|---|---|---|---|---|
| **7/16** | **HIT-RB 7/16** | - | | - |
| **1/2** | **HIT-RB 1/2** | **HIT-IP 1/2** | 9 mm | **HIT-DL 1/2** |
| **9/16** | **HIT-RB 9/16** | **HIT-IP 9/16** | 9 mm | **HIT-DL 9/16** |
| **5/8** | **HIT-RB 5/8** | **HIT-IP 5/8** | 9 mm | - |
| **11/16** | **HIT-RB 11/16** | **HIT-IP 11/16** | 9 mm | **HIT-DL 11/16** |
| **3/4** | **HIT-RB 3/4** | **HIT-IP 3/4** | 16 mm | **HIT-DL 3/4** |
| **7/8** | **HIT-RB 7/8** | **HIT-IP 7/8** | 16 mm | **HIT-DL 7/8** |
| **1** | **HIT-RB 1** | **HIT-IP 1** | 16 mm | **HIT-DL 1** |
| **1-1/8** | **HIT-RB 1 1/8** | **HIT-IP 1 1/8** | 16 mm | - |
| **1-1/4** | **HIT-RB 1 1/4** | **HIT-IP 1 1/4** | 16 mm | - |
| **1- 3/8** | **HIT-RB 1 3/8** | **HIT-IP 1 3/8** | 16 mm | **HIT-DL 1 3/8** |
| **1-1/2** | **HIT-RB 1 1/2** | **HIT-IP 1 1/2** | 16 mm | - |
| **1-3/4** | **HIT-RB 1 3/4** | **HIT-IP 1 3/4** | 16 mm | - |

1 Refer to adhesive anchor system installation instructions to determine the proper hole diameter for the fastening element to be used.
2 Attach brush to HIT-RBH T-handle, HIT-RBS or HIT-RBV extensions.
3 Use piston plugs to help prevent air voids during injection.

## Hilti HIT Profi accessories for brushing drilled holes

### Manual brush handle for round steel brush

| Description | | Qty |
|---|---|---|
| **HIT-RBH (T-handle)**<br>Use to clean holes up to 11 in. deep | ① | 1 |

### Manual brush extension for round steel brush

| Description | | Qty |
|---|---|---|
| **HIT-RBV 11 in. extension for HIT-RBH (T-handle)** | ② | 1 |

### Holders for brush extension RBS

Connects RBS extension to your Hilti drill for use in cleaning holes

| Description | | Qty |
|---|---|---|
| **TE-Y SDS Max connection** | ③ | 1 |
| **TE-C SDS + Connection** | ④ | 1 |

### Extensions for round steel brushes

| Description | | Diameter in | Length ft | Qty |
|---|---|---|---|---|
| **HIT-RBS 10/0.7** | ⑤ | 0.39 | 2.3 | 1 |
| **HIT-RBS-10/0.35** | ⑤ | 0.39 | 1.2 | 1 |

## Hilti HIT Profi accessories for adhesive injection

### Extension hoses

For use in holes deeper than 10 in.

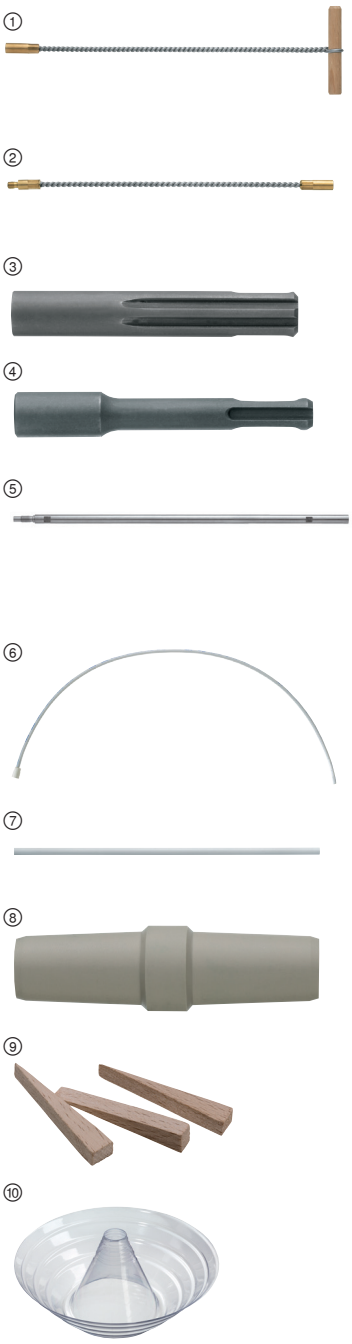
| Description | | Diameter in. | Length ft | Qty |
|---|---|---|---|---|
| **HIT-VL 9/1.0 flexible hose** | ⑥ | 0.35 | 3.3 | 10 |
| **HIT-VL 16/0.7 rigid tube** | ⑦ | 0.63 | 2.3 | 10 |
| **HIT-VL 16 flexible hose** | | 0.63 | 33 | 1 |

### Coupler for injection extensions

| Description | | Diameter in. | Qty |
|---|---|---|---|
| **HIT-VL K**<br>Plastic coupler for connecting 16 mm (0.63 in.) hoses and tubes | ⑧ | 0.63 | 5 |

### Overhead injection accessories

| Description | | Hole Diameter in. | Qty |
|---|---|---|---|
| **HIT-OHW overhead wedge** | ⑨ | 7/16 to 1-1/4 | 100 |
| **HIT-OHC1 overhead drip guard** | ⑩ | 7/16 to 5/8 | 10 |
| **HIT-OHC2 overhead drip guard** | | 11/16 to 1-1/4 | 10 |

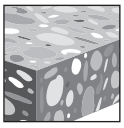


# 3.3.1 HDA UNDERCUT ANCHORS

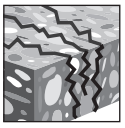
## PRODUCT DESCRIPTION

**HDA undercut anchors**

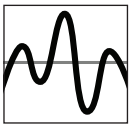
| Anchor system | Features and benefits |
|---|---|
| HDA-P undercut anchor pre-set type<br>  <br>HDA-T undercut anchor through-set type<br>  | • Undercut segments provide cast-in-place like performance with limited expansion stresses<br>• Self-undercutting wedges provide an easy, fast and reliable anchor installation<br>• Excellent performance in cracked concrete<br>• Suitable for dynamic loads including seismic, fatigue and shock. See Anchor Selector Guide<br>• Undercut keying load transfer allows for reduced edge distances and anchor spacings<br>• Through-set style provides increased shear capacity<br>• Fully removable Type 316 stainless steel for corrosive environments<br>• Sherardized zinc coating has equivalent corrosion resistance to hot-dip galvanization<br>• ACI 349-01 Nuclear Design Guide is available. Call Hilti Technical Support |



Uncracked concrete



Cracked concrete



Seismic design categories A-F




Profis anchor design software

| Approvals/Listings | |
|---|---|
| **ICC-ES (International Code Council)** | ESR-1546 in concrete per ACI 318-Ch. 17 / ACI 355.2/ ICC-ES AC193 |
| **European Technical Approval** | ETA-99/0009, ETA-99/0016 |
| **City of Los Angeles** | Research Report No. 25939 |
| **Nuclear Quality Assurance** | Qualified under NQA-1 Nuclear Quality Program |

## MATERIAL SPECIFICATIONS

**HDA-P and HDA-T carbon steel with electroplated zinc**

Cone bolts meet strength requirements of ISO 898, class 8.8. Minimum yield strength is 92.8 ksi (640 MPa) and minimum tensile strength is 116 ksi (800 MPa).

Sleeve for the M10 and M12 has a minimum tensile strength of 123 ksi (850 MPa).

Sleeve for the M16 has a minimum tensile strength of 101.5 ksi (700 MPa).

Sleeve for the M20 has a minimum tensile strength of 79.8 ksi (550 MPa).

The nut and washer are carbon steel.

All carbon steel components have a minimum 5 µm zinc plating thickness.

**HDA-PR and HDA-TR stainless steel**

Cone bolts have a minimum yield strength is 87 ksi (600 MPa) and minimum tensile strength is 116 ksi (800 MPa).

Sleeve for the M10 and M12 has a minimum tensile strength of 123 ksi (850 MPa).

Sleeve for the M16 has a minimum tensile strength of 101.5 ksi (700 MPa).

Nut conforms to DIN 934, grade A4-80.

**HDA-PF and HDA-TF carbon steel with sherardized heavy zinc plating**

Cone bolts meet strength requirements of ISO 898, class 8.8. Minimum yield strength is 92.8 ksi (640 MPa) and minimum tensile strength is 116 ksi (800 MPa).

Sleeve for the M10 and M12 has a minimum tensile strength of 123 ksi (850 MPa).

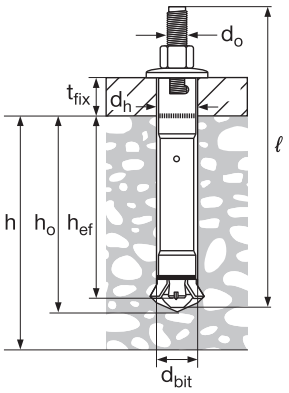
Sleeve for the M16 has a minimum tensile strength of 101.5 ksi (700 MPa).

Nuts and washers are carbon steel.

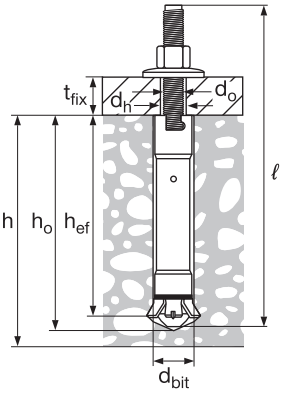
All carbon steel components have an average zinc plating thickness of 53 µm in accordance with ASTM A153.

# INSTALLATION PARAMETERS

**Figure 1 — Hilti HDA specifications**

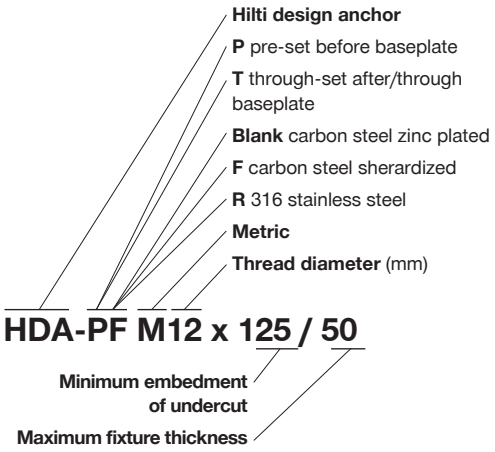



HDA-T




HDA-P

**Anchor nomenclature**




3.3.1

**Table 1 — Hilti HDA specifications**

| Setting information | Symbol | Units | Nominal anchor diameter | | | |
|---|---|---|---|---|---|---|
| | | | M10 | M12 | M16 | M20 |
| Cone bolt thread diameter | $d_o$ | mm | 10 | 12 | 16 | 20 |
| Nominal bit diameter[1] | $d_{bit}$ | mm | 20 | 22 | 30 | 37 |
| Effective minimum embedment | $h_{ef}$ | mm<br>(in.) | 100<br>(3.9) | 125<br>(4.9) | 190<br>(7.5) | 250<br>(9.8) |
| Hole depth | $h_o$ | mm<br>(in.) | 107<br>(4.2) | 135<br>(5.3) | 203<br>(8.0) | 266<br>(10.5) |
| Max.fixture thickness, HDA-P | $t_{fix}$ | | See Section 3.3.1 | | | |
| Fixture hole diameter, HDA-P | $d_h$ | mm<br>(in.) | 12<br>(1/2) | 14<br>(9/16) | 18<br>(3/4) | 22<br>(7/8) |
| Max.fixture thickness, HDA-T | $t_{fix}$ | | See Table 5 | | | |
| Fixture hole diameter, HDA-T | $d_h$ | mm<br>(in.) | 21<br>(7/8) | 23<br>(15/16) | 32<br>(1-1/4) | 40<br>(1-9/16) |
| Length of anchor | $\ell$ | | See Section 3.3.1 | | | |
| Minimum concrete member thickness[2] | $h_{min}$ | in.<br>(mm) | 7-1/8<br>(180) | 7-1/2<br>(200) | 10-5/8[3]<br>(270) | 13-3/4<br>(350) |
| Installation torque | $T_{inst}$ | ft-lb<br>(Nm) | 37<br>(50) | 59<br>(80) | 89<br>(120) | 221<br>(300) |
| Wrench size | | mm | 17 | 19 | 24 | 30 |

1 HDA must be installed with the specified Hilti hammer drill and Hilti metric stop bit. See section 3.3.1.5.
2 Minimum concrete thickness for HDA-P. For HDA-T, additional thickness needed to account for thin fixture which will increase effective embedment.
3 When setting the anchor with TE 70, $h_{min} \geq 300$mm (11.8 in) for HDA M16.

# DESIGN INFORMATION IN CONCRETE PER ACI 318

### ACI 318 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-1546 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-1546 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

**Table 2 — Hilti HDA-P and HDA-T carbon and stainless steel design strength with concrete/pullout failure in uncracked concrete[1,2,3,4,5]**

| Nominal anchor diameter | Effective embed. mm (in.) | Tension - $\phi N_n$ | | | | Shear - $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN)" | $f'_c$ = 6,000 psi lb (kN) | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) |
| M10 | 100 (3.9) | 7,615 (33.9) | 8,345 (37.1) | 9,635 (42.9) | 11,800 (52.5) | 16,405 (73.0) | 17,970 (79.9) | 20,750 (92.3) | 25,415 (113.1) |
| M12 | 125 (4.9) | 10,645 (47.4) | 11,660 (51.9) | 13,465 (59.9) | 16,490 (73.4) | 22,925 (102.0) | 25,115 (111.7) | 29,000 (129.0) | 35,515 (158.0) |
| M16 | 190 (7.5) | 19,945 (88.7) | 21,850 (97.2) | 25,230 (112.2) | 30,900 (137.4) | 42,965 (191.1) | 47,065 (209.4) | 54,345 (241.7) | 66,560 (296.1) |
| M20 | 250 (9.8) | 30,105 (133.9) | 32,980 (146.7) | 38,080 (169.4) | 46,640 (207.5) | 64,845 (288.4) | 71,035 (316.0) | 82,025 (364.9) | 100,460 (446.9) |

**Table 3 — Hilti HDA-P and HDA-T carbon and stainless steel design strength with concrete/pullout failure in cracked concrete[1,2,3,4,5]**

| Nominal anchor diameter | Effective embed. mm (in.) | Tension - $\phi N_n$ | | | | Shear - $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN)" | $f'_c$ = 6,000 psi lb (kN) | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) |
| M10 | 100 (3.9) | 5,845 (26.0) | 6,405 (28.5) | 7,395 (32.9) | 9,055 (40.3) | 13,125 (58.4) | 14,375 (63.9) | 16,600 (73.8) | 20,330 (90.4) |
| M12 | 125 (4.9) | 7,305 (32.5) | 8,005 (35.6) | 9,240 (41.1) | 11,320 (50.4) | 18,340 (81.6) | 20,090 (89.4) | 23,200 (103.2) | 28,415 (126.4) |
| M16 | 190 (7.5) | 14,615 (65.0) | 16,005 (71.2) | 18,485 (82.2) | 22,640 (100.7) | 34,370 (152.9) | 37,650 (167.5) | 43,475 (193.4) | 53,245 (236.8) |
| M20 | 250 (9.8) | 21,920 (97.5) | 24,010 (106.8) | 27,725 (123.3) | 33,955 (151.0) | 51,875 (230.8) | 56,830 (252.8) | 65,620 (291.9) | 80,365 (357.5) |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 9 as necessary. Compare to the steel values in tables 4 and 5. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For sand-lightweight multiply the design loads by $\lambda_a$ = 0.68.

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

**Table 4 — Steel strength for Hilti HDA-P carbon steel and stainless steel anchors[1,2]**

| Nominal anchor diameter | HDA-P carbon steel anchors | | | HDA-PR stainless steel anchors | | |
|---|---|---|---|---|---|---|
| | Tensile $\phi N_{sa}$[3] lb (kN) | Shear $\phi V_{sa}$[4] lb (kN) | Seismic shear $\phi V_{sa,eq}$[5] lb (kN) | Tensile $\phi N_{sa}$[3] lb (kN) | Shear $\phi V_{sa}$[4] lb (kN) | Seismic shear $\phi V_{sa,eq}$[5] lb (kN) |
| M10 | 7,830 (34.8) | 3,260 (14.5) | 2,920 (13.0) | 7,830 (34.8) | 3,945 (17.5) | 3,655 (16.3) |
| M12 | 11,395 (50.7) | 4,735 (21.1) | 4,235 (18.8) | 11,395 (50.7) | 5,845 (26.0) | 5,260 (23.4) |
| M16 | 21,140 (94.0) | 8,810 (39.2) | 7,890 (35.1) | 21,140 (94.0) | 10,960 (48.8) | 9,790 (43.5) |
| M20 | 33,060 (147.1) | 13,500 (60.1) | 12,130 (54.0) | n/a | n/a | n/a |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Hilti HDA-P Carbon and Stainless steel anchors are to be considered ductile steel elements.

3 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

4 Shear values determined by static shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.

5 Seismic shear values determined by seismic shear tests with $\phi V_{sa,eq} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17. See section 3.1.8 for additional information on seismic applications.



**Table 5 — Steel strength for Hilti HDA-T carbon steel and stainless steel anchors[1,2]**

| Nominal anchor diameter | Thickness of fastened parts $t_{fix}$ in. (mm) | HDA-T carbon steel anchors | | | HDA-TR stainless steel anchors | | |
|---|---|---|---|---|---|---|---|
| | | Tensile $\phi N_{sa}$[3] lb (kN) | Shear $\phi V_{sa}$[4] lb (kN) | Seismic shear $\phi V_{sa,eq}$[5] lb (kN) | Tensile $\phi N_{sa}$[3] lb (kN) | Shear $\phi V_{sa}$[4] lb (kN) | Seismic shear $\phi V_{sa,eq}$[5] lb (kN) |
| M10 | $5/8 \leq t_{fix} < 13/16$ ($15 \leq t_{fix} \leq 20$) | 7,830 (34.8) | 9,060 (40.3) | 8,185 (36.4) | 7,830 (34.8) | 10,080 (44.8) | 9,060 (40.3) |
| M12 | $5/8 \leq t_{fix} < 13/16$ ($15 \leq t_{fix} < 20$) | 11,395 (50.7) | 10,815 (48.1) | 9,790 (43.5) | 11,395 (50.7) | 13,155 (58.5) | 11,690 (52.0) |
| | $13/16 \leq t_{fix} < 2$ ($20 \leq t_{fix} \leq 50$) | | 12,130 (54.0) | 10,815 (48.1) | | 14,465 (64.3) | 13,005 (57.8) |
| M16 | $13/16 \leq t_{fix} < 1$ ($20 \leq t_{fix} < 25$) | 21,140 (94.0) | 19,875 (88.4) | 17,825 (79.3) | 21,140 (94.0) | 23,235 (103.4) | 20,900 (93.0) |
| | $1 \leq t_{fix} < 1\text{-}3/16$ ($25 \leq t_{fix} < 30$) | | 22,505 (100.1) | 20,315 (90.4) | | 24,550 (109.2) | 22,065 (98.1) |
| | $1\text{-}3/16 \leq t_{fix} \leq 1\text{-}3/8$ ($30 \leq t_{fix} < 35$) | | 24,845 (110.5) | 22,355 (99.4) | | 25,715 (114.4) | 23,090 (102.7) |
| | $1\text{-}3/8 < t_{fix} < 2\text{-}3/8$ ($35 \leq t_{fix} \leq 60$) | | 26,885 (119.6) | 24,110 (107.2) | | 26,595 (118.3) | 23,965 (106.6) |
| M20 | $1 \leq t_{fix} < 1\text{-}9/16$ ($25 \leq t_{fix} < 40$) | 33,060 (147.1) | 29,370 (130.6) | 26,450 (117.7) | n/a | n/a | n/a |
| | $1\text{-}9/16 \leq t_{fix} < 2\text{-}1/8$ ($40 \leq t_{fix} < 55$) | | 33,025 (146.9) | 29,665 (132.0) | | | |
| | $2\text{-}1/8 \leq t_{fix} < 4$ ($55 \leq t_{fix} \leq 100$) | | 35,510 (158.0) | 32,005 (142.4) | | | |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Hilti HDA-T Carbon and Stainless steel anchors are to be considered ductile steel elements.

3 Tensile = $\phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17

4 Shear values determined by static shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17

5 Seismic shear values determined by seismic shear tests with $\phi V_{sa,eq} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17 See section 3.1.8 for additional information on seismic applications.

**Table 6 — Load adjustment factors for M10 and M12 Hilti HDA-P and HDA-T carbon and stainless steel anchors in uncracked concrete[1,2]**

| M10 and M12 HDA-P and HDA-T uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear ⊥ toward edge $f_{RV}$ | | Edge distance in shear II to and away from edge $f_{RV}$ | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal diameter | | | M10 | M12 | M10 | M12 | M10 | M12 | M10 | M12 | M10 | M12 | M10 | M12 |
| Effective embedment $h_{ef}$ | mm | (in.) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 3-1/8 | (79) | n/a | n/a | 0.66 | n/a | n/a | n/a | 0.14 | n/a | 0.28 | n/a | n/a | n/a |
| | 3-1/2 | (89) | n/a | n/a | 0.70 | n/a | n/a | n/a | 0.17 | n/a | 0.33 | n/a | n/a | n/a |
| | 4 | (102) | 0.67 | n/a | 0.76 | 0.66 | 0.56 | n/a | 0.20 | 0.15 | 0.40 | 0.31 | n/a | n/a |
| | 4-1/2 | (114) | 0.69 | n/a | 0.82 | 0.71 | 0.56 | n/a | 0.24 | 0.18 | 0.48 | 0.37 | n/a | n/a |
| | 5 | (127) | 0.71 | 0.67 | 0.88 | 0.76 | 0.57 | 0.56 | 0.28 | 0.22 | 0.56 | 0.43 | n/a | n/a |
| | 6 | (152) | 0.75 | 0.70 | 1.00 | 0.86 | 0.59 | 0.57 | 0.37 | 0.28 | 0.74 | 0.57 | n/a | n/a |
| | 7 | (178) | 0.80 | 0.74 | | 0.96 | 0.60 | 0.58 | 0.47 | 0.36 | 0.93 | 0.71 | n/a | n/a |
| | 7-1/8 | (181) | 0.80 | 0.74 | | 0.97 | 0.60 | 0.59 | 0.48 | 0.37 | 0.96 | 0.73 | 0.64 | n/a |
| | 7-1/2 | (191) | 0.82 | 0.75 | | 1.00 | 0.61 | 0.59 | 0.52 | 0.40 | 1.00 | 0.79 | 0.66 | n/a |
| | 8 | (203) | 0.84 | 0.77 | | | 0.61 | 0.60 | 0.57 | 0.44 | | 0.87 | 0.68 | 0.62 |
| | 9 | (229) | 0.88 | 0.80 | | | 0.63 | 0.61 | 0.68 | 0.52 | | 1.00 | 0.72 | 0.66 |
| | 10 | (254) | 0.92 | 0.84 | | | 0.64 | 0.62 | 0.80 | 0.61 | | | 0.76 | 0.69 |
| | 11 | (279) | 0.97 | 0.87 | | | 0.66 | 0.63 | 0.92 | 0.70 | | | 0.79 | 0.73 |
| | 12 | (305) | 1.00 | 0.91 | | | 0.67 | 0.64 | 1.00 | 0.80 | | | 0.83 | 0.76 |
| | 14 | (356) | | 0.97 | | | 0.70 | 0.67 | | 1.00 | | | 0.90 | 0.82 |
| | 16 | (406) | | 1.00 | | | 0.73 | 0.69 | | | | | 0.96 | 0.88 |
| | 18 | (457) | | | | | 0.76 | 0.72 | | | | | 1.00 | 0.93 |
| | 20 | (508) | | | | | 0.79 | 0.74 | | | | | | 0.98 |
| | 24 | (610) | | | | | 0.84 | 0.79 | | | | | | 1.00 |
| | 30 | (762) | | | | | 0.93 | 0.86 | | | | | | |
| | 36 | (914) | | | | | 1.00 | 0.93 | | | | | | |
| | 42 | (1067) | | | | | | 1.00 | | | | | | |

**Table 7 — Load adjustment factors for M10 and M12 Hilti HDA-P and HDA-T carbon and stainless steel anchors in cracked concrete[1,2]**

| M10 and M12 HDA-P and HDA-T cracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear ⊥ toward edge $f_{RV}$ | | Edge distance in shear II to and away from edge $f_{RV}$ | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal diameter | | | M10 | M12 | M10 | M12 | M10 | M12 | M10 | M12 | M10 | M12 | M10 | M12 |
| Effective embedment $h_{ef}$ | mm | (in.) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 3-1/8 | (79) | n/a | n/a | 0.66 | n/a | n/a | n/a | 0.12 | n/a | 0.25 | n/a | n/a | n/a |
| | 3-1/2 | (89) | n/a | n/a | 0.70 | n/a | n/a | n/a | 0.15 | n/a | 0.29 | n/a | n/a | n/a |
| | 4 | (102) | 0.67 | n/a | 0.76 | 0.66 | 0.55 | n/a | 0.18 | 0.14 | 0.36 | 0.27 | n/a | n/a |
| | 4-1/2 | (114) | 0.69 | n/a | 0.82 | 0.71 | 0.56 | n/a | 0.21 | 0.16 | 0.43 | 0.33 | n/a | n/a |
| | 5 | (127) | 0.71 | 0.67 | 0.88 | 0.76 | 0.57 | 0.56 | 0.25 | 0.19 | 0.50 | 0.38 | n/a | n/a |
| | 6 | (152) | 0.75 | 0.70 | 1.00 | 0.86 | 0.58 | 0.57 | 0.33 | 0.25 | 0.66 | 0.50 | n/a | n/a |
| | 7 | (178) | 0.80 | 0.74 | | 0.96 | 0.59 | 0.58 | 0.42 | 0.32 | 0.83 | 0.64 | n/a | n/a |
| | 7-1/8 | (181) | 0.80 | 0.74 | | 0.97 | 0.59 | 0.58 | 0.43 | 0.33 | 0.86 | 0.65 | 0.62 | n/a |
| | 7-1/2 | (191) | 0.82 | 0.75 | | 1.00 | 0.60 | 0.58 | 0.46 | 0.35 | 0.92 | 0.71 | 0.63 | n/a |
| | 8 | (203) | 0.84 | 0.77 | | | 0.61 | 0.59 | 0.51 | 0.39 | 1.00 | 0.78 | 0.65 | 0.60 |
| | 9 | (229) | 0.88 | 0.80 | | | 0.62 | 0.60 | 0.61 | 0.46 | | 0.93 | 0.69 | 0.63 |
| | 10 | (254) | 0.92 | 0.84 | | | 0.63 | 0.61 | 0.71 | 0.54 | | 1.00 | 0.73 | 0.67 |
| | 11 | (279) | 0.97 | 0.87 | | | 0.65 | 0.62 | 0.82 | 0.63 | | | 0.76 | 0.70 |
| | 12 | (305) | 1.00 | 0.91 | | | 0.66 | 0.63 | 0.94 | 0.71 | | | 0.80 | 0.73 |
| | 14 | (356) | | 0.97 | | | 0.69 | 0.66 | 1.00 | 0.90 | | | 0.86 | 0.79 |
| | 16 | (406) | | 1.00 | | | 0.71 | 0.68 | | 1.00 | | | 0.92 | 0.84 |
| | 18 | (457) | | | | | 0.74 | 0.70 | | | | | 0.98 | 0.89 |
| | 20 | (508) | | | | | 0.77 | 0.72 | | | | | 1.00 | 0.94 |
| | 24 | (610) | | | | | 0.82 | 0.77 | | | | | | 1.00 |
| | 30 | (762) | | | | | 0.90 | 0.83 | | | | | | |
| | 36 | (914) | | | | | 0.98 | 0.90 | | | | | | |
| | 42 | (1067) | | | | | 1.00 | 0.97 | | | | | | |
| | > 48 | (1219) | | | | | | 1.00 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

**Table 8 — Load adjustment factors for M16 and M20 Hilti HDA-P and HDA-T carbon and stainless steel anchors in uncracked concrete[1,2]**

| M16 and M20 HDA-P and HDA-T uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | Edge distance in shear: II to and away from edge $f_{RV}$ | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal diameter | | | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 |
| Effective embedment $h_{ef}$ | mm | (in.) | 190 (7.48) | 250 (9.84) | 190 (7.48) | 250 (9.84) | 190 (7.48) | 250 (9.84) | 190 (7.48) | 250 (9.84) | 190 (7.48) | 250 (9.84) | 190 (7.48) | 250 (9.84) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 6 | (152) | n/a | n/a | 0.66 | n/a | n/a | n/a | 0.15 | n/a | 0.30 | n/a | n/a | n/a |
| | 7 | (178) | n/a | n/a | 0.72 | n/a | n/a | n/a | 0.19 | n/a | 0.38 | n/a | n/a | n/a |
| | 7-1/8 | (181) | n/a | n/a | 0.73 | n/a | n/a | n/a | 0.20 | n/a | 0.39 | n/a | n/a | n/a |
| | 7-1/2 | (191) | 0.67 | n/a | 0.75 | n/a | 0.56 | n/a | 0.21 | n/a | 0.42 | n/a | n/a | n/a |
| | 8 | (203) | 0.68 | n/a | 0.78 | 0.66 | 0.56 | n/a | 0.23 | 0.15 | 0.46 | 0.31 | n/a | n/a |
| | 9 | (229) | 0.70 | n/a | 0.85 | 0.71 | 0.57 | n/a | 0.28 | 0.18 | 0.55 | 0.37 | n/a | n/a |
| | 10 | (254) | 0.72 | 0.67 | 0.91 | 0.76 | 0.58 | 0.56 | 0.32 | 0.22 | 0.65 | 0.43 | n/a | n/a |
| | 11 | (279) | 0.75 | 0.69 | 0.98 | 0.81 | 0.59 | 0.57 | 0.37 | 0.25 | 0.75 | 0.50 | 0.59 | n/a |
| | 12 | (305) | 0.77 | 0.70 | 1.00 | 0.86 | 0.59 | 0.57 | 0.43 | 0.28 | 0.85 | 0.57 | 0.61 | n/a |
| | 14 | (356) | 0.81 | 0.74 | | 0.96 | 0.61 | 0.58 | 0.54 | 0.36 | 1.00 | 0.71 | 0.66 | 0.58 |
| | 16 | (406) | 0.86 | 0.77 | | 1.00 | 0.63 | 0.60 | 0.66 | 0.44 | | 0.87 | 0.71 | 0.62 |
| | 18 | (457) | 0.90 | 0.80 | | | 0.64 | 0.61 | 0.78 | 0.52 | | 1.00 | 0.75 | 0.66 |
| | 20 | (508) | 0.95 | 0.84 | | | 0.66 | 0.62 | 0.92 | 0.61 | | | 0.79 | 0.69 |
| | 24 | (610) | 1.00 | 0.91 | | | 0.69 | 0.64 | 1.00 | 0.80 | | | 0.87 | 0.76 |
| | 30 | (762) | | 1.00 | | | 0.74 | 0.68 | | 1.00 | | | 0.97 | 0.85 |
| | 36 | (914) | | | | | 0.78 | 0.72 | | | | | 1.00 | 0.93 |
| | 42 | (1067) | | | | | 0.83 | 0.75 | | | | | | 1.00 |
| | > 48 | (1219) | | | | | 0.88 | 0.79 | | | | | | |

**Table 9 — Load adjustment factors for M16 and M20 Hilti HDA-P and HDA-T carbon and stainless steel anchors in cracked concrete[1,2]**

| M16 and M20 HDA-P and HDA-T cracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | Edge distance in shear: II to and away from edge $f_{RV}$ | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal diameter | | | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 |
| Effective embedment $h_{ef}$ | mm | (in.) | 190 (7.48) | 250 (9.84) | 190 (7.48) | 250 (9.84) | 190 (7.48) | 250 (9.84) | 190 (7.48) | 250 (9.84) | 190 (7.48) | 250 (9.84) | 190 (7.48) | 250 (9.84) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 6 | (152) | n/a | n/a | 0.66 | n/a | n/a | n/a | 0.13 | n/a | 0.27 | n/a | n/a | n/a |
| | 7 | (178) | n/a | n/a | 0.72 | n/a | n/a | n/a | 0.17 | n/a | 0.34 | n/a | n/a | n/a |
| | 7-1/8 | (181) | n/a | n/a | 0.73 | n/a | n/a | n/a | 0.17 | n/a | 0.35 | n/a | n/a | n/a |
| | 7-1/2 | (191) | 0.67 | n/a | 0.75 | n/a | 0.55 | n/a | 0.19 | n/a | 0.38 | n/a | n/a | n/a |
| | 8 | (203) | 0.68 | n/a | 0.78 | 0.66 | 0.56 | n/a | 0.21 | 0.14 | 0.41 | 0.27 | n/a | n/a |
| | 9 | (229) | 0.70 | n/a | 0.85 | 0.71 | 0.57 | n/a | 0.25 | 0.16 | 0.49 | 0.33 | n/a | n/a |
| | 10 | (254) | 0.72 | 0.67 | 0.91 | 0.76 | 0.57 | 0.56 | 0.29 | 0.19 | 0.58 | 0.38 | n/a | n/a |
| | 11 | (279) | 0.75 | 0.69 | 0.98 | 0.81 | 0.58 | 0.56 | 0.33 | 0.22 | 0.67 | 0.44 | 0.57 | n/a |
| | 12 | (305) | 0.77 | 0.70 | 1.00 | 0.86 | 0.59 | 0.57 | 0.38 | 0.25 | 0.76 | 0.50 | 0.59 | n/a |
| | 14 | (356) | 0.81 | 0.74 | | 0.96 | 0.60 | 0.58 | 0.48 | 0.32 | 0.96 | 0.64 | 0.64 | 0.56 |
| | 16 | (406) | 0.86 | 0.77 | | 1.00 | 0.62 | 0.59 | 0.59 | 0.39 | 1.00 | 0.78 | 0.68 | 0.60 |
| | 18 | (457) | 0.90 | 0.80 | | | 0.63 | 0.60 | 0.70 | 0.46 | | 0.93 | 0.72 | 0.63 |
| | 20 | (508) | 0.95 | 0.84 | | | 0.65 | 0.61 | 0.82 | 0.54 | | 1.00 | 0.76 | 0.67 |
| | 24 | (610) | 1.00 | 0.91 | | | 0.68 | 0.63 | 1.00 | 0.71 | | | 0.84 | 0.73 |
| | 30 | (762) | | 1.00 | | | 0.72 | 0.67 | | 1.00 | | | 0.94 | 0.82 |
| | 36 | (914) | | | | | 0.76 | 0.70 | | | | | 1.00 | 0.89 |
| | 42 | (1067) | | | | | 0.81 | 0.73 | | | | | | 0.97 |
| | > 48 | (1219) | | | | | 0.85 | 0.77 | | | | | | 1.00 |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

## DESIGN INFORMATION IN CONCRETE PER ACI 318

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-1546. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

**Table 10 — Steel resistance for Hilti HDA-P carbon steel and stainless steel anchors[1,2]**

| Nominal anchor diameter | HDA-P carbon steel anchors | | | HDA-PR stainless steel anchors | | |
|---|---|---|---|---|---|---|
| | Tensile[3] $N_{sar}$ lb (kN) | Shear[4] $V_{sar}$ lb (kN) | Seismic shear[5] $V_{sar,eq}$ lb (kN) | Tensile[3] $N_{sar}$ lb (kN) | Shear[4] $V_{sar}$ lb (kN) | Seismic shear[5] $V_{sar,eq}$ lb (kN) |
| M10 | 7,100 (31.6) | 3,195 (14.2) | 2,865 (12.7) | 7,100 (31.6) | 3,870 (17.2) | 3,585 (15.9) |
| M12 | 10,335 (46.0) | 4,645 (20.7) | 4,155 (18.5) | 10,335 (46.0) | 5,730 (25.5) | 5,160 (23.0) |
| M16 | 19,170 (85.3) | 8,640 (38.4) | 7,740 (34.4) | 19,170 (85.3) | 10,750 (47.8) | 9,600 (42.7) |
| M20 | 29,975 (133.3) | 13,240 (58.9) | 11,895 (52.9) | n/a | n/a | n/a |

1 See section 3.1.8 to convert design strength value to ASD value.
2 Hilti HDA-P/-PR anchors are to be considered ductile steel elements.
3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3, Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3, Annex D. See Section 3.1.8 for additional information on seismic applications.

**Table 11 — Steel resistance for Hilti HDA-T carbon steel and stainless steel anchors[1,2]**

| Nominal anchor diameter | Thickness of fastened parts $t_{fix}$ in. (mm) | HDA-T carbon steel anchors | | | HDA-TR stainless steel anchors | | |
|---|---|---|---|---|---|---|---|
| | | Tensile[3] $N_{sar}$ lb (kN) | Shear[4] $V_{sar}$ lb (kN) | Seismic shear[5] $V_{sar,eq}$ lb (kN) | Tensile[3] $N_{sar}$ lb (kN) | Shear[4] $V_{sar}$ lb (kN) | Seismic shear[5] $V_{sar,eq}$ lb (kN) |
| M10 | 5/8 ≤ $t_{fix}$ < 13/16 (15 ≤ $t_{fix}$ ≤ 20) | 7,100 (31.6) | 8,885 (39.5) | 8,025 (35.7) | 7,100 (31.6) | 9,890 (44.0) | 8,885 (39.5) |
| M12 | 5/8 ≤ $t_{fix}$ < 13/16 (15 ≤ $t_{fix}$ < 20) | 10,335 (46.0) | 10,605 (47.2) | 9,600 (42.7) | 10,335 (46.0) | 12,900 (57.4) | 11,465 (51.0) |
| | 13/16 ≤ $t_{fix}$ < 2 (20 ≤ $t_{fix}$ ≤ 50) | | 11,895 (52.9) | 10,605 (47.2) | | 14,190 (63.1) | 12,755 (56.7) |
| M16 | 13/16 ≤ tfix < 1 (20 ≤ $t_{fix}$ < 25) | 19,170 (85.3) | 19,490 (86.7) | 17,485 (77.8) | 19,170 (85.3) | 22,785 (101.4) | 20,495 (91.2) |
| | 1 ≤ $t_{fix}$ < 1-3/16 (25 ≤ $t_{fix}$ < 30) | | 22,070 (98.2) | 19,920 (88.6) | | 24,080 (107.1) | 21,640 (96.3) |
| | 1-3/16 ≤ $t_{fix}$ ≤ 1-3/8 (30 ≤ $t_{fix}$ < 35) | | 24,365 (108.4) | 21,925 (97.5) | | 25,225 (112.2) | 22,645 (100.7) |
| | 1-3/8 < $t_{fix}$ < 2-3/8 (35 ≤ $t_{fix}$ ≤ 60) | | 26,370 (117.3) | 23,650 (105.2) | | 26,085 (116.0) | 23,505 (104.6) |
| M20 | 1 ≤ $t_{fix}$ < 1-9/16 (25 ≤ $t_{fix}$ < 40) | 29,975 (133.3) | 28,805 (128.1) | 25,940 (115.4) | N/A | N/A | N/A |
| | 1-9/16 ≤ $t_{fix}$ < 2-1/8 (40 ≤ $t_{fix}$ < 55) | | 32,390 (144.1) | 29,090 (129.4) | | | |
| | 2-1/8 ≤ $t_{fix}$ < 4 (55 ≤ $t_{fix-}$ ≤ 100) | | 34,825 (154.9) | 31,385 (139.6) | | | |

1 See section 3.1.8 to convert design strength value to ASD value.
2 Hilti T/-TR anchors are to be considered ductile steel elements.
3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3, Annex D.
4 Shear determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3, Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3, Annex D. See Section 3.1.8 for additional information on seismic applications.

## Table 12 — Hilti HDA carbon and stainless steel design information in accordance with CSA A23.3[1]

| Design parameter | Symbol | Units | Nominal anchor diameter | | | | | | | Ref A23.3 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | M10 | | M12 | | M16 | | M20 | |
| | | | HDA | HDA-R | HDA | HDA-R | HDA | HDA-R | HDA | |
| Anchor O.D. | $d_a$ | mm<br>(in) | 19<br>(0.75) | | 21<br>(0.83) | | 29<br>(1.14) | | 35<br>(1.38) | |
| Effective minimum embedment[2] | $h_{ef}$ | mm<br>(in) | 100<br>(3.94) | | 125<br>(4.92) | | 190<br>(7.48) | | 250<br>(9.84) | |
| Min. concrete thickness | $h_{min}$ | - | See tables 1 of this section, or 3A and 3B of ESR-1546 | | | | | | | |
| Critical edge distance | $c_{ac}$ | - | 1.5 x hef : See section 4.1.11 of ESR-1546 | | | | | | | |
| Min. edge distance | $c_{min}$ | mm<br>(in) | 80<br>(3.15) | | 100<br>(3.94) | | 150<br>(5.91) | | 200<br>(7.87) | |
| Min. anchor spacing | $s_{min}$ | mm<br>(in) | 100<br>(3.94) | | 125<br>(4.92) | | 190<br>(7.48) | | 250<br>(9.84) | |
| Min. specified yield strength | $f_{ya}$ | psi<br>($N/mm^2$) | 92,800<br>(640) | | | | | | | |
| Min. specified ult. strength | $f_{uta}$ | psi<br>($N/mm^2$) | 116,000<br>(800) | | | | | | | |
| Effective tensile stress area | $A_{se,N}$ | $in^2$<br>($mm^2$) | 0.090<br>(58.1) | | 0.131<br>(84.5) | | 0.243<br>(156.8) | | 0.380<br>(245.2) | |
| Steel embed. material resistance factor for reinforcement | $\phi_s$ | - | 0.85 | | | | | | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes[3] | R | - | 0.80 | | | | | | | D.5.3 |
| Resistance modification factor for shear, steel failure modes[3] | R | - | 0.75 | | | | | | | D.5.3 |
| Factored steel resistance in tension | $N_{sar}$ | - | See tables 10 and 11 of this section | | | | | | | D.6.1.2 |
| Factored steel resistance in shear | $V_{sar}$ | - | See tables 10 and 11 of this section | | | | | | | D.7.1.2 |
| Factored steel resistance in shear, seismic | $V_{sar,eq}$ | - | See tables 10 and 11 of this section | | | | | | | |
| Coeff. for factored concrete breakout resistance, uncracked concrete | $k_{c,uncr}$ | - | 12.5 | | | | | | | D.6.2.2 |
| Coeff. for factored concrete breakout resistance, cracked concrete | $k_{c,cr}$ | - | 10 | | | | | | | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked concrete[4] | $\psi_{c,N}$ | - | 1.0 | | | | | | | D.6.2.6 |
| Anchor category | - | - | 1 | | | | | | | D.5.3 (c ) |
| Concrete material resistance factor | $\phi_c$ | - | 0.65 | | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | R | - | 1.00 | | | | | | | D.5.3 (c ) |
| Factored pullout resistance in 20 MPa uncracked concrete[6] | $N_{pr,uncr}$ | lb<br>(kN) | N/A | | | | | | | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete[6] | $N_{pr,cr}$ | lb<br>(kN) | 6,295<br>(28.0) | | 7,870<br>(35.0) | | 15,745<br>(70.0) | | 23,615<br>(105.0) | D.6.3.2 |

1 Design information in this table is taken from ICC-ES ESR-1546, dated March 2020 and converted for use with CSA A23.3 Annex D.

2 See figure 1 of this section.

3 The HDA is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.

4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.

5 For use with the load combinations of CSA A23.3 Chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

6 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-1546 for additional information.

## Table 13 — Hilti HDA-P and HDA-T carbon and stainless steel factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

| Nominal anchor diameter | Effective embed. mm (in.) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| M10 | 100 (3.94) | 8,170 (36.3) | 9,135 (40.6) | 10,005 (44.5) | 11,550 (51.4) | 16,335 (72.7) | 18,265 (81.3) | 20,010 (89.0) | 23,105 (102.8) |
| M12 | 125 (4.92) | 11,415 (50.8) | 12,765 (56.8) | 13,980 (62.2) | 16,145 (71.8) | 22,830 (101.6) | 25,525 (113.6) | 27,965 (124.4) | 32,290 (143.6) |
| M16 | 190 (7.48) | 21,395 (95.2) | 23,920 (106.4) | 26,200 (116.6) | 30,255 (134.6) | 42,785 (190.3) | 47,840 (212.8) | 52,405 (233.1) | 60,510 (269.2) |
| M20 | 250 (9.84) | 32,290 (143.6) | 36,100 (160.6) | 39,545 (175.9) | 45,665 (203.1) | 64,580 (287.3) | 72,200 (321.2) | 79,095 (351.8) | 91,330 (406.3) |

## Table 14 — Hilti HDA-P and HDA-T carbon and stainless steel factored resistance with concrete/pullout failure in cracked concrete[1,2,3,4,5]

| Nominal anchor diameter | Effective embed. mm (in.) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| M10 | 100 (3.94) | 6,295 (28.0) | 7,040 (31.3) | 7,710 (34.3) | 8,905 (39.6) | 13,070 (58.1) | 14,615 (65.0) | 16,005 (71.2) | 18,485 (82.2) |
| M12 | 125 (4.92) | 7,870 (35.0) | 8,800 (39.1) | 9,640 (42.9) | 11,130 (49.5) | 18,265 (81.3) | 20,420 (90.8) | 22,370 (99.5) | 25,830 (114.9) |
| M16 | 190 (7.48) | 15,745 (70.0) | 17,600 (78.3) | 19,280 (85.8) | 22,265 (99.0) | 34,230 (152.3) | 38,270 (170.2) | 41,925 (186.5) | 48,410 (215.3) |
| M20 | 250 (9.84) | 23,615 (105.0) | 26,400 (117.4) | 28,920 (128.6) | 33,395 (148.5) | 51,665 (229.8) | 57,760 (256.9) | 63,275 (281.5) | 73,065 (325.0) |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 9 as necessary. Compare to the steel values in tables 10 and 11. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

## INSTALLATION AND REMOVAL INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance.

HDA Undercut Anchors are fully removable. The removal process strips the anchor threads to prevent reuse of anchors for safety purposes.

Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in IFU.

## ORDERING INFORMATION



### HDA-T anchor





| Description | HDA-T | HDA-TF | HDA-TR | HDA | Stop drill bit | Diamond core bit[1] | Setting tool |
|---|---|---|---|---|---|---|---|
| bolt dia. x $h_{ef}$ / $t_{fix,max}$ overall length $\ell$ | Galvanized | Sherardised | 316 Stainless | Box Qty | Description (mm) dia. x drill depth | Diameter (mm) | Description |
| M10x100/20 150 mm | ● | ● | ● | 12 | TE-C-B20x120 | 20 | TE-C-ST 20 M10 |
| | | | | | TE-Y-B20x120 | | TE-Y-ST 20 M10 |
| M12x125/30 190 mm | ● | ● | ● | 8 | TE-C-B22x155 | 22 | TE-C-ST 22 M12 |
| | | | | | TE-Y-B22x155 | | TE-Y-ST 22 M12 |
| M12x125/50 210 mm | ● | ● | ● | 8 | TE-C-B22x175 | 22 | TE-C-ST 22 M12 |
| | | | | | TE-Y-B22x175 | | TE-Y-ST 22 M12 |
| M16x190/40 275 mm | ● | ● | ● | 4 | TE-Y B30x230 | 30 | TE-Y-ST 30 M16 |
| M16x190/60 295 mm | ● | ● | ● | 4 | TE-Y B30x250 | | |
| M20x250/50 360 mm | ● | | | 2 | TE-Y B37x300 | 37 | TE-Y-ST 37 M20 |
| M20x250/100 410 mm | ● | | | 2 | TE-Y B37x350 | | |

1 The drilling depth with the diamond core bit must not exceed 2/3 of the specified minimum drill hole depth. The last 1/3 of the drill hole depth must be completed with the specified hammer drill and stop drill bit. Always consult the engineer of record before cutting rebar.

### HDA-P anchor

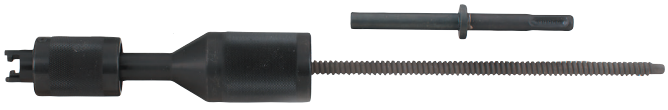




| Description | HDA-P | HDA-PF | HDA-PR | HDA | Stop drill bit | Diamond core bit[1] | Setting tool |
|---|---|---|---|---|---|---|---|
| bolt dia. x $h_{ef}$ / $t_{fix,max}$ overall length $\ell$ | Galvanized | Sherardised | 316 Stainless | Box Qty | Description (mm) dia. x drill depth | Diameter (mm) | Description |
| M10x100/20 150 mm | ● | ● | ● | 12 | TE-C B20x100 | 20 | TE-C-ST 20 M10 |
| | | | | | TE-Y B20x100 | | TE-Y-ST 20 M10 |
| M12x125/30 190 mm | ● | ● | ● | 8 | TE-C B22x125 | 22 | TE-C-ST 22 M12 |
| | | | | | TE-Y B22x125 | | TE-Y-ST 22 M12 |
| M12x125/50 210 mm | ● | ● | ● | 8 | TE-C-B22x125 | 22 | TE-C-ST 22 M12 |
| | | | | | TE-Y-B22x125 | | TE-Y-ST 22 M12 |
| M16x190/40 275 mm | ● | ● | ● | 4 | TE-Y B30x190 | 30 | TE-Y-ST 30 M16 |
| M16x190/60 295 mm | ● | ● | ● | 4 | | | |
| M20x250/50 360 mm | ● | | | 2 | TE-Y B37x250 | 37 | TE-Y-ST 37 M20 |
| M20x250/100 410 mm | ● | | | 2 | | | |

1 The drilling depth with the diamond core bit must not exceed 2/3 of the specified minimum drill hole depth. The last 1/3 of the drill hole depth must be completed with the specified hammer drill and stop drill bit. Always consult the engineer of record before cutting rebar.

### Removal tool with adapter



| Description | Qty/pkg | Applicable anchor sizes |
|---|---|---|
| TE-C-HDA-RT 20-M10 | 1 | HDA M10 |
| TE-C-HDA-RT 22-M12 | 1 | HDA M12 |
| TE-C-HDA-RT 30-M16 | 1 | HDA M16 |
| TE-C-HDA-RT 37-M20 | 1 | HDA M20 |

# HAMMER DRILLS REQUIRED FOR SETTING HDA ANCHORS

## HDA carbon steel — zinc plated

| Anchor | Hilti hammer drill[1] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | TE 25 (1st gear) | TE 36-A | TE 40/ 40-AVR | TE 56/ 56-ATC | TE 60-ATC | TE 70[2]/ 70-ATC | TE 75 | TE-76/ 76-ATC | TE 80-ATC |
| | connection end | | | | | | | | |
| | TE-C | | | TE-Y | | | | | |
| HDA-P M10x100/20 | ● | ● | ● | ● | ● | | | | |
| HDA-T M10x100/20 | ● | ● | ● | ● | ● | | | | |
| HDA-P M12x125/30 | ● | ● | ● | ● | ● | | | | |
| HDA-T M12x125/30 | ● | ● | ● | ● | ● | | | | |
| HDA-P M12x125/50 | ● | ● | ● | ● | ● | | | | |
| HDA-T M12x125/50 | ● | ● | ● | ● | ● | | | | |
| HDA-P M16x190/40 | | | | | | ● | ● | ● | ● |
| HDA-T M16x190/40 | | | | | | ● | ● | ● | ● |
| HDA-P M16x190/60 | | | | | | ● | ● | ● | ● |
| HDA-T M16x190/60 | | | | | | ● | ● | ● | ● |
| HDA-P M20x250/50 | | | | | | ● | | ● | ● |
| HDA-T M20x250/50 | | | | | | ● | | ● | ● |
| HDA-P M20x250/100 | | | | | | ● | | ● | ● |
| HDA-T M20x250/100 | | | | | | ● | | ● | ● |

## HDA-R stainless steel

| Anchor | Hilti hammer drill[1] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | TE 25 (1st gear) | TE 36-A | TE 40/ 40-AVR | TE 56/ 56-ATC | TE 60-ATC | TE 70[2]/ 70-ATC | TE 75 | TE-76/ 76-ATC | TE 80-ATC |
| | connection end | | | | | | | | |
| | TE-C | | | TE-Y | | | | | |
| HDA-PR M10x100/20 | ● | ● | ● | | | | | | |
| HDA-TR M10x100/20 | ● | ● | ● | ● | ● | | | | |
| HDA-PR M12x125/30 | ● | ● | ● | ● | ● | | | | |
| HDA-TR M12x125/30 | ● | ● | ● | ● | ● | | | | |
| HDA-PR M12x125/50 | ● | ● | ● | ● | ● | | | | |
| HDA-TR M12x125/50 | ● | ● | ● | ● | ● | | | | |
| HDA-PR M16x190/40 | | | | | | ● | ● | ● | ● |
| HDA-PR M16x190/60 | | | | | | ● | ● | ● | ● |
| HDA-PR M16x190/60 | | | | | | ● | ● | ● | ● |
| HDA-TR M16x190/60 | | | | | | ● | ● | ● | ● |

## HDA-F carbon steel — sherardized (heavy-duty galvanization)

| Anchor | Hilti hammer drill[1] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | TE 25 (1st gear) | TE 36-A | TE 40/ 40-AVR | TE 56/ 56-ATC | TE 60-ATC | TE 70[2]/ 70-ATC | TE 75 | TE-76/ 76-ATC | TE 80-ATC |
| | connection end | | | | | | | | |
| | TE-C | | | TE-Y | | | | | |
| HDA-PFM10x100/20 | | ● | ● | | ● | | | | |
| HDA-TF M10x100/20 | | ● | ● | | ● | | | | |
| HDA-PF M12x125/30 | | ● | ● | | ● | | | | |
| HDA-TF M12x125/30 | | ● | ● | | ● | | | | |
| HDA-PF M12x125/50 | | ● | ● | | ● | | | | |
| HDA-TF M12x125/50 | | ● | ● | | ● | | | | |
| HDA-PF M16x190/40 | | | | | | ● | ● | ● | ● |
| HDA-TF M16x190/40 | | | | | | ● | ● | ● | ● |
| HDA-PF M16x190/60 | | | | | | ● | ● | ● | ● |
| HDA-TF M16x190/60 | | | | | | ● | ● | ● | ● |

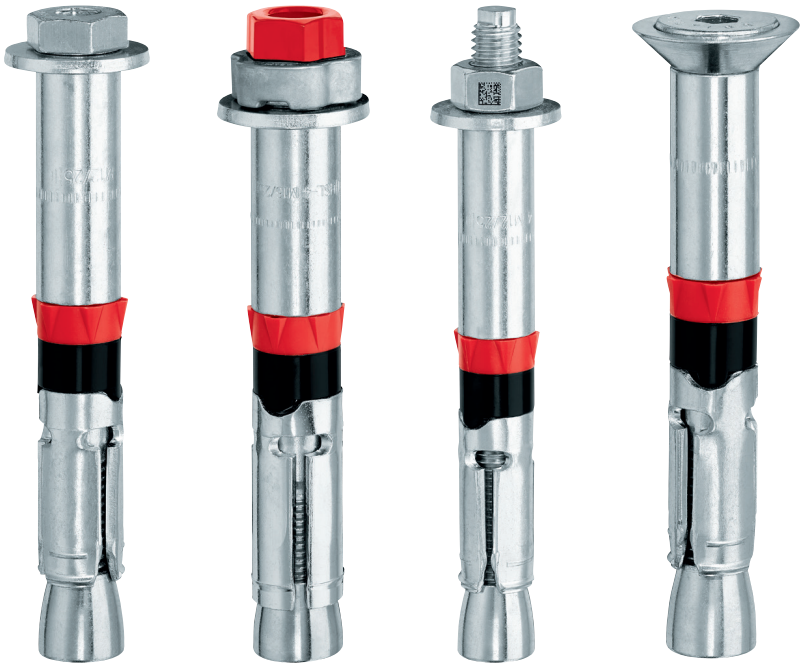
1 To ensure IBC compliance, reference ESR-1546 or contact Hilti Technical Support.

2 Increase $h_{min}$ when setting the HDA M16 with the TE 70. See Table 1 of this section, or ESR-1546 Table 3A and 3B.

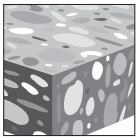
# 3.3.2 HSL4 HEAVY-DUTY EXPANSION ANCHORS

## PRODUCT DESCRIPTION

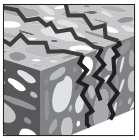
| Anchor system | | | | Features and benefits |
|---|---|---|---|---|
| HSL4 Heavy-duty Expansion Anchor | HSL4-B Heavy-duty Expansion Anchor with Torque Cap | HSL4-G Heavy-duty Expansion Anchor with Threaded Rod | HSL4-SK Countersunk version available as special | • Approved for use in the concrete tension zone (cracked concrete)<br>• Approved for use with cored drilled holes using the Hilti diamond coring tool, DD-30 or DD-EC-1 with the SPX-T core bits or with the Hilti Diamond Coring Tool DD-110 to DD-250 with the SPPX-H, SPX-L or SPX-L Handheld core bits<br>• Data for use with the Strength Design provisions of ACI 318 Chapter 17 and ACI 349 Appendix B<br>• High load capacity<br>• Force-controlled expansion which allows for follow-up expansion<br>• Suitable for dynamic loading, including seismic[1], fatigue and shock<br>• No spinning of the anchor in hole when tightening bolt or nut<br>• Seismic qualification per ICC-ES AC193 and the requirements of ACI 318 Chapter 17 |



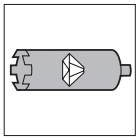
[1] HSL4-G M24 is not approved for seismic design.



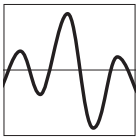
Uncracked concrete



Cracked concrete



Diamond cored holes for cracked and uncracked concrete



Seismic Design Categories A-F




Profis Anchor design software




Hollow Drill Bit

| Approvals/Listings | |
|---|---|
| ICC-ES (International Code Council) | ESR-4386 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193 |
| European Technical Approval | ETA-19/0556 |
| City of Los Angeles | 2020 LABC Supplement (within ESR-4386) |
| Nuclear Quality Assurance | Qualified under NQA-1 Nuclear Quality Program |

# MATERIAL SPECIFICATIONS

| |
|---|
| Carbon steel bolt or threaded rod for HSL4, HSL4-G, HSL4-B and HSL4-SK conform to the steel strength requirements of ISO 898-1, grade 8 .8, $f_{ya}$ > 93 ksi, $f_{uta}$ > 116 ksi. |
| Nut, washer, expansion cone, expansion sleeve and spacing sleeve are all made of carbon steel. |
| Collapsible sleeve is made from acetal polyoxymethylene (POM) resin and thermoplastic elastomer (TPE). |

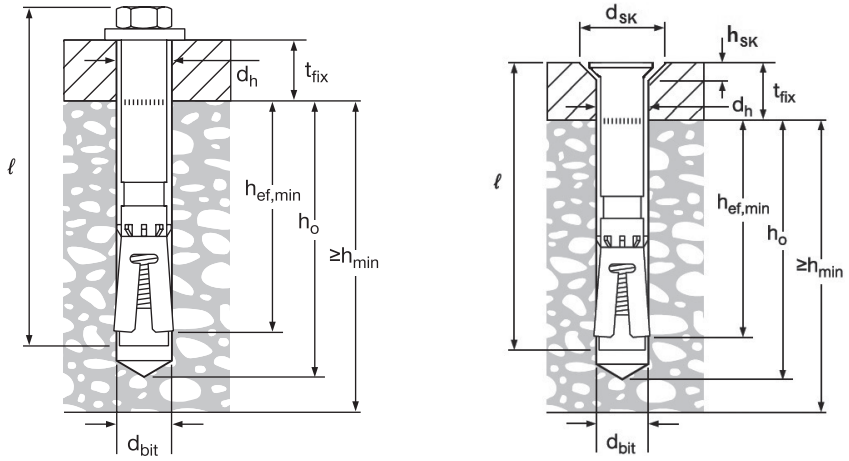
# INSTALLATION PARAMETERS

**Table 1 — HSL4 Specifications**

| Details | | | HSL4 anchor thread diameter | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M8 | | M10 | | M12 | | | M16 | | | M20 | | M24 | |
| Nominal drill bit diameter[1] | $d_{bit}$ | mm | 12 | | 15 | | 18 | | | 24 | | | 28 | | 32 | |
| Minimum concrete thickness | $h_{min}$ | mm (in.) | See table 5 | | | | | | | | | | | | | |
| Minimum hole depth | $h_o$ | mm (in.) | 80 (3-1/8) | | 90 (3-1/2) | | 105 (4-1/8) | | | 125 (4-7/8) | | | 155 (6-1/8) | | 180 (7-1/8) | |
| Effective minimum embedment | $h_{ef,min}$ | mm (in.) | 60 (2-3/8) | | 70 (2-3/4) | | 80 (3-1/8) | | | 100 (3-7/8) | | | 125 (4-7/8) | | 150 (5-7/8) | |
| Fixture hole diameter | $d_h$ | mm (in.) | 14 (9/16) | | 17 (11/16) | | 20 (13/16) | | | 26 (1) | | | 31 (1-1/4) | | 35 (1-3/8) | |
| Maximum thickness of part fastened HSL4, HSL4-B | $t_{fix}$ | mm (in.) | 20 (3/4) | 40 (1-1/2) | 20 (3/4) | 40 (1-1/2) | 5 (1/5) | 25 (1) | 50 (2) | 10 (2/5) | 25 (1) | 50 (2) | 30 (1-1/8) | 60 (2-1/4) | 30 (1-1/8) | 60 (2-1/4) |
| Maximum thickness of part fastened HSL4-G | $t_{fix}$ | mm (in.) | 20 (3/4) | | 20 (3/4) | 100 (4) | 25 (1) | | 50 (2) | 25 (1) | | 50 (2) | 30 (1-1/8) | 60 (2-1/4) | – – | – – |
| Washer diameter | $d_w$ | mm (in.) | 20 (3/4) | | 25 (1) | | 30 (1-1/8) | | | 40 (1-9/16) | | | 45 (1-3/4) | | 50 (2) | |
| Installation torque HSL4 | $T_{inst}$ | Nm (ft-lb) | 15 (11) | | 25 (18) | | 60 (44) | | | 75 (55) | | | 145 (107) | | 210 (155) | |
| Installation torque HSL4-G | $T_{inst}$ | Nm (ft-lb) | 20 (15) | | 27 (20) | | 60 (44) | | | 70 (52) | | | 105 (77) | | 180 (132) | |
| Installation torque HSL4-SK | $T_{inst}$ | Nm (ft-lb) | 25 (18) | | 32 (24) | | 65 (48) | | | – | | | – | | – | |
| Wrench size HSL4, HSL4-G | SW | mm | 13 | | 17 | | 19 | | | 24 | | | 30 | | 36 | |
| Wrench size HSL4-B | SW | mm | – | | – | | 24 | | | 30 | | | 36 | | 41 | |
| Wrench size HSL4-SK | SW | mm | 5 | | 6 | | 8 | | | – | | | – | | – | |
| Diameter of countersunk hole HSL4-SK | $d_{sk}$ | mm | 22.5 | | 25.5 | | 32.9 | | | – | | | – | | – | |

[1] Use metric bits only.

**Figure 1**



# DESIGN DATA IN CONCRETE PER ACI 318

## ACI 318 Chapter 17 Design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-4386 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8 of the North American Product Technical Guide, Volume 2: Anchor Fastening Technical Guide, Edition 22 (PTG Ed. 21). Data tables from ESR-4386 are not contained in this section but can be found at www.icc-es.org or at www.hilti.com.



**Table 2 — Hilti HSL4 design strength with concrete / pullout failure in uncracked concrete[1,2,3,4,5]**

| Nominal anchor diameter | Effective embed. mm (in.) | Tension - $\varphi N_n$ | | | | Shear - $\varphi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) |
| M8 | 60 (2.4) | 2,735 (12.2) | 2,995 (13.3) | 3,455 (15.4) | 4,235 (18.8) | 3,050 (13.6) | 3,340 (14.9) | 3,860 (17.2) | 4,725 (21.0) |
| M10 | 70 (2.8) | 3,570 (15.9) | 3,910 (17.4) | 4,515 (20.1) | 5,530 (24.6) | 7,685 (34.2) | 8,420 (37.5) | 9,720 (43.2) | 11,905 (53.0) |
| M12 | 80 (3.2) | 4,360 (19.4) | 4,775 (21.2) | 5,515 (24.5) | 6,755 (30.0) | 9,390 (41.8) | 10,285 (45.7) | 11,880 (52.8) | 14,550 (64.7) |
| M16 | 100 (3.9) | 6,095 (27.1) | 6,675 (29.7) | 7,705 (34.3) | 9,440 (42.0) | 13,125 (58.4) | 14,375 (63.9) | 16,600 (73.8) | 20,330 (90.4) |
| M20 | 125 (4.9) | 8,515 (37.9) | 9,330 (41.5) | 10,770 (47.9) | 13,190 (58.7) | 18,340 (81.6) | 20,090 (89.4) | 23,200 (103.2) | 28,415 (126.4) |
| M24 | 150 (5.9) | 11,195 (49.8) | 12,260 (54.5) | 14,160 (63.0) | 17,340 (77.1) | 24,110 (107.2) | 26,410 (117.5) | 30,495 (135.6) | 37,350 (166.1) |

**Table 3 — Hilti HSL4 design strength with concrete / pullout failure in cracked concrete[1,2,3,4,5]**

| Nominal anchor diameter | Effective embed. mm (in.) | Tension - $\varphi N_n$ | | | | Shear - $\varphi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) |
| M8 | 60 (2.4) | 1,825 (8.1) | 2,000 (8.9) | 2,310 (10.3) | 2,830 (12.6) | 2,160 (9.6) | 2,365 (10.5) | 2,730 (12.1) | 3,345 (14.9) |
| M10 | 70 (2.8) | 2,920 (13.0) | 3,200 (14.2) | 3,695 (16.4) | 4,525 (20.1) | 7,685 (34.2) | 8,420 (3 .5) | 9,720 (43.2) | 11,905 (53.0) |
| M12 | 80 (3.2) | 4,360 (19.4) | 4,775 (21.2) | 5,515 (24.5) | 6,755 (30.0) | 9,390 (41.8) | 10,285 (45.7) | 11,880 (52.8) | 14,550 (64.7) |
| M16 | 100 (3.9) | 6,095 (27.1) | 6,675 (29.7) | 7,705 (34.3) | 9,440 (42.0) | 13,125 (58.4) | 14,375 (63.9) | 16,600 (73.8) | 20,330 (90.4) |
| M20 | 125 (4.9) | 8,515 (37.9) | 9,330 (41.5) | 10,770 (47.9) | 13,190 (58.7) | 18,340 (81.6) | 20,090 (89.4) | 23,200 (103.2) | 28,415 (126.4) |
| M24[5] | 150 (5 .9) | 11,195 (49.8) | 12,260 (54.5) | 14,160 (63.0) | 17,340 (77.1) | 24,110 (107.2) | 26,410 (117.5) | 30,495 (135.6) | 37,350 (166.1) |

1 See PTG Ed. 21 section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 5 to 8 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.
4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0 .60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For all seismic tension loads for all other anchors, multiply cracked concrete tabular values in tension only by the following reduction factors:
M24 - $\alpha_{N,seis}$ = 0 .62. HSL4-G M24 is not approved for seismic design.
All other sizes - $\alpha_{N,seis}$ = 0.75
No reduction needed for seismic shear. See PTG Ed. 21 section 3.1.8 for additional information on seismic applications.

## Table 4 — Steel strength for Hilti HSL4 anchors[1,2]

| Nominal anchor diameter | HSL4, HSL4-B, HSL4-SK | | | HSL4-G | | |
|---|---|---|---|---|---|---|
| | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic shear[5] $\phi V_{sa,eq}$ lb (kN) | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic shear[5] $\phi V_{sa,eq}$ lb (kN) |
| M8 | 4,960 (22 .1) | 4,705 (20 .9) | 2,995 (13 .3) | 4,960 (22 .1) | 3,945 (17 .5) | 2,455 (10 .9) |
| M10 | 7,830 (34 .8) | 6,650 (29 .6) | 5,495 (24 .4) | 7,830 (34 .8) | 5,450 (24 .2) | 4,500 (20 .0) |
| M12 | 11,395 (50 .7) | 9,570 (42 .6) | 7,730 (34 .4) | 11,395 (50 .7) | 7,905 (35 .2) | 6,385 (28 .4) |
| M16 | 21,140 (94 .0) | 17,360 (77 .2) | 16,115 (71 .7) | 21,140 (94 .0) | 14,745 (65 .6) | 13,690 (60 .9) |
| M20 | 33,060 (147 .1) | 25,690 (114 .3) | 18,940 (84 .2) | 33,060 (147 .1) | 21,555 (95 .9) | 15,900 (70 .7) |
| M24 | 47,590 (211 .7) | 29,870 (132 .9) | 24,810 (110 .4) | 47,590 (211 .7) | 28,060 (124 .8) | n/a |

1 See PTG Ed. 21 section 3.1.8 to convert design strength value to ASD value.
2 Hilti HSL4 Carbon Steel anchors are to be considered ductile steel elements.
3 Tensile $\phi N_{sa} = \phi_{Ase,N} f_{uta}$ as noted in ACI 318 Chapter 17
4 Shear values determined by static shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa,\ eq} \leq \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17
See PTG Ed. 21 section 3.1.8 for additional information on seismic applications.

**Table 5 — Edge distance, spacing and member thickness requirements[1]**

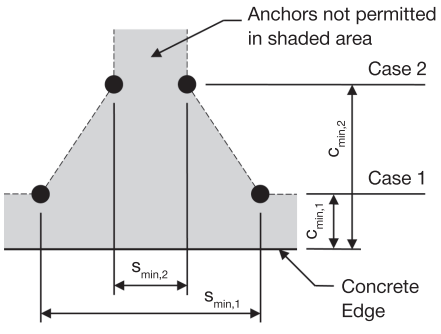
| Condition | Dimensional parameter | | Symbol | Units | Nominal anchor diameter | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | M8 | M10 | M12 | M16 | M20 | M24 |
| A | Minimum concrete thickness | | $h_{min}$ | in. (mm) | 4-3/4 (120) | 5-1/2 (140) | 6-1/4 (160) | 7-7/8 (200) | 9-7/8 (250) | 11-7/8 (300) |
| | Critical edge distance | | $c_{ac}$ | in. (mm) | 4-3/8 (110) | 4-3/8 (110) | 4-3/4 (120) | 5-7/8 (150) | 8-7/8 (225) | 8-7/8 (225) |
| | Case 1 | Minimum edge distance | $c_{min,1}$ | in. (mm) | 2-3/8 (60) | 2-3/4 (70) | 3-1/2 (90) | 4-3/4 (120) | 5 (125) | 5-7/8 (150) |
| | | Minimum anchor spacing | $s_{min,1}$ | in. (mm) | 5-1/2 (140) | 9-1/2 (240) | 11 (280) | 12-5/8 (320) | 13-3/4 (350) | 11-7/8 (300) |
| | Case 2 | Minimum edge distance | $c_{min,2}$ | in. (mm) | 3-3/8 (85) | 5 (125) | 6-1/8 (155) | 7-7/8 (200) | 8-1/4 (210) | 8-1/4 (210) |
| | | Minimum anchor spacing | $s_{min,2}$ | in. (mm) | 2-3/8 (60) | 2-3/4 (70) | 3-1/8 (80) | 4 (100) | 5 (125) | 5-7/8 (150) |
| B | Minimum concrete thickness | | $h_{min}$ | in. (mm) | 4-3/8 (110) | 4-3/4 (120) | 5-3/8 (135) | 6-1/4 (160) | 7-1/2 (190) | 8-7/8 (225) |
| | Critical edge distance | | $c_{ac}$ | in. (mm) | 5-7/8 (150) | 6-7/8 (175) | 7-7/8 (200) | 9-7/8 (250) | 12-3/8 (312 .5) | 14-3/4 (375) |
| | Case 1 | Minimum edge distance | $c_{min,1}$ | in. (mm) | 2-3/8 (60) | 3-1/2 (90) | 4-3/8 (110) | 6-1/4 (160) | 7-7/8 (200) | 8-7/8 (225) |
| | | Minimum anchor spacing | $s_{min,1}$ | in. (mm) | 7 (180) | 10-1/4 (260) | 12-5/8 (320) | 15 (380) | 15-3/4 (400) | 15 (380) |
| | Case 2 | Minimum edge distance | $c_{min,2}$ | in. (mm) | 4 (100) | 6-1/4 (160) | 7-7/8 (200) | 10-5/8 (270) | 11-7/8 (300) | 12-5/8 (320) |
| | | Minimum anchor spacing | $s_{min,2}$ | in. (mm) | 2-3/8 (60) | 2-3/4 (70) | 3-1/8 (80) | 4 (100) | 5 (125) | 5-7/8 (150) |

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2.
Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacing s as follows:

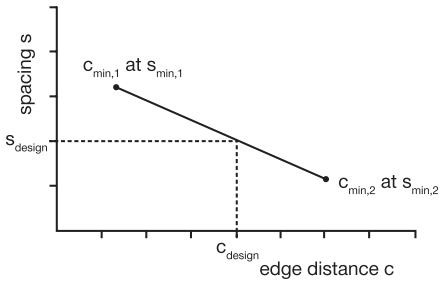
$$S \geq S_{min,2} + \frac{\left(S_{min,1} - S_{min,2}\right)}{\left(C_{min,1} - C_{min,2}\right)}\left(C - C_{min,2}\right)$$

3.3.2

**Figure 2**




For a specific edge distance, the permitted spacing is calculated as follows:



## Table 6 — Load adjustment factors for M8, M10, and M12 Hilti HSL4 anchors in uncracked concrete[1,2]

| M8, M10 and M12 HSL4 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ to and away from edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal dia. | | | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 |
| Effective embedment $h_{ef}$ | | in. (mm) | 2.38 (60) | 2.76 (70) | 3.15 (80) | 2.36 (60) | 2.76 (70) | 3.15 (80) | 2.38 (60) | 2.76 (70) | 3.15 (80) | 2.38 (60) | 2.76 (70) | 3.15 (80) | 2.38 (60) | 2.76 (70) | 3.15 (80) | 2.38 (60) | 2.76 (70) | 3.15 (80) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in (mm) | 2-3/8 | (60) | 0.67 | n/a | n/a | 0.45 | n/a | n/a | 0.58 | n/a | n/a | 0.32 | n/a | n/a | 0.45 | n/a | n/a | n/a | n/a | n/a |
| | 2-1/2 | (64) | 0.68 | n/a | n/a | 0.47 | n/a | n/a | 0.58 | n/a | n/a | 0.35 | n/a | n/a | 0.47 | n/a | n/a | n/a | n/a | n/a |
| | 2-3/4 | (70) | 0.69 | 0.67 | n/a | 0.50 | 0.45 | n/a | 0.59 | 0.55 | n/a | 0.40 | 0.18 | n/a | 0.50 | 0.36 | n/a | n/a | n/a | n/a |
| | 3 | (76) | 0.71 | 0.68 | n/a | 0.53 | 0.48 | n/a | 0.60 | 0.56 | n/a | 0.46 | 0.20 | n/a | 0.53 | 0.41 | n/a | n/a | n/a | n/a |
| | 3-1/8 | (79) | 0.72 | 0.69 | 0.67 | 0.55 | 0.49 | n/a | 0.60 | 0.56 | 0.56 | 0.49 | 0.22 | n/a | 0.55 | 0.44 | n/a | n/a | n/a | n/a |
| | 3-1/2 | (89) | 0.75 | 0.71 | 0.69 | 0.60 | 0.53 | 0.48 | 0.62 | 0.57 | 0.56 | 0.58 | 0.26 | 0.23 | 0.60 | 0.52 | 0.46 | n/a | n/a | n/a |
| | 4 | (102) | 0.78 | 0.74 | 0.71 | 0.68 | 0.59 | 0.53 | 0.63 | 0.58 | 0.57 | 0.71 | 0.32 | 0.28 | 0.71 | 0.59 | 0.53 | n/a | n/a | n/a |
| | 4-3/8 | (111) | 0.81 | 0.76 | 0.73 | 0.74 | 0.64 | 0.56 | 0.65 | 0.58 | 0.58 | 0.81 | 0.36 | 0.32 | 0.81 | 0.64 | 0.56 | 0.76 | n/a | n/a |
| | 4-1/2 | (114) | 0.82 | 0.77 | 0.74 | 0.77 | 0.65 | 0.58 | 0.65 | 0.59 | 0.58 | 0.85 | 0.38 | 0.34 | 0.85 | 0.65 | 0.58 | 0.77 | n/a | n/a |
| | 4-3/4 | (121) | 0.84 | 0.79 | 0.75 | 0.81 | 0.69 | 0.60 | 0.66 | 0.59 | 0.59 | 0.92 | 0.41 | 0.37 | 0.92 | 0.69 | 0.60 | 0.79 | 0.61 | n/a |
| | 5 | (127) | 0.85 | 0.80 | 0.76 | 0.85 | 0.73 | 0.63 | 0.67 | 0.60 | 0.59 | 0.99 | 0.44 | 0.40 | 0.99 | 0.73 | 0.63 | 0.81 | 0.62 | n/a |
| | 5-3/8 | (137) | 0.88 | 0.83 | 0.78 | 0.91 | 0.78 | 0.68 | 0.68 | 0.60 | 0.60 | 1.00 | 0.49 | 0.44 | 1.00 | 0.78 | 0.68 | 0.84 | 0.64 | 0.62 |
| | 6 | (152) | 0.92 | 0.86 | 0.82 | 1.00 | 0.87 | 0.76 | 0.70 | 0.62 | 0.61 | | 0.58 | 0.52 | | 0.87 | 0.76 | 0.89 | 0.68 | 0.66 |
| | 7 | (178) | 0.99 | 0.92 | 0.87 | | 1.00 | 0.89 | 0.73 | 0.64 | 0.63 | | 0.73 | 0.65 | | 1.00 | 0.89 | 0.96 | 0.73 | 0.71 |
| | 8 | (203) | 1.00 | 0.98 | 0.92 | | | 1.00 | 0.77 | 0.65 | 0.64 | | 0.89 | 0.80 | | | 1.00 | 1.00 | 0.79 | 0.76 |
| | 9 | (229) | | 1.00 | 0.98 | | | | 0.80 | 0.67 | 0.66 | | 1.00 | 0.95 | | | | | 0.83 | 0.80 |
| | 10 | (254) | | 1.00 | 1.00 | | | | .083 | 0.69 | 0.68 | | | 1.00 | | | | | 0.88 | 0.85 |
| | 12 | (305) | | 1.00 | 1.00 | | | | 0.90 | 0.73 | 0.72 | | | | | | | | 0.96 | 0.93 |
| | 14 | (356) | | | 1.00 | | | | 0.96 | 0.77 | 0.75 | | | | | | | | 1.00 | 1.00 |
| | 16 | (406) | | | | | | | 1.00 | 0.81 | 0.79 | | | | | | | | | |
| | 18 | (457) | | | | | | | | 0.85 | 0.82 | | | | | | | | | |
| | 20 | (508) | | | | | | | | 0.89 | 0.86 | | | | | | | | | |
| | 24 | (610) | | | | | | | | 0.96 | 0.93 | | | | | | | | | |
| | > 30 | (762) | | | | | | | | 1.00 | 1.00 | | | | | | | | | |

## Table 7 — Load adjustment factors for M8, M10, and M12 Hilti HSL4 anchors in cracked concrete[1,2]

| M8, M10 and M12 HSL4 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ to and away from edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal dia. | | | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 |
| Effective embedment $h_{ef}$ | | in. (mm) | 2.38 (60) | 2.76 (70) | 3.15 (80) | 2.36 (60) | 2.76 (70) | 3.15 (80) | 2.38 (60) | 2.76 (70) | 3.15 (80) | 2.38 (60) | 2.76 (70) | 3.15 (80) | 2.38 (60) | 2.76 (70) | 3.15 (80) | 2.38 (60) | 2.76 (70) | 3.15 (80) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h), - in (mm) | 2-3/8 | (60) | 0.67 | n/a | n/a | 0.75 | n/a | n/a | 0.58 | n/a | n/a | 0.33 | n/a | n/a | 0.65 | n/a | n/a | n/a | n/a | n/a |
| | 2-1/2 | (64) | 0.68 | n/a | n/a | 0.78 | n/a | n/a | 0.58 | n/a | n/a | 0.35 | n/a | n/a | 0.71 | n/a | n/a | n/a | n/a | n/a |
| | 2-3/4 | (70) | 0.69 | 0.67 | n/a | 0.83 | 0.75 | n/a | 0.59 | 0.54 | n/a | 0.41 | 0.13 | n/a | 0.82 | 0.28 | n/a | n/a | n/a | n/a |
| | 3 | (76) | 0.71 | 0.68 | n/a | 0.88 | 0.79 | n/a | 0.60 | 0.55 | n/a | 0.46 | 0.15 | n/a | 0.88 | 0.29 | n/a | n/a | n/a | n/a |
| | 3-1/8 | (79) | 0.72 | 0.69 | 0.67 | 0.91 | 0.81 | n/a | 0.60 | 0.55 | 0.54 | 0.49 | 0.16 | n/a | 0.91 | 0.31 | n/a | n/a | n/a | n/a |
| | 3-1/2 | (89) | 0.75 | 0.71 | 0.69 | 0.99 | 0.88 | 0.80 | 0.62 | 0.55 | 0.55 | 0.59 | 0.18 | 0.17 | 0.99 | 0.37 | 0.33 | n/a | n/a | n/a |
| | 4 | (102) | 0.78 | 0.74 | 0.71 | 1.00 | 0.97 | 0.88 | 0.63 | 0.56 | 0.56 | 0.72 | 0.23 | 0.20 | 1.00 | 0.45 | 0.40 | n/a | n/a | n/a |
| | 4-3/8 | (111) | 0.81 | 0.76 | 0.73 | | 1.00 | 0.94 | 0.65 | 0.57 | 0.56 | 0.82 | 0.26 | 0.23 | | 0.51 | 0.46 | 0.76 | n/a | n/a |
| | 4-1/2 | (114) | 0.82 | 0.77 | 0.74 | | 1.00 | 0.96 | 0.65 | 0.57 | 0.56 | 0.85 | 0.27 | 0.24 | | 0.54 | 0.48 | 0.77 | n/a | n/a |
| | 4-3/4 | (121) | 0.84 | 0.79 | 0.75 | | 1.00 | 1.00 | 0.66 | 0.57 | 0.57 | 0.93 | 0.29 | 0.26 | | 0.58 | 0.52 | 0.80 | 0.54 | n/a |
| | 5 | (127) | 0.85 | 0.80 | 0.76 | | 1.00 | 1.00 | 0.67 | 0.58 | 0.57 | 1.00 | 0.31 | 0.28 | | 0.63 | 0.56 | 0.82 | 0.56 | n/a |
| | 5-3/8 | (137) | 0.88 | 0.83 | 0.78 | | 1.00 | 1.00 | 0.68 | 0.58 | 0.58 | | 0.35 | 0.31 | | 0.70 | 0.63 | 0.85 | 0.58 | 0.56 |
| | 6 | (152) | 0.92 | 0.86 | 0.82 | | 1.00 | 1.00 | 0.70 | 0.59 | 0.59 | | 0.41 | 0.37 | | 0.83 | 0.74 | 0.89 | 0.61 | 0.59 |
| | 7 | (178) | 0.99 | 0.92 | 0.87 | | 1.00 | 1.00 | 0.73 | 0.61 | 0.60 | | 0.52 | 0.47 | | 1.00 | 0.93 | 0.97 | 0.66 | 0.63 |
| | 8 | (203) | 1.00 | 0.98 | 0.92 | | | 1.00 | 0.77 | 0.62 | 0.61 | | 0.64 | 0.57 | | | 1.00 | 1.00 | 0.70 | 0.68 |
| | 9 | (229) | | 1.00 | 0.98 | | | | 0.80 | 0.67 | 0.63 | | 1.00 | 0.68 | | | | | 0.74 | 0.72 |
| | 10 | (254) | | 1.00 | 1.00 | | | | .083 | 0.65 | 0.64 | | 0.89 | 0.80 | | | | | 0.79 | 0.76 |
| | 12 | (305) | | 1.00 | 1.00 | | | | 0.90 | 0.69 | 0.67 | | 1.00 | 1.00 | | | | | 0.86 | 0.83 |
| | 14 | (356) | | | 1.00 | | | | 0.96 | 0.72 | 0.70 | | | | | | | | 1.93 | 0.90 |
| | 16 | (406) | | | | | | | 1.00 | 0.75 | 0.73 | | | | | | | | 0.99 | 0.96 |
| | 18 | (457) | | | | | | | | 0.78 | 0.76 | | | | | | | | 1.00 | 1.00 |
| | 20 | (508) | | | | | | | | 0.81 | 0.86 | | | | | | | | | |
| | 24 | (610) | | | | | | | | 0.87 | 0.84 | | | | | | | | | |
| | > 30 | (762) | | | | | | | | 0.96 | 0.93 | | | | | | | | | |

1. Linear interpolation not permitted.
2. When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.
3. Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.
4. Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, it may not be permitted if both edge and spacing are less than "critical" distances. Check table 5 and figure 2 of this section to calculate permissible edge distance, spacing and concrete thickness combinations. For the HSL4-SH M8, M10 and M12 diameters, the minimum slab thickness must be increased by 5 mm (3/16-in.).

## Table 8 — Load adjustment factors for M16, M20, and M24 Hilti HSL4 anchors in uncracked concrete [1,2]

| M16, M20 and M24 HSL4 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear II to and away from edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal dia. | | | M16 | M20 | M24 | M16 | M20 | M24 | M16 | M20 | M24 | M16 | M20 | M24 | M16 | M20 | M24 | M16 | M20 | M24 |
| Effective embedment $h_{ef}$ | | in. (mm) | 3.948 (100) | 4.92 (125) | 5.91 (150) | 3.948 (100) | 4.92 (125) | 5.91 (150) | 3.948 (100) | 4.92 (125) | 5.91 (150) | 3.948 (100) | 4.92 (125) | 5.91 (150) | 3.948 (100) | 4.92 (125) | 5.91 (150) | 3.948 (100) | 4.92 (125) | 5.91 (150) |
| Spacing (s) / edge distance ($c_{al}$) / concrete thickness (h), - in (mm) | 4 | (102) | 0.67 | n/a | n/a | n/a | n/a | n/a | 0.56 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4-1/2 | (114) | 0.69 | n/a | n/a | n/a | n/a | n/a | 0.57 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4-3/4 | (121) | 0.70 | n/a | n/a | 0.51 | n/a | n/a | 0.58 | n/a | n/a | 0.30 | n/a | n/a | 0.51 | n/a | n/a | n/a | n/a | n/a |
| | 5 | (127) | 0.71 | 0.67 | n/a | 0.53 | 0.45 | n/a | 0.58 | 0.57 | n/a | 0.33 | 0.25 | n/a | 0.53 | 0.45 | n/a | n/a | n/a | n/a |
| | 5-1/2 | (140) | 0.73 | 0.69 | n/a | 0.57 | 0.48 | n/a | 0.59 | 0.57 | n/a | 0.38 | 0.29 | n/a | 0.57 | 0.48 | n/a | n/a | n/a | n/a |
| | 5-7/8 | (149) | 0.75 | 0.70 | 0.67 | 0.60 | 0.50 | 0.45 | 0.59 | 0.58 | 0.57 | 0.42 | 0.32 | 0.26 | 0.60 | 0.50 | 0.45 | n/a | n/a | n/a |
| | 6 | (152) | 0.75 | 0.70 | 0.67 | 0.61 | 0.51 | 0.45 | 0.59 | 0.58 | 0.57 | 0.43 | 0.33 | 0.27 | 0.61 | 0.51 | 0.45 | n/a | n/a | n/a |
| | 6-1/4 | (159) | 0.76 | 0.71 | 0.68 | 0.63 | 0.53 | 0.47 | 0.60 | 0.58 | 0.57 | 0.46 | 0.35 | 0.29 | 0.63 | 0.53 | 0.47 | 0.63 | n/a | n/a |
| | 7 | (178) | 0.80 | 0.74 | 0.70 | 0.71 | 0.57 | 0.50 | 0.61 | 0.59 | 0.58 | 0.54 | 0.42 | 0.34 | 0.71 | 0.57 | 0.50 | 0.67 | n/a | n/a |
| | 7-1/2 | (191) | 0.82 | 0.75 | 0.71 | 0.76 | 0.61 | 0.53 | 0.62 | 0.60 | 0.59 | 0.60 | 0.46 | 0.38 | 0.76 | 0.61 | 0.53 | 0.69 | 0.63 | n/a |
| | 8 | (203) | 0.84 | 0.77 | 0.73 | 0.81 | 0.65 | 0.55 | 0.63 | 0.61 | 0.59 | 0.66 | 0.51 | 0.41 | 0.81 | 0.65 | 0.55 | 0.71 | 0.65 | n/a |
| | 8-7/8 | (225) | 0.88 | 0.80 | 0.75 | 0.90 | 0.72 | 0.60 | 0.64 | 0.62 | 0.60 | 077 | 0.60 | 0.48 | 0.90 | 0.72 | 0.60 | 0.75 | 0.69 | 0.64 |
| | 9 | (229) | 0.88 | 0.80 | 0.75 | 0.91 | 0.73 | 0.61 | 0.64 | 0.62 | 0.60 | 0.79 | 0.61 | 0.49 | 0.91 | 0.73 | 0.61 | 0.75 | 0.69 | 0.65 |
| | 10 | (254) | 0.92 | 0.84 | 0.78 | 1.00 | 0.81 | 0.68 | 0.66 | 0.63 | 0.62 | 0.92 | 0.71 | 0.58 | 1.00 | 0.81 | 0.68 | 0.79 | 0.73 | 0.68 |
| | 11 | (279) | 0.97 | 0.87 | 0.81 | 1.00 | 0.89 | 0.75 | 0.67 | 0.65 | 0.63 | 1.00 | 0.82 | 0.67 | 1.00 | 0.89 | 0.75 | 0.83 | 0.77 | 0.71 |
| | 12 | (305) | 1.00 | 0.91 | 0.84 | | 0.97 | 0.81 | 0.69 | 0.66 | 0.64 | | 0.94 | 0.76 | | 0.97 | 0.81 | 0.87 | 0.80 | 0.75 |
| | 14 | (356) | 1.00 | 0.97 | 0.90 | | 1.00 | 0.95 | 0.72 | 0.69 | 0.66 | | 1.00 | 0.96 | | 1.00 | 0.96 | 0.94 | 0.86 | 0.80 |
| | 16 | (406) | 1.00 | 1.00 | 0.95 | | | 1.00 | 0.75 | 0.71 | 0.69 | | | 1.00 | | | 1.00 | 1.00 | 0.92 | 0.86 |
| | 18 | (457) | | | 1.00 | | | | 0.78 | 0.74 | 0.71 | | | | | | | | 0.98 | 0.91 |
| | 20 | (508) | | | | | | | 0.82 | 0.77 | 0.73 | | | | | | | | 1.00 | 0.96 |
| | 24 | (610) | | | | | | | 0.88 | 0.82 | 0.78 | | | | | | | | | 1.00 |
| | 30 | (762) | | | | | | | 0.97 | 0.90 | 0.85 | | | | | | | | | |
| | 36 | (914) | | | | | | | 1.00 | 0.98 | 0.92 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | | 1.00 | 1.00 | | | | | | | | | |

## Table 9 — Load adjustment factors for M8, M10, and M12 Hilti HSL4 anchors in cracked concrete[1,2]

| M16, M20 and M24 HSL4 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear II to and away from edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal dia. | | | M16 | M20 | M24 | M16 | M20 | M24 | M16 | M20 | M24 | M16 | M20 | M24 | M16 | M20 | M24 | M16 | M20 | M24 |
| Effective embedment $h_{ef}$ | | in. (mm) | 3.948 (100) | 4.92 (125) | 5.91 (150) | 3.948 (100) | 4.92 (125) | 5.91 (150) | 3.948 (100) | 4.92 (125) | 5.91 (150) | 3.948 (100) | 4.92 (125) | 5.91 (150) | 3.948 (100) | 4.92 (125) | 5.91 (150) | 3.948 (100) | 4.92 (125) | 5.91 (150) |
| Spacing (s) / edge distance ($c_{al}$) / concrete thickness (h), - in (mm) | 4 | (102) | 0.67 | n/a | n/a | n/a | n/a | n/a | 0.55 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4-1/2 | (114) | 0.69 | n/a | n/a | n/a | n/a | n/a | 0.56 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4-3/4 | (121) | 0.70 | n/a | n/a | 0.85 | n/a | n/a | 0.56 | n/a | n/a | 0.22 | n/a | n/a | 0.43 | n/a | n/a | n/a | n/a | n/a |
| | 5 | (127) | 0.71 | 0.67 | n/a | 0.88 | 0.76 | n/a | 0.56 | 0.55 | n/a | 0.23 | 0.18 | n/a | 0.47 | 0.36 | n/a | n/a | n/a | n/a |
| | 5-1/2 | (140) | 0.73 | 0.69 | n/a | 0.95 | 0.81 | n/a | 0.57 | 0.56 | n/a | 0.27 | 0.21 | n/a | 0.54 | 0.42 | n/a | n/a | n/a | n/a |
| | 5-7/8 | (149) | 0.75 | 0.70 | 0.67 | 1.00 | 0.84 | 0.75 | 0.57 | 0.56 | 0.55 | 0.30 | 0.23 | 0.19 | 0.59 | 0.46 | 0.37 | n/a | n/a | n/a |
| | 6 | (152) | 0.75 | 0.70 | 0.67 | 1.00 | 0.86 | 0.76 | 0.58 | 0.56 | 0.56 | 0.31 | 0.24 | 0.19 | 0.61 | 0.47 | 0.38 | n/a | n/a | n/a |
| | 6-1/4 | (159) | 0.76 | 0.71 | 0.68 | 1.00 | 0.88 | 0.78 | 0.58 | 0.57 | 0.56 | 0.33 | 0.25 | 0.20 | 0.65 | 0.50 | 0.41 | 0.56 | n/a | n/a |
| | 7 | (178) | 0.80 | 0.74 | 0.70 | 1.00 | 0.96 | 0.84 | 0.59 | 0.57 | 0.56 | 0.39 | 0.30 | 0.24 | 0.77 | 0.60 | 0.48 | 0.59 | n/a | n/a |
| | 7-1/2 | (191) | 0.82 | 0.75 | 0.71 | 1.00 | 1.00 | 0.88 | 0.59 | 0.58 | 0.57 | 0.43 | 0.33 | 0.27 | 0.86 | 0.66 | 0.54 | 0.62 | 0.56 | n/a |
| | 8 | (203) | 0.84 | 0.77 | 0.73 | 1.00 | 1.00 | 0.92 | 0.60 | 0.59 | 0.57 | 0.47 | 0.36 | 0.30 | 0.94 | 0.73 | 0.59 | 0.64 | 0.58 | n/a |
| | 8-7/8 | (225) | 0.88 | 0.80 | 0.75 | 1.00 | 1.00 | 1.00 | 0.61 | 0.59 | 0.58 | 0.55 | 0.43 | 0.35 | 1.00 | 0.85 | 0.69 | 0.67 | 0.61 | 0.57 |
| | 9 | (229) | 0.88 | 0.80 | 0.75 | 1.00 | 1.00 | 1.00 | 0.61 | 0.60 | 0.58 | 0.56 | 0.43 | 0.35 | 1.00 | 0.87 | 0.71 | 0.67 | 0.62 | 0.58 |
| | 10 | (254) | 0.92 | 0.84 | 0.78 | 1.00 | 1.00 | 1.00 | 0.63 | 0.61 | 0.59 | 0.66 | 0.51 | 0.41 | 1.00 | 1.00 | 0.83 | 0.71 | 0.65 | 0.61 |
| | 11 | (279) | 0.97 | 0.87 | 0.81 | 1.00 | 1.00 | 1.00 | 0.64 | 0.62 | 0.60 | 0.76 | 0.59 | 0.48 | 1.00 | 1.00 | 0.95 | 0.75 | 0.68 | 0.64 |
| | 12 | (305) | 1.00 | 0.91 | 0.84 | | 1.00 | 1.00 | 0.65 | 0.63 | 0.61 | 0.87 | 0.67 | 0.54 | | 1.00 | 1.00 | 0.78 | 0.71 | 0.67 |
| | 14 | (356) | 1.00 | 0.97 | 0.90 | | | 1.00 | 0.68 | 0.65 | 0.63 | 1.00 | 0.84 | 0.68 | | | 1.00 | 0.84 | 0.77 | 0.72 |
| | 16 | (406) | 1.00 | 1.00 | 0.95 | | | | 0.70 | 0.67 | 0.65 | | 1.00 | 0.84 | | | | 0.90 | 0.82 | 0.77 |
| | 18 | (457) | | | 1.00 | | | | 0.73 | 0.69 | 0.67 | | | 1.00 | | | | 0.95 | 0.87 | 0.82 |
| | 20 | (508) | | | | | | | 0.75 | 0.71 | 0.68 | | | 1.00 | | | | 1.00 | 0.92 | 0.86 |
| | 24 | (610) | | | | | | | 0.80 | 0.76 | 0.72 | | | | | | | | 1.00 | 0.94 |
| | 30 | (762) | | | | | | | 0.88 | 0.82 | 0.78 | | | | | | | | | 1.00 |
| | 36 | (914) | | | | | | | 0.95 | 0.88 | 0.83 | | | | | | | | | |
| | > 48 | (1219) | | | | | | | 1.00 | 1.00 | 0.94 | | | | | | | | | |

1. Linear interpolation not permitted.
2. When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.
3. Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.
4. Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, it may not be permitted if both edge and spacing are less than "critical" distances. Check table 5 and figure 2 of this section to calculate permissible edge distance, spacing and concrete thickness combinations. For the HSL4-SH M8, M10 and M12 diameters, the minimum slab thickness must be increased by 5 mm (3/16-in.).

## DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-4386. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to PTG Ed. 21 Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

**Table 10 — Steel strength for Hilti HSL4 anchors[1,2]**

| Nominal anchor diameter | HSL4, HSL4-B, HSL4-SK | | | HSL4-G | | |
|---|---|---|---|---|---|---|
| | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic shear[5] $\phi V_{sa,eq}$ lb (kN) | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic shear[5] $\phi V_{sa,eq}$ lb (kN) |
| M8 | 4,495 (20.0) | 4,615 (20.5) | 2,940 (13.1) | 4,495 (20.0) | 3,870 (17.2) | 2,410 (10.7) |
| M10 | 7,100 (31.6) | 6,520 (29.0) | 5,390 (24.0) | 7,100 (31.6) | 5,345 (23.8) | 4,415 (19.6) |
| M12 | 10,335 (46.0) | 9,385 (41.7) | 7,580 (33.7) | 10.335 (46.0) | 7,755 (34.5) | 6,265 (27.9) |
| M16 | 19,170 (94 .0) | 17,025 (75.7) | 15,805 (70.3) | 19,170 (85.3) | 14,460 (64.3) | 13,430 (59.7) |
| M20 | 29,975 (133.3) | 25,195 (112.1) | 18,575 (82.6) | 29,975 (133.3) | 21,140 (94.0) | 15,595 (69.4) |
| M24 | 43,145 (191.9) | 29,295 (130.3) | 24,335 (108.2) | 43,145 (191.0) | 27,520 (122.4) | n/a |

1. See PTG Ed. 21 section 3.1.8 to convert design strength value to ASD value.
2. Hilti HSL4 anchors are to be considered ductile steel elements.
3. Tensile $N_{sar} = A_{se,N}\, \phi_s\, f_{uta}$ R as noted in CSA A23.3 Annex D .
4. Shear determined by static shear tests with $V_{sar} < A_{se,V}\, \phi_s$ 0 .6 $f_{uta}$ R as noted in CSA A23.3 Annex D .
5. Seismic shear values determined by seismic shear tests with $V_{sar,eq}$ < Ase,V $\phi_s$ 0 .6 $f_{uta}$ R as noted in CSA A23.3 Annex D . See Section 3.1.8 for additional information on seismic applications.

## Table 11 — Hilti HSL4 design information in accordance with CSA A23.3 Annex D[1]

| Design parameter | Symbol | Units | Nominal anchor diameter | | | | | | Ref A23.3 |
|---|---|---|---|---|---|---|---|---|---|
| | | | M8 | M10 | M12 | M16 | M20 | M24 | |
| Anchor O.D. | $d_a$ | mm (in.) | 12 (0.47) | 15 (0.59) | 18 (0.71) | 21 (0.94) | 28 (1.10) | 32 (1.26) | |
| Effective minimum embedment[2] | $h_{ef}$ | mm (in.) | 60 (2.4) | 70 (2.8) | 80 (3.1) | 100 (3.9) | 125 (4.9) | 150 (5.9) | |
| Minimum concrete thickness | $h_{min}$ | mm (in.) | See table 5 | | | | | | |
| Critical edge distance | $c_{ac}$ | mm (in.) | See table 5 | | | | | | |
| Minimum edge distance | $c_{min}$ | mm (in.) | See table 5 | | | | | | |
| | for s > | mm (in.) | See table 5 | | | | | | |
| Minimum anchor spacing | $s_{min}$ | mm (in.) | See table 5 | | | | | | |
| | for c > | mm (in.) | See table 5 | | | | | | |
| Minimum hole depth in concrete | $h_o$ | mm (in.) | 80 (3.1) | 90 (3.5) | 105 (4.1) | 125 (4.9) | 155 (6.1) | 190 (7.5) | |
| Minimum specified yield strength | $f_{ya}$ | N/mm² (psi) | 641 (93,000) | | | | | | |
| Minimum specified ultimate strength | $f_{uta}$ | N/mm² (psi) | 800 (116,000) | | | | | | |
| Effective tensile stress area | $A_{se,N}$ | mm² (in²) | 36.8 (0.057) | 58.1 (0.090) | 84.5 (0.131) | 156.8 (0.243) | 245.2 (0.380) | 352.9 (0.547) | |
| Steel embed. material resistance factor for reinforcement | $\phi_s$ | – | 0.85 | | | | | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes[3] | R | – | 0.80 | | | | | | D.5.3 |
| Resistance modification factor for shear, steel failure modes[3] | R | – | 0.75 | | | | | | D.5.3 |
| Factored steel resistance in tension | $N_{sar}$ | lb (kN) | 4,495 (20.0) | 7,100 (31.6) | 10,335 (46.0) | 19,170 (85.3) | 29,975 (133.3) | 43,145 (191.9) | D.6.1.2 |
| Factored steel resistance in shear HSL4, HSL-B, HSL4-SK | $V_{sar}$ | lb (kN) | 4,615 (20.5) | 6,520 (29.0) | 9,385 (41.7) | 17,025 (75.7) | 25,195 (112.1) | 29,295 (130.3) | D.7.1.2 |
| Factored steel resistance in shear HSL4-G | | lb (kN) | 3,870 (17.2) | 5,345 (23.8) | 7,755 (34.5) | 14,460 (62.3) | 21,140 (94.0) | 27,520 (122.4) | D.7.1.2 |
| Factored steel resistance in shear, seismic HSL4, HSL-B, HSL4-SK | $V_{sar,eq}$ | lb (kN) | 2,940 (13.1) | 5,390 (24.0) | 7,580 (33.7) | 15,805 (70.3) | 18,575 (82.6) | 24,335 (108.3) | |
| Factored steel resistance in shear, seismic HSL4-G | | lb (kN) | 2,410 (10.7) | 4,415 (19.6) | 6,265 (27.9) | 13,430 (59.7) | 15,595 (69.4) | n/a[7] | |
| Coeff. for factored conc. breakout resistance, uncracked concrete | $k_{c,uncr}$ | – | 10 | | | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete | $k_{c,cr}$ | – | 7 | 10 | | | | | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked concrete[4] | $\psi_{c,N}$ | – | 1.0 | | | | | | D.6.2.6 |
| Anchor category | – | – | 1.0 | | | | | | D.5.3(c) |
| Concrete material resistance factor | $\phi_c$ | – | 0.65 | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | R | – | 1.0 | | | | | | D.5.3(c) |
| Factored pullout resistance in 20 MPa uncracked concrete[6] | $N_{pr,uncr}$ | lb (kN) | 2,945 (13.1) | n/a | n/a | n/a | n/a | n/a | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete[6] | $N_{pr,cr}$ | lb (kN) | 1,970 (8.8) | 3,150 (14.0) | n/a | n/a | n/a | n/a | D.6.3.2 |
| Factored seismic pullout resistance in 20 MPa cracked concrete[6] | $N_{pr,eq}$ | lb (kN) | 1,970 (8.8) | 3,150 (14.0) | n/a | n/a | n/a | 10,030[7] (44.6) | |
| Load bearing length of anchor in shear | $\ell_e$ | mm (in.) | 24 (0.94) | 30 (1.18) | 36 (1.42) | 48 (1.89) | 56 (2.20) | 64 (2.52) | D.7.2.2 |

1 Design information in this table is taken from ICC-ES ESR-4386, table 3, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The HSL4 is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used .
5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 For all design cases, $\psi_{c,P}$ = 1.0 . NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-4386 for additional information.
7 HSL4-G M24 is not permitted for seismic applications.

## Table 12 — Hilti HSL4 anchors factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

| Nominal anchor diameter | Effective embed. mm (in.) | Tension - $\varphi N_n$ | | | | Shear - $\varphi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| M8 | 60 (2.4) | 2,945 (13.1) | 3,290 (14.6) | 3,605 (16.0) | 4,165 (18.5) | 3,035 (13.5) | 3,395 (15.1) | 3,720 (16.5) | 4,295 (19.1) |
| M10 | 70 (2.8) | 3,825 (17.0) | 4,280 (19.0) | 4,685 (20.9) | 5,415 (24.1) | 7,655 (34.0) | 8,560 (38.1) | 9,375 (41.7) | 10,825 (48.2) |
| M12 | 80 (3.1) | 4,675 (20.8) | 5,230 (23.3) | 5,725 (25.5) | 6,615 (29.4) | 9,350 (41.6) | 10,455 (46.5) | 11,455 (50.9) | 13,225 (58.8) |
| M16 | 100 (3.9) | 6,535 (29.1) | 7,305 (32.5) | 8,005 (35.6) | 9,240 (41.1) | 13,070 (58.1) | 14,615 (65.0) | 16,005 (71.2) | 18,485 (82.2) |
| M20 | 125 (4.9) | 9,135 (40.6) | 10,210 (45.4) | 11,185 (49.8) | 12,915 (57.5) | 18,265 (81.3) | 20,420 (90.8) | 22,370 (99.5) | 25,830 (114.9) |
| M24 | 150 (5.9) | 12,005 (53.4) | 13,425 (59.7) | 14,705 (65.4) | 16,980 (75.5) | 24,010 (106.8) | 26,845 (119.4) | 29,405 (130.8) | 33,955 (151.0) |

## Table 13 — Hilti HSL4 anchor factored resistance with concrete / pullout failure in cracked concrete[1,2,3,4,5]

| Nominal anchor diameter | Effective embed. mm (in.) | Tension - $\varphi N_n$ | | | | Shear - $\varphi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| M8 | 60 (2.4) | 1,970 (8.8) | 2,200 (9.8) | 2,410 (10.7) | 2,785 (12.4) | 2,125 (9.5) | 2,375 (10.6) | 2,605 (11.6) | 3,005 (13.4) |
| M10 | 70 (2.8) | 3,150 (17.0) | 3,520 (19.0) | 3,855 (20.9) | 4,455 (24.1) | 7,655 (34.0) | 8,560 (38.1) | 9,375 (41.7) | 10,825 (48.2) |
| M12 | 80 (3.1) | 4,675 (20.8) | 5,230 (23.3) | 5,725 (25.5) | 6,615 (29.4) | 9,350 (41.6) | 10,455 (46.5) | 11,455 (50.9) | 13,225 (58.8) |
| M16 | 100 (3.9) | 6,535 (29.1) | 7,305 (32.5) | 8,005 (35.6) | 9,240 (41.1) | 13,070 (58.1) | 14,615 (65.0) | 16,005 (71.2) | 18,485 (82.2) |
| M20 | 125 (4.9) | 9,135 (40.6) | 10,210 (45.4) | 11,185 (49.8) | 12,915 (57.5) | 18,265 (81.3) | 20,420 (90.8) | 22,370 (99.5) | 25,830 (114.9) |
| M24[5] | 150 (5.9) | 12,005 (53.4) | 13,425 (59.7) | 14,705 (65.4) | 16,980 (75.5) | 24,010 (106.8) | 26,845 (119.4) | 29,405 (130.8) | 33,955 (151.0) |

1 See PTG Ed. 21 section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 9 as necessary. Compare to the steel values in table 10. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0 .60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by the following reduction factors:
M24 - $\alpha_{N,seis}$ = 0 .62. HSL4-G M24 is not permitted for seismic applications.
All other sizes - $\alpha_{N,seis}$ = 0 .75
No reduction needed for seismic shear. See PTG Ed. 21 section 3.1.8 for additional information on seismic applications.

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## ORDERING INFORMATION



**HSL4 Bolt version**

| Description | Box qty |
|---|---|
| HSL4 M8 d12x97 20/-/- | 40 |
| HSL4 M8 d12x117 40/20/- | 40 |
| HSL4 M10 d15x109 20/-/- | 20 |
| HSL4 M10 d15x129 40/20/- | 20 |
| HSL4 M12 d18x131 25/-/- | 20 |
| HSL4 M12 d18x156 50/25/- | 20 |
| HSL4 M16 d24x138 10/-/- | 10 |
| HSL4 M16 d24x153 25/-/- | 10 |
| HSL4 M16 d24x178 50/25/- | 10 |
| HSL4 M20 d28x183 30/-/- | 6 |
| HSL4 M20 d28x213 60/30/- | 6 |
| HSL4 M24 d32x205 30/-/- | 4 |
| HSL4 M24 d32x235 60/30/- | 4 |



**HSL4-B Torque cap**

| Description | Box qty |
|---|---|
| HSL4-B M12 d18x121 5/-/- | 20 |
| HSL4-B M12 d18x141 25/-/- | 20 |
| HSL4-B M12 d18x166 50/25/- | 10 |
| HSL4-B M16 d24x151 10/-/- | 10 |
| HSL4-B M16 d24x166 25/-/- | 10 |
| HSL4-B M20 d28x198 30/-/- | 6 |
| HSL4-B M24 d32x223 30/-/- | 4 |



**HSL4-G Stud version**

| Description | Box qty |
|---|---|
| HSL4-G M8 d12x107 20/-/- | 40 |
| HSL4-G M10 d15x121 20/-/- | 20 |
| HSL4-G M10 d15x201 100/80/60 | 20 |
| HSL4-G M12 d18x147 25/-/- | 20 |
| HSL4-G M12 d18x172 50/25/- | 20 |
| HSL4-G M16 d24x175 25/-/- | 10 |
| HSL4-G M16 d24x200 50/25/- | 10 |
| HSL4-G M20 d28x205 30/-/- | 6 |
| HSL4-G M20 d28x235 60/30/- | 6 |



**HSL4-SK Countersunk**

| Description | Box qty |
|---|---|
| HSL4-SK M8 d12x80 10/-/- | 20 |
| HSL4-SK M8 d12x90 20/-/- | 20 |
| HSL4-SK M10 d15x100 20/-/- | 10 |
| HSL4-SK M12 d18x120 25/-/- | 10 |

**Product nomenclature**

**HSL4-G M10 d15x201 100/80/60**

A B C D E

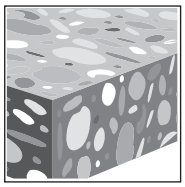
A: Anchor Name
B: Threaded rod diameter
C: Drill bit diameter
D: Total length of the anchor
E: Maximum fixture thickness at Min/Std/Max effective embedment

# 3.3.3 HSL-3-R HEAVY-DUTY STAINLESS STEEL EXPANSION ANCHORS

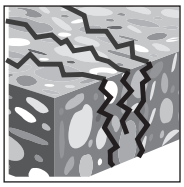
## PRODUCT DESCRIPTION

**HSL–3-R Heavy-duty Expansion Anchor**

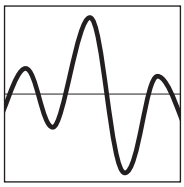
| Anchor System | Features and Benefits |
|---|---|
|  HSL-3-R<br>  HSL-3-GR<br>  HSL-3-SKR | • Approved for use in cracked tension zone (cracked concrete)<br>• Data for use with the Strength Design provisions of ACI 318 Chapter 17 and CSA A23.3 Annex D.<br>• High load capacity<br>• Force-controlled expansion which allows for follow-up expansion<br>• Reliable clamping of part fastened to help overcome gap<br>• No spinning of the anchor in hole when tightening bolt or nut<br>• Seismic qualification per ICC-ES AC 193 and the requirements of ACI 318 Chapter 17<br>• Simplified tables for edge distance and spacing provided |



Uncracked concrete



Cracked concrete



Seismic Desing Categories A-F




PROFIS Anchor design software

| Listings/Approvals | |
|---|---|
| **ICC-ES (International Code Council)** | ESR-1545 |
| **European Technical Approval** | ETA-02/0042 |
| **City of Los Angeles** | LABD Supplement to ESR |

## MATERIAL SPECIFICATIONS

- Stainless steel bolt or threaded rod per DIN EN 10088-3.
- Stainless steel washer per DIN EN 10088-3.
- Stainless steel expansion sleeve per ASTM A 276/276A.
- Stainless steel spacing sleeve per ASTM A 511/A 511M.
- Stainless steel expansion cone  per ASTM A 511/A 511M.
- Collapsible sleeve is made from acetal polyoxymethylene (POM) resin.

# INSTALLATION PARAMETERS

## Table 1 — HSL-3-R Specifications

| Details | Symbol | Units | Nominal anchor diameter | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M8 | | M10 | | M12 | | M16 | | M20 | |
| Nominal drill bit diameter | $d_{bit}$ | mm | 12 | | 15 | | 18 | | 24 | | 28 | |
| Minimum concrete thickness | $h_{min}$ | mm<br>(in) | 120<br>(4-3/4) | | 140<br>(5-1/2) | | 150<br>(5-7/8) | | 200<br>(7-7/8) | | 250<br>(9-7/8) | |
| Minimum hole depth | $h_o$ | mm<br>(in) | 80<br>(3-1/8) | | 90<br>(3-9/16) | | 105<br>(4-1/8) | | 125<br>(4-15/16) | | 155<br>(6-1/8) | |
| Effective minimum embedment | $h_{ef,min}$ | mm<br>(in) | 60<br>(2.36) | | 70<br>(2.76) | | 80<br>(3.15) | | 100<br>(3.94) | | 125<br>(4.92) | |
| Minimum fixture hole diameter | $d_h$ | mm<br>(in) | 14<br>(9/16) | | 17<br>(11/16) | | 20<br>(13/16) | | 26<br>(1) | | 31<br>(1-1/4) | |
| Diameter of countersunk hole in the fixture HSL-3-SKR | $d_{SK}$ | mm<br>(in) | 22.5<br>(7/8) | | 25.5<br>(1) | | 32.9<br>(1-5/16) | | N/A | | N/A | |
| Height of countersunk head in the fixture HSL-3-SKR | $h_{SK}$ | mm<br>(in) | 5.8<br>(1/4) | | 6<br>(1/4) | | 8<br>(5/16) | | N/A | | N/A | |
| Max. cumulative gap between part(s) being fastened and concrete surface | - | mm<br>(in) | 4<br>(1/8) | | 5<br>(3/16) | | 8<br>(5/16) | | 9<br>(3/8) | | 12<br>(1/2) | |
| Maximum thickness of part fastened HSL-3-R | $t_{fix,max}$ | mm<br>(in) | 20<br>(3/4) | 40<br>(1-1/2) | 20<br>(3/4) | 40<br>(1-1/2) | 25<br>(1) | 50<br>(2) | 25<br>(1) | 50<br>(2) | 30<br>(1-1/8) | 60<br>(2-1/4) |
| Overall length of anchor HSL-3-R | $\ell$ | mm<br>(in) | 98<br>(3-7/8) | 118<br>(4-5/8) | 110<br>(4-3/8) | 130<br>(5-1/8) | 131<br>(5-1/8) | 156<br>(6-1/8) | 153<br>(6) | 178<br>(7) | 183<br>(7-1/4) | 213<br>(8-3/8) |
| Maximum thickness of part fastened HSL-3-GR | $t_{fix,max}$ | mm<br>(in) | 20<br>(3/4) | 100<br>(4) | 20<br>(3/4) | 100<br>(4) | 25<br>(1) | 100<br>(4) | 25<br>(1) | 100<br>(4) | 30<br>(1-1/8) | 100<br>(4) |
| Overall length of anchor HSL-3-GR | $\ell$ | mm<br>(in) | 102<br>(4) | 182<br>(7-1/8) | 115<br>(4-1/2) | 197<br>(7-3/4) | 139<br>(5-1/2) | 214<br>(8-1/2) | 163<br>(6-3/8) | 238<br>(9-3/8) | 190<br>(7-1/2) | 260<br>(10-1/4) |
| Maximum thickness of part fastened HSL-3-SKR | $t_{fix,max}$ | mm<br>(in) | 20<br>(3/4) | | 20<br>(3/4) | | 25<br>(1) | | N/A | | N/A | |
| Overall length of anchor HSL-3-SKR | $\ell$ | mm<br>(in) | 98<br>(3-7/8) | | 110<br>(4-3/8) | | 131<br>(5-1/8) | | N/A | | N/A | |
| Installation torque HSL-3-R | $T_{inst}$ | Nm<br>(ft-lb) | 25<br>(18) | | 35<br>(26) | | 80<br>(59) | | 120<br>(89) | | 200<br>(148) | |
| Installation torque HSL-3-GR | $T_{inst}$ | Nm<br>(ft-lb) | 30<br>(22) | | 50<br>(37) | | 80<br>(59) | | 120<br>(89) | | 200<br>(148) | |
| Installation torque HSL-3-SKR | $T_{inst}$ | Nm<br>(ft-lb) | 18<br>(13) | | 50<br>(37) | | 80<br>(59) | | N/A | | N/A | |
| Wrench size, HSL-3-R, HSL-3-GR | SW | mm | 13 | | 17 | | 19 | | 24 | | 30 | |
| Allen wrench size, HSL-3-SKR | SW | mm | 5 | | 6 | | 8 | | N/A | | N/A | |

**Figure 1 — HSL-3-R and HSL-3-GR in the installed condition (HSL-3-R shown)**

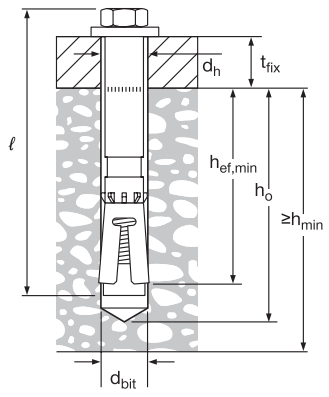
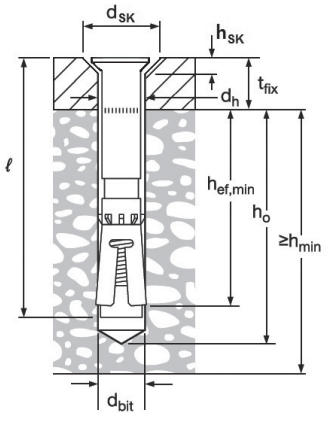



**Figure 2 — HSL-3-SKR in the installed condition**



# DESIGN DATA IN CONCRETE PER ACI 318

### ACI 318 Chapter 17 design

The load values in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR 1545 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8 of Hilti Product Technical Guide Volume 2-21. Data tables from ESR 1545 are not contained in this section, but can be found at **www.icc-es.org** or at **www.hilti.com**.

## Table 2 — Hilti HSL-3-R design strength with concrete / pullout failure in uncracked concrete [1,2,3,4,5]

| Nominal Anchor Diameter mm | Effective Embed. Depth mm (in.) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6000 psi (41.4 MPa) lb (kN) |
| **M8** | 60 (2.36) | 1,700 (7.6) | 1,730 (7.7) | 1,780 (7.9) | 1,855 (8.3) | 3,050 (13.6) | 3,340 (14.9) | 3,860 (17.2) | 4,725 (21.0) |
| **M10** | 70 (2.76) | 3,020 (13.4) | 3,310 (14.7) | 3,820 (17.0) | 4,680 (20.8) | 7,685 (34.2) | 8,420 (37.5) | 9,720 (43.2) | 11,905 (53.0) |
| **M12** | 80 (3.15) | 3,690 (16.4) | 4,040 (18.0) | 4,665 (20.8) | 5,715 (25.4) | 9,390 (41.8) | 10,285 (45.7) | 11,880 (52.8) | 14,550 (64.7) |
| **M16** | 100 (3.94) | 6,855 (30.5) | 7,510 (33.4) | 8,670 (38.6) | 10,620 (47.2) | 14,765 (65.7) | 16,175 (71.9) | 18,675 (83.1) | 22,875 (101.8) |
| **M20** | 125 (4.92) | 10,645 (47.4) | 11,660 (51.9) | 13,465 (59.9) | 16,490 (73.4) | 22,925 (102.0) | 25,115 (111.7) | 29,000 (129.0) | 35,515 (158.0) |

## Table 3 — Hilti HSL-3-R design strength with concrete / pullout failure in cracked concrete [1,2,3,4,5,6]

| Nominal Anchor Diameter mm | Effective Embed. Depth mm (in.) | Tension — $\Phi N_n$ | | | | Shear — $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6000 psi (41.4 MPa) lb (kN) |
| **M8** | 60 (2.36) | 1,390 (6.2) | 1,520 (6.8) | 1,755 (7.8) | 2,150 (9.6) | 2,160 (9.6) | 2,365 (10.5) | 2,730 (12.1) | 3,345 (14.9) |
| **M10** | 70 (2.76) | 2,495 (11.1) | 2,735 (12.2) | 3,160 (14.1) | 3,865 (17.2) | 6,725 (29.9) | 7,365 (32.8) | 8,505 (37.8) | 10,420 (46.4) |
| **M12** | 80 (3.15) | 3,690 (16.4) | 4,040 (18.0) | 4,665 (20.8) | 5,715 (25.4) | 9,390 (41.8) | 10,285 (45.7) | 11,880 (52.8) | 14,550 (64.7) |
| **M16** | 100 (3.94) | 6,095 (27.1) | 6,675 (29.7) | 7,705 (34.3) | 9,440 (42.0) | 13,125 (58.4) | 14,375 (63.9) | 16,600 (73.8) | 20,330 (90.4) |
| **M20** | 125 (4.92) | 7,715 (34.3) | 8,450 (37.6) | 9,760 (43.4) | 11,950 (53.2) | 18,340 (81.6) | 20,090 (89.4) | 23,200 (103.2) | 28,415 (126.4) |

1 See Section 3.1.6 for explanation on development of load values.
2 See Section 3.1.9 to convert design strength value to ASD value.
3 Linear interpolation between concrete compressive strengths is not permitted.
4 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 9 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.
5 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.68. For all-lightweight, $\lambda_a$ = 0.60.
6 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by
$\alpha_{N,seis}$ = 0.75. See Section 3.1.9 of Hilti Product Technical Guide Volume 2-19 for additional information on seismic applications.

## Table 4 — Steel strength for Hilti HSL-3-R stainless steel anchors [1,2]

| Nominal Anchor Diameter mm | HSL-3-R | | | HSL-3-GR | | | HSL-3-SKR | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[3] $\Phi N_{sa}$ lb (kN) | Shear[4] $\Phi V_{sa}$ lb (kN) | Seismic Shear[5] $\Phi V_{sa}$ lb (kN) | Tensile[3] $\Phi N_{sa}$ lb (kN) | Shear[4] $\Phi V_{sa}$ lb (kN) | Seismic Shear[5] $\Phi V_{sa}$ lb (kN) | Tensile[3] $\Phi N_{sa}$ lb (kN) | Shear[4] $\Phi V_{sa}$ lb (kN) | Seismic Shear[5] $\Phi V_{sa}$ lb (kN) |
| **M8** | 4,320 (19.2) | 6,490 (28.9) | 1,770 (7.9) | 4,320 (19.2) | 5,890 (26.2) | 1,770 (7.9) | 4,320 (19.2) | 6,490 (28.9) | 1,770 (7.9) |
| **M10** | 6,845 (30.4) | 9,160 (40.7) | 4,310 (19.2) | 6,845 (30.4) | 8,620 (38.3) | 4,310 (19.2) | 6,845 (30.4) | 9,160 (40.7) | 4,310 (19.2) |
| **M12** | 9,950 (44.3) | 11,895 (52.9) | 4,605 (20.5) | 9,950 (44.3) | 11,515 (51.2) | 4,605 (20.5) | 9,950 (44.3) | 11,895 (52.9) | 4,605 (20.5) |
| **M16** | 18,530 (82.4) | 18,735 (83.3) | 9,350 (41.6) | 18,530 (82.4) | 18,940 (84.2) | 9,350 (41.6) | - | - | - |
| **M20** | 28,915 (128.6) | 21,215 (94.4) | 9,350 (41.6) | 28,915 (128.6) | 23,380 (104.0) | 9,350 (41.6) | - | - | - |

1 See Section 3.1.9 to convert design strength value to ASD value.
2 Hilti HSL-3 Stainless Steel anchors are to be considered ductile steel elements.
3 Tensile = $\Phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17
4 Shear values determined by static shear tests with $\Phi V_{sa} \leq \Phi 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.
5 Seismic shear values determined by seismic shear tests with $\Phi V_{sa} < \Phi 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17. See Section 3.1.9 of Hilti Product Technical Guide Volume 2-21 for additional information on seismic applications.

3.3.3

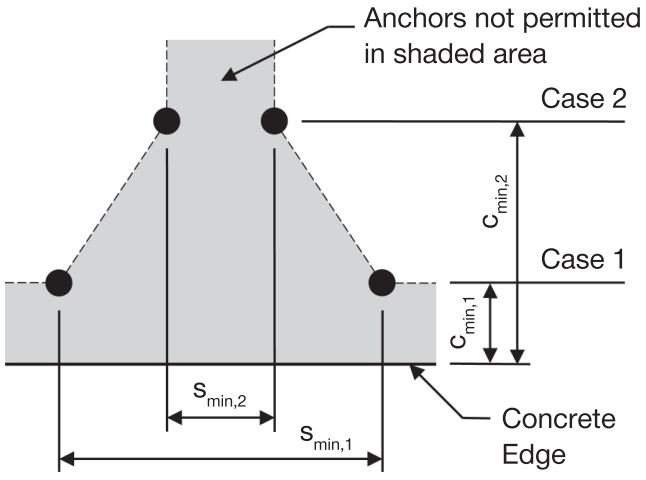
## Table 5 — Edge distance, spacing and member thickness requirements [1]

| Dimensional Parameter | | Symbol | Units | Nominal anchor diameter | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | M8 | M10 | M12 | M16 | M20 |
| Minimum concrete thickness | | $h_{min}$ | in. (mm) | 4-3/4 (120) | 5-1/2 (140) | 5-7/8 (150) | 7-7/8 (200) | 9-7/8 (250) |
| Critical edge distance | | $c_{ac}$ | in. (mm) | 7-7/8 (200) | 11 (280) | 8-5/8 (220) | 9-1/2 (240) | 15 (380) |
| Case 1 | Minimum edge distance | $c_{min,1}$ | in. (mm) | 2-3/4 (70) | 3-1/2 (90) | 3-1/2 (90) | 4 (100) | 5-7/8 (150) |
| | Minimum anchor spacing | $s_{min,1}$ | in. (mm) | 5-1/2 (140) | 6-1/4 160) | 9-7/8 (250) | 9-1/2 (240) | 11-7/8 (300) |
| Case 2 | Minimum edge distance | $c_{min,2}$ | in. (mm) | 4-3/4 (120) | 5-1/8 (130) | 6-1/4 (160) | 9-1/2 (240) | 11-7/8 (300) |
| | Minimum anchor spacing | $s_{min,2}$ | in. (mm) | 2-3/4 (70) | 3-1/2 (90) | 4 (100) | 4 (100) | 5 (125) |

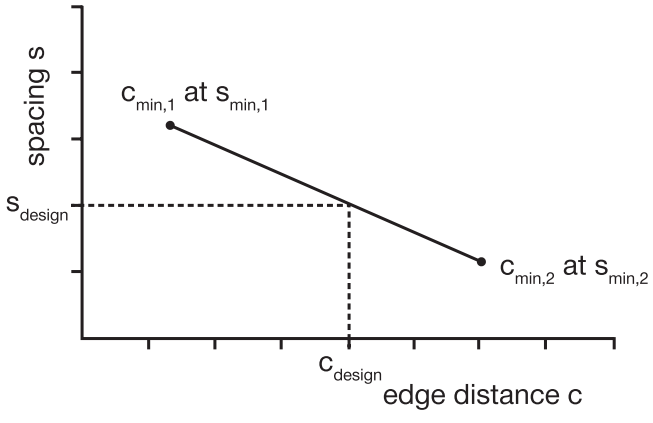
1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2.
Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissable spacing s as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$

## Figure 3 — Interpolation of Minimum Edge Distance and Anchor Spacing




For a specific edge distance, the permitted spacing is calculated as follows:



## Table 6 — Load adjustment factors for M8, M10, and M12 HSL-3-R anchors in uncracked concrete [1,4]

| M8, M10 and M12 HSL-3-R Uncracked Concrete | | Spacing Factor in Tension $f_{AN}$ | | | Edge Distance Factor in Tension $f_{RN}$ | | | Spacing Factor in Shear [2] $f_{AV}$ | | | Edge Distance in Shear | | | | | | Conc. Thickness Factor in Shear [3] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | ⊥ Toward Edge $f_{RV}$ | | | ∥ To Edge $f_{RV}$ | | | | | |
| Nominal Diameter mm | | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 |
| Effective Embed. $h_{ef}$ mm (in) | | 60 (2.36) | 70 (2.76) | 80 (3.15) | 60 (2.36) | 70 (2.76) | 80 (3.15) | 60 (2.36) | 70 (2.76) | 80 (3.15) | 60 (2.36) | 70 (2.76) | 80 (3.15) | 60 (2.36) | 70 (2.76) | 80 (3.15) | 60 (2.36) | 70 (2.76) | 80 (3.15) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | | | | | | | | | | | | | | | | | | | |
| 2-3/4 | (70) | 0.69 | n/a | n/a | 0.37 | n/a | n/a | 0.56 | n/a | n/a | 0.21 | n/a | n/a | 0.37 | n/a | n/a | n/a | n/a | n/a |
| 3 | (76) | 0.71 | n/a | n/a | 0.40 | n/a | n/a | 0.56 | n/a | n/a | 0.24 | n/a | n/a | 0.40 | n/a | n/a | n/a | n/a | n/a |
| 3-1/2 | (89) | 0.75 | 0.71 | n/a | 0.45 | 0.33 | 0.44 | 0.57 | 0.55 | n/a | 0.30 | 0.18 | 0.23 | 0.45 | 0.33 | 0.44 | n/a | n/a | n/a |
| 4 | (102) | 0.78 | 0.74 | 0.71 | 0.51 | 0.37 | 0.48 | 0.58 | 0.56 | 0.57 | 0.36 | 0.22 | 0.28 | 0.51 | 0.37 | 0.48 | n/a | n/a | n/a |
| 4-3/4 | (121) | 0.84 | 0.79 | 0.75 | 0.60 | 0.43 | 0.55 | 0.60 | 0.57 | 0.59 | 0.47 | 0.28 | 0.37 | 0.60 | 0.43 | 0.55 | 0.63 | n/a | n/a |
| 5 | (127) | 0.85 | 0.80 | 0.76 | 0.63 | 0.45 | 0.58 | 0.61 | 0.58 | 0.59 | 0.51 | 0.31 | 0.40 | 0.63 | 0.45 | 0.58 | 0.65 | n/a | n/a |
| 5-1/8 | (130) | 0.86 | 0.81 | 0.77 | 0.65 | 0.47 | 0.59 | 0.61 | 0.58 | 0.59 | 0.53 | 0.32 | 0.41 | 0.65 | 0.47 | 0.59 | 0.66 | n/a | n/a |
| 5-1/2 | (140) | 0.89 | 0.83 | 0.79 | 0.70 | 0.50 | 0.64 | 0.62 | 0.58 | 0.60 | 0.58 | 0.35 | 0.46 | 0.70 | 0.50 | 0.64 | 0.68 | 0.58 | n/a |
| 6 | (152) | 0.92 | 0.86 | 0.82 | 0.76 | 0.55 | 0.70 | 0.63 | 0.59 | 0.61 | 0.67 | 0.40 | 0.52 | 0.76 | 0.55 | 0.70 | 0.71 | 0.60 | n/a |
| 6-1/4 | (159) | 0.94 | 0.88 | 0.83 | 0.79 | 0.57 | 0.72 | 0.63 | 0.59 | 0.61 | 0.71 | 0.43 | 0.55 | 0.79 | 0.57 | 0.72 | 0.73 | 0.62 | 0.67 |
| 6-1/2 | (165) | 0.96 | 0.89 | 0.84 | 0.83 | 0.59 | 0.75 | 0.64 | 0.60 | 0.62 | 0.75 | 0.45 | 0.59 | 0.83 | 0.59 | 0.75 | 0.74 | 0.63 | 0.68 |
| 7 | (178) | 0.99 | 0.92 | 0.87 | 0.89 | 0.64 | 0.81 | 0.65 | 0.61 | 0.63 | 0.84 | 0.51 | 0.65 | 0.89 | 0.64 | 0.81 | 0.77 | 0.65 | 0.71 |
| 8 | (203) | 1.00 | 0.98 | 0.92 | 1.00 | 0.73 | 0.93 | 0.67 | 0.62 | 0.64 | 1.00 | 0.62 | 0.80 | 1.00 | 0.73 | 0.93 | 0.82 | 0.70 | 0.76 |
| 9 | (229) | | 1.00 | 0.98 | | 0.82 | 1.00 | 0.69 | 0.64 | 0.66 | | 0.74 | 0.95 | | 0.82 | 1.00 | 0.87 | 0.74 | 0.80 |
| 9-7/8 | (251) | | | 1.00 | | 0.90 | | 0.71 | 0.65 | 0.68 | | 0.85 | 1.00 | | 0.90 | | 0.91 | 0.77 | 0.84 |
| 10 | (254) | | | | | 0.91 | | 0.71 | 0.65 | 0.68 | | 0.87 | | | 0.91 | | 0.92 | 0.78 | 0.85 |
| 11 | (279) | | | | | 1.00 | | 0.73 | 0.67 | 0.70 | | 1.00 | | | 1.00 | | 0.96 | 0.82 | 0.89 |
| 12 | (305) | | | | | | | 0.75 | 0.68 | 0.72 | | | | | | | 1.00 | 0.85 | 0.93 |
| 14 | (356) | | | | | | | 0.80 | 0.71 | 0.75 | | | | | | | | 0.92 | 1.00 |
| 16 | (406) | | | | | | | 0.84 | 0.74 | 0.79 | | | | | | | | 0.98 | |
| 18 | (457) | | | | | | | 0.88 | 0.77 | 0.82 | | | | | | | | 1.00 | |
| 20 | (508) | | | | | | | 0.92 | 0.80 | 0.86 | | | | | | | | | |
| 24 | (610) | | | | | | | 1.00 | 0.86 | 0.93 | | | | | | | | | |
| > 30 | (762) | | | | | | | | 0.95 | 1.00 | | | | | | | | | |

## Table 7 — Load adjustment factors for M8, M10, and M12 HSL-3-R anchors in cracked concrete [1,4]

| M8, M10 and M12 HSL-3-R Cracked Concrete | | Spacing Factor in Tension $f_{AN}$ | | | Edge Distance Factor in Tension $f_{RN}$ | | | Spacing Factor in Shear [2] $f_{AV}$ | | | Edge Distance in Shear | | | | | | Conc. Thickness Factor in Shear [3] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | ⊥ Toward Edge $f_{RV}$ | | | ∥ To Edge $f_{RV}$ | | | | | |
| Nominal Diameter mm | | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 | M8 | M10 | M12 |
| Effective Embed. $h_{ef}$ mm (in) | | 60 (2.36) | 70 (2.76) | 80 (3.15) | 60 (2.36) | 70 (2.76) | 80 (3.15) | 60 (2.36) | 70 (2.76) | 80 (3.15) | 60 (2.36) | 70 (2.76) | 80 (3.15) | 60 (2.36) | 70 (2.76) | 80 (3.15) | 60 (2.36) | 70 (2.76) | 80 (3.15) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | | | | | | | | | | | | | | | | | | | |
| 2-3/4 | (70) | 0.69 | n/a | n/a | 0.83 | n/a | n/a | 0.59 | n/a | n/a | 0.41 | n/a | n/a | 0.82 | n/a | n/a | n/a | n/a | n/a |
| 3 | (76) | 0.71 | n/a | n/a | 0.88 | n/a | n/a | 0.60 | n/a | n/a | 0.46 | n/a | n/a | 0.88 | n/a | n/a | n/a | n/a | n/a |
| 3-1/2 | (89) | 0.75 | 0.71 | n/a | 0.99 | 0.88 | 0.80 | 0.62 | 0.56 | n/a | 0.59 | 0.21 | 0.17 | 0.99 | 0.42 | 0.33 | n/a | n/a | n/a |
| 4 | (102) | 0.78 | 0.74 | 0.71 | 1.00 | 0.97 | 0.88 | 0.63 | 0.57 | 0.56 | 0.72 | 0.26 | 0.20 | 1.00 | 0.51 | 0.40 | n/a | n/a | n/a |
| 4-3/4 | (121) | 0.84 | 0.79 | 0.75 | | 1.00 | 1.00 | 0.66 | 0.58 | 0.57 | 0.93 | 0.33 | 0.26 | | 0.67 | 0.52 | 0.80 | n/a | n/a |
| 5 | (127) | 0.85 | 0.80 | 0.76 | | 1.00 | 1.00 | 0.67 | 0.58 | 0.57 | 1.00 | 0.36 | 0.28 | | 0.72 | 0.56 | 0.82 | n/a | n/a |
| 5-1/8 | (130) | 0.86 | 0.81 | 0.77 | | 1.00 | 1.00 | 0.67 | 0.59 | 0.57 | | 0.37 | 0.29 | | 0.75 | 0.59 | 0.83 | n/a | n/a |
| 5-1/2 | (140) | 0.89 | 0.83 | 0.79 | | | 1.00 | 0.68 | 0.59 | 0.58 | | 0.41 | 0.33 | | 0.83 | 0.65 | 0.86 | 0.61 | n/a |
| 6 | (152) | 0.92 | 0.86 | 0.82 | | | 1.00 | 0.70 | 0.60 | 0.59 | | 0.47 | 0.37 | | 0.95 | 0.74 | 0.89 | 0.64 | n/a |
| 6-1/4 | (159) | 0.94 | 0.88 | 0.83 | | | 1.00 | 0.71 | 0.61 | 0.59 | | 0.50 | 0.39 | | 1.00 | 0.79 | 0.91 | 0.65 | 0.60 |
| 6-1/2 | (165) | 0.96 | 0.89 | 0.84 | | | | 0.72 | 0.61 | 0.59 | | 0.53 | 0.42 | | | 0.84 | 0.93 | 0.66 | 0.61 |
| 7 | (178) | 0.99 | 0.92 | 0.87 | | | | 0.73 | 0.62 | 0.60 | | 0.60 | 0.47 | | | 0.93 | 0.97 | 0.69 | 0.63 |
| 8 | (203) | 1.00 | 0.98 | 0.92 | | | | 0.77 | 0.63 | 0.61 | | 0.73 | 0.57 | | | 1.00 | 1.00 | 0.73 | 0.68 |
| 9 | (229) | | 1.00 | 0.98 | | | | 0.80 | 0.65 | 0.63 | | 0.87 | 0.68 | | | | | 0.78 | 0.72 |
| 9-7/8 | (251) | | | 1.00 | | | | 0.83 | 0.67 | 0.64 | | 1.00 | 0.78 | | | | | 0.82 | 0.75 |
| 10 | (254) | | | | | | | 0.83 | 0.67 | 0.64 | | | 0.80 | | | | | 0.82 | 0.76 |
| 11 | (279) | | | | | | | 0.87 | 0.69 | 0.66 | | | 0.92 | | | | | 0.86 | 0.79 |
| 12 | (305) | | | | | | | 0.90 | 0.70 | 0.67 | | | 1.00 | | | | | 0.90 | 0.83 |
| 14 | (356) | | | | | | | 0.97 | 0.74 | 0.70 | | | | | | | | 0.97 | 0.90 |
| 16 | (406) | | | | | | | 1.00 | 0.77 | 0.73 | | | | | | | | 1.00 | 0.96 |
| 18 | (457) | | | | | | | | 0.80 | 0.76 | | | | | | | | | 1.00 |
| 20 | (508) | | | | | | | | 0.84 | 0.79 | | | | | | | | | |
| 24 | (610) | | | | | | | | 0.90 | 0.84 | | | | | | | | | |
| > 30 | (762) | | | | | | | | 1.00 | 0.93 | | | | | | | | | |

1 Linear interpolation not permitted.
2 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.
3 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.
4 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

— If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 of this section to calculate permissable edge distance and spacing combinations.

## Table 8 — Load adjustment factors for M16 and M20, HSL-3-R anchors in uncracked concrete [1,4]

| M16 and M20 HSL-3-R Uncracked Concrete | | | Spacing Factor in Tension $f_{AN}$ | | Edge Distance Factor in Tension $f_{RN}$ | | Spacing Factor in Shear [2] $f_{AV}$ | | Edge Distance in Shear ⊥ Toward Edge $f_{RV}$ | | Edge Distance in Shear ∥ To Edge $f_{RV}$ | | Conc. Thickness Factor in Shear [3] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Diameter mm | | | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 |
| Effective Embed. $h_{ef}$ mm (in) | | | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 4 | (102) | 0.67 | n/a | 0.47 | n/a | 0.56 | n/a | 0.21 | n/a | 0.42 | n/a | n/a | n/a |
| | 5 | (127) | 0.71 | 0.67 | 0.55 | n/a | 0.57 | 0.56 | 0.29 | n/a | 0.55 | n/a | n/a | n/a |
| | 5-7/8 | (149) | 0.75 | 0.70 | 0.62 | 0.41 | 0.59 | 0.57 | 0.37 | 0.26 | 0.62 | 0.41 | n/a | n/a |
| | 6 | (152) | 0.75 | 0.70 | 0.63 | 0.42 | 0.59 | 0.57 | 0.38 | 0.27 | 0.63 | 0.42 | n/a | n/a |
| | 7 | (178) | 0.80 | 0.74 | 0.74 | 0.47 | 0.60 | 0.58 | 0.48 | 0.33 | 0.74 | 0.47 | n/a | n/a |
| | 7-7/8 | (200) | 0.83 | 0.77 | 0.83 | 0.53 | 0.62 | 0.59 | 0.57 | 0.40 | 0.83 | 0.53 | 0.68 | n/a |
| | 8 | (203) | 0.84 | 0.77 | 0.84 | 0.53 | 0.62 | 0.59 | 0.59 | 0.41 | 0.84 | 0.53 | 0.68 | n/a |
| | 9 | (229) | 0.88 | 0.80 | 0.95 | 0.60 | 0.63 | 0.60 | 0.70 | 0.49 | 0.95 | 0.60 | 0.73 | n/a |
| | 9-1/2 | (241) | 0.90 | 0.82 | 1.00 | 0.63 | 0.64 | 0.61 | 0.76 | 0.53 | 1.00 | 0.63 | 0.74 | n/a |
| | 9-7/8 | (251) | 0.92 | 0.83 | | 0.66 | 0.64 | 0.61 | 0.80 | 0.56 | | 0.66 | 0.76 | 0.67 |
| | 10 | (254) | 0.92 | 0.84 | | 0.67 | 0.65 | 0.61 | 0.82 | 0.57 | | 0.67 | 0.76 | 0.68 |
| | 11 | (279) | 0.97 | 0.87 | | 0.73 | 0.66 | 0.63 | 0.95 | 0.66 | | 0.73 | 0.80 | 0.71 |
| | 11-7/8 | (302) | 1.00 | 0.90 | | 0.79 | 0.67 | 0.64 | 1.00 | 0.74 | | 0.79 | 0.83 | 0.74 |
| | 12 | (305) | | 0.91 | | 0.80 | 0.68 | 0.64 | | 0.75 | | 0.80 | 0.84 | 0.74 |
| | 13 | (330) | | 0.94 | | 0.87 | 0.69 | 0.65 | | 0.85 | | 0.87 | 0.87 | 0.77 |
| | 14 | (356) | | 0.97 | | 0.93 | 0.70 | 0.66 | | 0.94 | | 0.94 | 0.90 | 0.80 |
| | 15 | (381) | | 1.00 | | 1.00 | 0.72 | 0.67 | | 1.00 | | 1.00 | 0.94 | 0.83 |
| | 16 | (406) | | | | | 0.73 | 0.68 | | | | | 0.97 | 0.86 |
| | 18 | (457) | | | | | 0.76 | 0.71 | | | | | 1.00 | 0.91 |
| | 20 | (508) | | | | | 0.79 | 0.73 | | | | | | 0.96 |
| | 24 | (610) | | | | | 0.85 | 0.78 | | | | | | 1.00 |
| | 30 | (762) | | | | | 0.94 | 0.84 | | | | | | |
| | 36 | (914) | | | | | 1.00 | 0.91 | | | | | | |
| | > 48 | (1219) | | | | | | 1.00 | | | | | | |

## Table 9 — Load adjustment factors for M16, and M20, HSL-3-R anchors in cracked concrete [1,4]

| M16 and M20 HSL-3-R Uncracked Concrete | | | Spacing Factor in Tension $f_{AN}$ | | Edge Distance Factor in Tension $f_{RN}$ | | Spacing Factor in Shear [2] $f_{AV}$ | | Edge Distance in Shear ⊥ Toward Edge $f_{RV}$ | | Edge Distance in Shear ∥ ∥ To Edge $f_{RV}$ | | Conc. Thickness Factor in Shear [3] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Diameter mm | | | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 | M16 | M20 |
| Effective Embed. $h_{ef}$ mm (in) | | | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) | 100 (3.94) | 125 (4.92) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 4 | (102) | 0.67 | n/a | 0.76 | n/a | 0.55 | n/a | 0.17 | n/a | 0.33 | n/a | n/a | n/a |
| | 5 | (127) | 0.71 | 0.67 | 0.88 | n/a | 0.56 | 0.55 | 0.23 | n/a | 0.47 | n/a | n/a | n/a |
| | 5-7/8 | (149) | 0.75 | 0.70 | 1.00 | 0.84 | 0.57 | 0.56 | 0.30 | 0.23 | 0.59 | 0.46 | n/a | n/a |
| | 6 | (152) | 0.75 | 0.70 | 1.00 | 0.86 | 0.58 | 0.56 | 0.31 | 0.24 | 0.61 | 0.47 | n/a | n/a |
| | 7 | (178) | 0.80 | 0.74 | 1.00 | 0.96 | 0.59 | 0.57 | 0.39 | 0.30 | 0.77 | 0.60 | n/a | n/a |
| | 7-7/8 | (200) | 0.83 | 0.77 | 1.00 | 1.00 | 0.60 | 0.58 | 0.46 | 0.36 | 0.92 | 0.71 | 0.63 | n/a |
| | 8 | (203) | 0.84 | 0.77 | 1.00 | 1.00 | 0.60 | 0.59 | 0.47 | 0.36 | 0.94 | 0.73 | 0.64 | n/a |
| | 9 | (229) | 0.88 | 0.80 | 1.00 | 1.00 | 0.61 | 0.60 | 0.56 | 0.43 | 1.00 | 0.87 | 0.67 | n/a |
| | 9-1/2 | (241) | 0.90 | 0.82 | 1.00 | 1.00 | 0.62 | 0.60 | 0.61 | 0.47 | 1.00 | 0.94 | 0.69 | n/a |
| | 9-7/8 | (251) | 0.92 | 0.83 | | 1.00 | 0.62 | 0.60 | 0.65 | 0.50 | | 1.00 | 0.71 | 0.65 |
| | 10 | (254) | 0.92 | 0.84 | | 1.00 | 0.63 | 0.61 | 0.66 | 0.51 | | 1.00 | 0.71 | 0.65 |
| | 11 | (279) | 0.97 | 0.87 | | 1.00 | 0.64 | 0.62 | 0.76 | 0.59 | | 1.00 | 0.75 | 0.68 |
| | 11-7/8 | (302) | 1.00 | 0.90 | | 1.00 | 0.65 | 0.63 | 0.85 | 0.66 | | 1.00 | 0.77 | 0.71 |
| | 12 | (305) | | 0.91 | | | 0.65 | 0.63 | 0.87 | 0.67 | | | 0.78 | 0.71 |
| | 13 | (330) | | 0.94 | | | 0.66 | 0.64 | 0.98 | 0.75 | | | 0.81 | 0.74 |
| | 14 | (356) | | 0.97 | | | 0.68 | 0.65 | 1.00 | 0.84 | | | 0.84 | 0.77 |
| | 15 | (381) | | 1.00 | | | 0.69 | 0.66 | | 0.94 | | | 0.87 | 0.80 |
| | 16 | (406) | | | | | 0.70 | 0.67 | | 1.00 | | | 0.90 | 0.82 |
| | 18 | (457) | | | | | 0.73 | 0.69 | | | | | 0.95 | 0.87 |
| | 20 | (508) | | | | | 0.75 | 0.71 | | | | | 1.00 | 0.92 |
| | 24 | (610) | | | | | 0.80 | 0.76 | | | | | | 1.00 |
| | 30 | (762) | | | | | 0.88 | 0.82 | | | | | | |
| | 36 | (914) | | | | | 0.95 | 0.88 | | | | | | |
| | > 48 | (1219) | | | | | 1.00 | 1.00 | | | | | | |

1 Linear interpolation not permitted.2 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.
3 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.
4 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17 or CSA A23.3 Annex D.

— If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 of this section to calculate permissable edge distance and spacing combinations.

# DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-1545. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures. For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

**Table 10 — HSL-3-R stainless steel design information in accordance with CSA A23.3 Annex D [1]**

| Design parameter | Symbol | Units | Nominal anchor diameter | | | | | Ref A23.3 |
|---|---|---|---|---|---|---|---|---|
| | | | M8 | M10 | M12 | M16 | M20 | |
| Anchor O.D. | $d_a$ | mm (in) | 12 (0.47) | 15 (0.59) | 18 (0.71) | 24 (0.94) | 28 (1.10) | |
| Effective min. embedment [2] | $h_{ef}$ | mm (in) | 60 (2.36) | 70 (2.76) | 80 (3.15) | 100 (3.94) | 125 (4.92) | |
| Min. concrete thickness | $h_{min}$ | - | See Table 5 of this document, or Table 5 of ESR-1545 | | | | | |
| Critical edge distance | $c_{ac}$ | - | See Table 5 of this document, or Table 5 of ESR-1545 | | | | | |
| Minimum edge distance | $c_{min}$ | - | See Table 5 of this document, or Table 5 of ESR-1545 | | | | | |
| Minimum anchor spacing | $s_{min}$ | - | See Table 5 of this document, or Table 5 of ESR-1545 | | | | | |
| Min. specified yield strength HSL-3-R | $f_{ya}$ | psi (N/mm²) | 81,200 (560) | 65,300 (450) | | | | |
| Min. specified yield strength HSL-3-GR | | psi (N/mm²) | 81,200 (560) | | | | | |
| Min. specified yield strength HSL-3-SKR | | psi (N/mm²) | 81,200 (560) | 65,300 (450) | | NA | NA | |
| Min. specified ult. strength | $f_{ut}$ | psi (N/mm²) | 101,500 (700) | | | | | |
| Effective tensile stress area | $A_{se,N}$ | in² (mm²) | 0.057 (36.6) | 0.090 (58.0) | 0.131 (84.3) | 0.243 (157.0) | 0.380 (245.0) | |
| Steel embed. material resistance factor for reinforcement | $\Phi_s$ | - | 0.85 | | | | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes [3] | R | - | 0.80 | | | | | D.5.3 |
| Resistance modification factor for shear, steel failure modes [3] | R | - | 0.75 | | | | | D.5.3 |
| Factored steel resistance in tension | $N_{sar}$ | lb (kN) | 3,915 (17.4) | 6,205 (27.6) | 9,020 (40.1) | 16,800 (74.7) | 26,215 (116.6) | D.6.1.2 |
| Factored steel resistance in shear HSL-3-R | $V_{sar}$ | lb (kN) | 6,365 (28.3) | 8,985 (40.0) | 11,665 (51.9) | 18,375 (81.7) | 20,810 (92.6) | D.7.1.2 |
| Factored steel resistance in shear HSL-3-GR | | lb (kN) | 5,775 (25.7) | 8,455 (37.6) | 11,295 (50.2) | 18,575 (82.6) | 22,930 (102.0) | D.7.1.2 |
| Factored steel resistance in shear HSL-3-SKR | | lb (kN) | 4,815 (21.4) | 5,345 (23.8) | 7,755 (34.5) | NA | NA | D.7.1.2 |
| Factored steel resistance in shear, seismic — all versions | $V_{sar,eq}$ | lb (kN) | 1,735 (7.7) | 4,230 (18.8) | 4,515 (20.1) | 9,170 (40.8) | 9,170 (40.8) | |
| Coeff. for factored conc. breakout resistance, uncracked concrete | $k_{c,uncr}$ | - | 10.0 | | | 11.3 | 12.6 | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete | $k_{c,cr}$ | - | 7.1 | 8.8 | 10.0 | | | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked conc. [4] | $\Psi_{c,N}$ | - | 1.0 | | | | | D.6.2.6 |
| Anchor category | - | - | 3 | 2 | 2 | 1 | 1 | D.5.3 (c ) |
| Concrete material resistance factor | $\Phi_c$ | - | 0.65 | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B [5] | R | - | 0.75 | 0.85 | 0.85 | 1.00 | 1.00 | D.5.3 (c ) |
| Factored pullout resistance in 20 MPa uncracked concrete [6] | $N_{pr,uncr}$ | lb (kN) | 1,870 (8.3) | NA | | | | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete [6] | $N_{pr,cr}$ | lb (kN) | NA | 2,700 (12.0) | NA | NA | 8,310 (37.0) | D.6.3.2 |
| Factored seismic pullout resistance in 20 MPa cracked concrete [6] | $N_{pr,eq}$ | lb (kN) | 1,620 (7.2) | 2,700 (12.0) | 3,985 (17.7) | 6,565 (29.2) | 8,310 (37.0) | |
| Load bearing length of anchor in shear | $l_e$ | mm (in) | 24 (0.94) | 30 (1.18) | 36 (1.42) | 48 (1.89) | 56 (2.20) | D.7.2.2 |

1 Design information in this table is taken from ICC-ES ESR-1545, table 4, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 and 2.
3 The HSL-3-R is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete (kc,cr) or uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-1545 for additional information.

## Table 11 — Hilti HSL-3-R factored resistance with concrete / pullout failure in uncracked concrete [1,2,3,4]

| Nominal anchor diameter | Effective embed. mm (in) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| M8 | 60 (2.36) | 1,870 (8.3) | 1,910 (8.5) | 1,945 (8.7) | 2,005 (8.9) | 2,280 (10.1) | 2,545 (11.3) | 2,790 (12.4) | 3,220 (14.3) |
| M10 | 70 (2.76) | 3,255 (14.5) | 3,635 (16.2) | 3,985 (17.7) | 4,600 (20.5) | 6,505 (28.9) | 7,275 (32.4) | 7,970 (35.4) | 9,200 (40.9) |
| M12 | 80 (3.15) | 3,975 (17.7) | 4,445 (19.8) | 4,870 (21.7) | 5,620 (25.0) | 7,950 (35.4) | 8,890 (39.5) | 9,735 (43.3) | 11,240 (50.0) |
| M16 | 100 (3.94) | 7,385 (32.8) | 8,255 (36.7) | 9,045 (40.2) | 10,445 (46.5) | 14,770 (65.7) | 16,510 (73.5) | 18,090 (80.5) | 20,885 (92.9) |
| M20 | 125 (4.92) | 11,505 (51.2) | 12,865 (57.2) | 14,095 (62.7) | 16,275 (72.4) | 23,015 (102.4) | 25,730 (114.5) | 28,185 (125.4) | 32,550 (144.8) |

## Table 12 — Hilti HSL-3-R factored resistance with concrete / pullout failure in cracked concrete [1,2,3,4,5]

| Nominal anchor diameter | Effective embed. mm (in) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| M8 | 60 (2.36) | 1,615 (7.2) | 1,810 (8.0) | 1,980 (8.8) | 2,285 (10.2) | 1,615 (7.2) | 1,810 (8.0) | 1,980 (8.8) | 2,285 (10.2) |
| M10 | 70 (2.76) | 2,705 (12.0) | 3,020 (13.4) | 3,310 (14.7) | 3,825 (17.0) | 5,725 (25.5) | 6,400 (28.5) | 7,010 (31.2) | 8,095 (36.0) |
| M12 | 80 (3.15) | 3,975 (17.7) | 4,445 (19.8) | 4,870 (21.7) | 5,620 (25.0) | 7,950 (35.4) | 8,890 (39.5) | 9,735 (43.3) | 11,240 (50.0) |
| M16 | 100 (3.94) | 6,535 (29.1) | 7,305 (32.5) | 8,005 (35.6) | 9,240 (41.1) | 13,070 (58.1) | 14,615 (65.0) | 16,005 (71.2) | 18,485 (82.2) |
| M20 | 125 (4.92) | 8,310 (37.0) | 9,295 (41.3) | 10,180 (45.3) | 11,755 (52.3) | 18,265 (81.3) | 20,420 (90.8) | 22,370 (99.5) | 25,830 (114.9) |

1 See Section 3.1.9 of Hilti Product Technical Guide Volume 2-21 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in Tables 6 through 9 as necessary. Compare to the steel values in Table 13. The lesser of the values is to be used for the design.
4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75. See Section 3.1.9 of Hilti Product Technical Guide Volume 2-21 for additional information on seismic applications.

## Table 13 — Steel resistance for Hilti HSL-3-R anchors [1,2]

| Nominal Anchor Diameter mm | HSL-3-R | | | HSL-3-GR | | | HSL-3-SKR | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[3] $N_{sar}$ lb (kN) | Shear[4] $V_{sar}$ lb (kN) | Seismic Shear[5] $V_{sar,eq}$ lb (kN) | Tensile[3] Nsar lb (kN) | Shear[4] Vsar lb (kN) | Seismic Shear[5] Vsar,eq lb (kN) | Tensile[3] Nsar lb (kN) | Shear[4] Vsar lb (kN) | Seismic Shear[5] Vsar,eq lb (kN) |
| M8 | 3,915 (17.4) | 6,365 (28.3) | 1,735 (7.7) | 3,915 (17.4) | 5,775 (25.7) | 1,735 (7.7) | 3,915 (17.4) | 6,365 (28.3) | 1,735 (7.7) |
| M10 | 6,205 (27.6) | 8,985 (40.0) | 4,230 (18.8) | 6,205 (27.6) | 8,455 (37.6) | 4,230 (18.8) | 6,205 (27.6) | 8,985 (40.0) | 4,230 (18.8) |
| M12 | 9,020 (40.1) | 11,665 (51.9) | 4,515 (20.1) | 9,020 (40.1) | 11,295 (50.2) | 4,515 (20.1) | 9,020 (40.1) | 11,665 (51.9) | 4,515 (20.1) |
| M16 | 16,800 (74.7) | 18,375 (81.7) | 9,170 (40.8) | 16,800 (74.7) | 18,575 (82.6) | 9,170 (40.8) | - | - | - |
| M20 | 26,215 (116.6) | 20,810 (92.6) | 9,170 (40.8) | 26,215 (116.6) | 22,930 (102.0) | 9,170 (40.8) | - | - | - |

1 See Section 3.1.9 of Hilti Product Technical Guide Volume 2-21 to convert design strength value to ASD value.
2 Hilti HSL-3-R anchors are to be considered ductile steel elements.
2 Tensile = $A_{se,N}$ $\Phi_s$ $f_{uta}$ R as noted in CSA A23.3 Annex D
4 Shear determined by static shear tests with $V_{sar} \le 0.6\ A_{se,V}\ \Phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \le 0.60\ A_{se,V}\ \Phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D. See Section 3.1.9 of Hilti Product Technical Guide Volume 2-21 for additional information on seismic applications.

## INSTALLATION INSTRUCTIONS

Installation Instructions for Use (IFU) are included with each product package. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## ORDERING INFORMATION

### HSL-3-R bolt version

| Description | Box qty |
|---|---|
| **HSL-3-R M8 20/-/-** | 40 |
| **HSL-3-R M8 40/20/-** | 40 |
| **HSL-3-R M10 20/-/-** | 20 |
| **HSL-3-R M10 40/20/-** | 20 |
| **HSL-3-R M12 25/-/-** | 20 |
| **HSL-3-R M12 50/25/-** | 20 |
| **HSL-3-R M16 25/-/-** | 10 |
| **HSL-3-R M16 50/25/-** | 10 |
| **HSL-3-R M20 30/-/-** | 6 |
| **HSL-3-R M20 60/30/-** | 6 |



HSL-3-R

### HSL-3-GR stud version

| Description | Box qty |
|---|---|
| **HSL-3-GR M8 20/-/-** | 40 |
| **HSL-3-GR M8 100/80/60** | 40 |
| **HSL-3-GR M10 20/-/-** | 20 |
| **HSL-3-GR M10 100/80/60** | 20 |
| **HSL-3-GR M12 25/-/-** | 20 |
| **HSL-3-GR M12 100/75/50** | 20 |
| **HSL-3-GR M16 25/-/-** | 10 |
| **HSL-3-GR M16 100/75/50** | 10 |
| **HSL-3-GR M20 30/-/-** | 6 |
| **HSL-3-GR M20 100/70/40** | 6 |



HSL-3-GR

### HSL-3-SKR countersunk version

| Description |
|---|
| **HSL-3-SKR M8/10** |
| **HSL-3-SKR M8/20** |
| **HSL-3-SKR M10/20** |
| **HSL-3-SKR M12/25** |

HSL-3-SKR available by special order



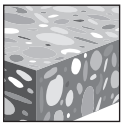
HSL-3-SKR

# 3.3.4 HSL-GR STAINLESS STEEL HEAVY DUTY EXPANSION ANCHORS

## PRODUCT DESCRIPTION

**HSL-GR stainless steel heavy-duty expansion anchors**

| Anchor System | Features and Benefits |
|---|---|
| HSL-GR Heavy-duty Expansion Anchor  | • Type 316 stainless steel<br>• High load capacity<br>• Reliable clamping to help overcome gaps between fixture and concrete<br>• Force-controlled expansion<br>• HSL-GR will not spin during application of installation torque |



Uncracked concrete

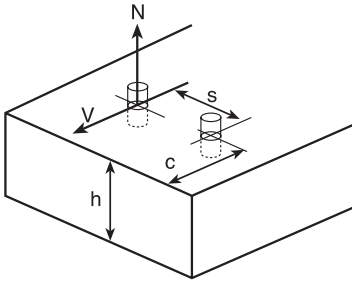


## MATERIAL SPECIFICATIONS

| |
|---|
| Stainless steel threaded rod conforms to DIN 267, Type A4-70, $f_{ya}$ = 65 ksi, $f_{uta}$ ≥ 102 ksi. |
| Stainless steel expansion sleeve conforms to DIN 17440, $f_{uta}$ ≥ 102 ksi. |
| Stainless steel cone conforms to DIN 17440, $f_{uta}$ ≥ 102 ksi. |
| Stainless steel washer conforms to DIN 17441, 74 ksi ≤ $f_{uta}$ ≤ 103 ksi. |
| Stainless steel nut conforms to DIN 934. |
| Collapsible sleeve is made of Acetal resin plastic. |

# DESIGN DATA IN CONCRETE PER ALLOWABLE STRESS DESIGN

## Anchor spacing and edge distance guidelines




### Anchor spacing adjustment factors

s = Actual spacing

$s_{min}$ = 1.0 $h_{nom}$

$s_{cr}$ = 3.0 $h_{ef}$

### Edge distance adjustment factors

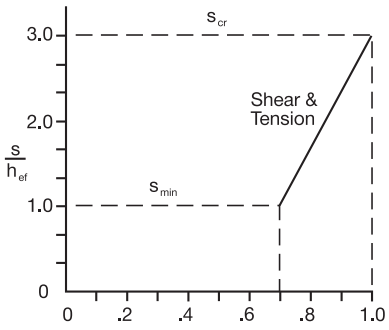
c = Actual edge distance

| | |
|---|---|
| $c_{min}$ = 1.0 $h_{nom}$<br>$c_{cr}$ = 2.5 $h_{ef}$ | Tension |
| $c_{min}$ = 1.0 $h_{nom}$<br>$c_{cr}$ = 2.5 $h_{nom}$ | Shear |

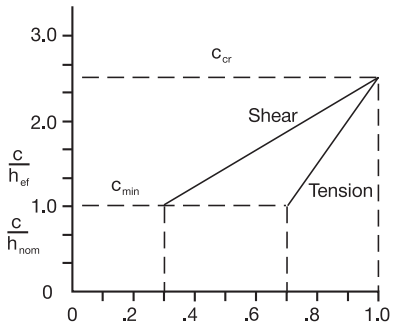
| Anchor Size | $h_{nom}$ mm | (in.) |
|---|---|---|
| M10 | 75 | (3) |
| M12 | 80 | (3-3/16) |
| M16 | 105 | (4-1/8) |
| M20 | 130 | (5-1/8) |

$h_{ef}$ - actual embedment depth

$h_{nom}$ - standard embedment depth




Anchor Spacing Adjustment Factor ($f_A$)




Edge Distance Adjustment Factor ($f_{RV}$, $f_{RN}$)

| Load adjustment factors (anchor spacing) $f_A$ | | | | | | Load adjustment factors (edge distance) $f_R$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tension/Shear | | | | | | Tension $f_{RN}$ | | | | | | Shear $f_{RV}$ | | | |
| Spacing s | | Anchor diameter | | | | Edge distance c | | Anchor diameter | | | | Anchor diameter | | | |
| mm | (in.) | M10 | M12 | M16 | M20 | mm | (in.) | M10 | M12 | M16 | M20 | M10 | M12 | M16 | M20 |
| 65 | (2-1/2) | | | | | 65 | (2-1/2) | | | | | | | | |
| 75 | (3) | .70 | | | | 75 | ( 3) | .70 | | | | .30 | | | |
| 80 | (3-1/8) | .71 | .70 | | | 80 | (3-1/8) | .71 | .70 | | | .33 | .30 | | |
| 105 | (4-1/8) | .76 | .74 | .70 | | 105 | (4-1/8) | .78 | .76 | .70 | | .48 | .44 | .30 | |
| 130 | (5-1/8) | .81 | .79 | .73 | .70 | 130 | (5-1/8) | .85 | .83 | .74 | .70 | .64 | .59 | .41 | .30 |
| 155 | (6-1/8) | .86 | .84 | .77 | .72 | 155 | (6-1/8) | .91 | .88 | .79 | .73 | .80 | .74 | .52 | .39 |
| 175 | (6-7/8) | .90 | .87 | .80 | .75 | 162 | (6-3/8) | .93 | .90 | .80 | .75 | .84 | .78 | .55 | .41 |
| 195 | (7-5/8) | .94 | .91 | .82 | .77 | 187 | (7-3/8) | 1.0 | .96 | .85 | .78 | 1.0 | .92 | .66 | .50 |
| 225 | (8-7/8) | 1.0 | .97 | .87 | .80 | 200 | (7-7/8) | | 1.0 | .88 | .80 | | 1.0 | .72 | .55 |
| 240 | (9-3/8) | | 1.0 | .89 | .82 | 225 | (8-7/8) | | | .92 | .84 | | | .83 | .64 |
| 275 | (10-3/4) | | | .94 | .86 | 265 | (10-3/8) | | | 1.0 | .91 | | | 1.0 | .79 |
| 315 | (12-3/8) | | | 1.0 | .91 | 275 | (10-3/4) | | | | .92 | | | 1.0 | .82 |
| 350 | (13-3/4) | | | | .95 | 300 | (11-3/4) | | | | .96 | | | | .91 |
| 395 | (15-1/2) | | | | 1.0 | 325 | (12-3/4) | | | | 1.0 | | | | 1.0 |
| 430 | (17) | | | | | 350 | (13-3/4) | | | | | | | | |
| 470 | (18-1/2) | | | | | 390 | (15-3/8) | | | | | | | | |

$s_{min} = 1.0\ h_{nom}$ $s_{cr} = 3.0\ h_{ef}$

$$f_A = 0.15 \frac{s}{h_{ef}} + 0.55$$

for $s_{cr} > s > s_{min}$

$c_{min} = 1.0\ h_{nom}$ $c_{cr} = 2.5\ h_{ef}$

$$f_{RN} = (0.30)\left(\frac{c - 1.0\ h_{nom}}{2.5\ h_{ef} - 1.0\ h_{nom}}\right) + 0.70$$

for $c_{cr} > c > c_{min}$

$c_{min} = 1.0\ h_{nom}$ $c_{cr} = 2.5\ h_{nom}$

$$f_{RV} = 0.47 \frac{c}{h_{nom}} - 0.17$$

for $c_{cr} > c > c_{min}$

**Table 2 — Stainless steel Hilti HSL-GR allowable loads in normal-weight concrete[1]**

| Nominal anchor diameter | Nominal embedment mm (in.) | $f'_c$ = 2,000 psi | | $f'_c$ = 3,000 psi | | $f'_c$ = 4,000 psi | | $f'_c$ = 6,000 psi | |
|---|---|---|---|---|---|---|---|---|---|
| | | Tension kN (lb) | Shear kN (lb) | Tension kN (lb) | Shear kN (lb) | Tension kN (lb) | Shear kN (lb) | Tension kN (lb) | Shear kN (lb) |
| M10 | 75 (3) | 6.8 (1,535) | 13.7 (3,090) | 9.1 (2,055) | 14.8 (3,325) | 11.5 (2,575) | 15.8 (3,560) | 11.5 (2,595) | 16.4 (3,690) |
| M12 | 80 (3-3/16) | 8.7 (1,960) | 20.2 (4,540) | 11.3 (2,530) | 21.8 (4,890) | 13.8 (3,105) | 23.3 (5,245) | 17.5 (3,925) | 25.0 (5,615) |
| M16 | 105 (4-1/8) | 17.6 (3,965) | 34.7 (7,805) | 20.9 (4,705) | 39.9 (8,965) | 24.2 (5,450) | 45.0 (10,125) | 30.7 (6,900) | 46.9 (10,550) |
| M20 | 130 (5-1/8) | 25.1 (5,650) | 52.9 (11,900) | 30.7 (6,910) | 58.7 (13,195) | 36.4 (8,175) | 64.5 (14,490) | 44.5 (10,005) | 64.5 (14,490) |

1 Allowable loads calculated using a factor of safety of 3.5.

**Table 3 — Stainless steel Hilti HSL-GR ultimate loads in normal-weight concrete**

| Nominal anchor diameter | Nominal embedment mm (in.) | $f'_c$ = 2,000 psi | | $f'_c$ = 3,000 psi | | $f'_c$ = 4,000 psi | | $f'_c$ = 6,000 psi | |
|---|---|---|---|---|---|---|---|---|---|
| | | Tension kN (lb) | Shear kN (lb) | Tension kN (lb) | Shear kN (lb) | Tension kN (lb) | Shear kN (lb) | Tension kN (lb) | Shear kN (lb) |
| M10 | 75 (3) | 23.8 (5,350) | 47.8 (10,785) | 31.9 (7,165) | 51.6 (11,595) | 40.0 (8,985) | 55.2 (12,410) | 40.3 (9,055) | 57.3 (12,880) |
| M12 | 80 (3-3/16) | 30.4 (6,830) | 70.5 (15,845) | 39.3 (8,830) | 75.9 (17,070) | 48.2 (10,835) | 81.4 (18,300) | 60.9 (13,700) | 87.1 (19,590) |
| M16 | 105 (4-1/8) | 61.6 (13,840) | 121.1 (27,220) | 73.0 (16,420) | 139.1 (31,270) | 84.5 (19,005) | 157.1 (35,320) | 107.0 (24,065) | 163.7 (36,800) |
| M20 | 130 (5-1/8) | 87.7 (19,715) | 184.7 (41,510) | 107.3 (24,115) | 204.7 (46,025) | 126.9 (28,520) | 224.8 (50,540) | 155.3 (34,910) | 224.8 (50,540) |



**Combined shear and tension loading**

$$\left(\frac{N_d}{N_{rec}}\right)^{5/3} + \left(\frac{V_d}{V_{rec}}\right)^{5/3} \leq 1.0$$

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## ORDERING INFORMATION



**Stainless Steel Heavy-duty Expansion Anchor (31655)**

| Description | Box qty |
|---|---|
| M 10/20 | 20 |
| M 12/25 | 20 |
| M 16/25 | 10 |
| M 20/30 | 6 |

# ONE TOOL
# MANY FEATURES
# HILTI SIW 6AT
# PLUS SI-AT MODULE

## Installation. Documentation. Greater quality assurance.




Display provides information regarding selected anchor and settings

Simple navigation buttons

Scan bar codes on Hilti packaging to automatically adjust the setting

A quick glance lets you know if your installation was adequately pretensioned thanks to the SIW 6AT's brightly-lit LED displays

Lock button

# WORKS ACCORDING TO PLAN

## Hilti SIW 6AT plus SI-AT module for setting of Hilti expansion anchors.

Have more confidence that your design is installed properly on the jobsite with Hilti's new Adaptive Torque system! Hilti's next-generation intelligent impact wrench features adaptive torque technology, which allows for project documentation and greater quality assurance of installation. Hilti SIW 6AT Tool and SI-AT module quickly and definitively confirms that the anchor is adequately pretensioned without a calibrated torque wrench.

## APPLICATIONS

Hilti KB-TZ2 and KB1 (3/8" diameter to 5/8 diameter sizes) expansion anchors used in:

- Specified structural applications
- Safety-relevant applications
- Less critical applications, e.g. securing lightweight ducts, lighting, and wiring in seismic risk areas
- Applications which require documentation and greater quality assurance

### Lock and load

Hilti expansion anchors such as KB-TZ2 are secured by applying a specific torque to the nut. These anchor types derive tension resistance through the friction generated by expansion forces against the wall of the drilled hole. The torque generates the necessary expansion forces and pretension in the anchor to achieve its performance.

## HIGHLIGHTS

- Automated project documentation and quality assurance
- Tested and approved in accordance with international standards (ETA and ICC-ES)
- Automatic update of new products, firmware, user-interface, functionality, etc.
- Verify the anchor was adequately pretensioned

## HOW IT WORKS

The Hilti SIW 6AT plus SI-AT module is calibrated to install anchors with the appropriate pretension, similar to that provided by installing with a calibrated torque wrench.




## DONE RIGHT EVERY TIME - ONLY WITH SAFESET

The best design method and your most accurate design are contingent on contractors following your specifications, in addition to proper installation.

The SIW 6AT is part of Hilti's Safeset solution and helps eliminate installation ambiguity almost entirely.

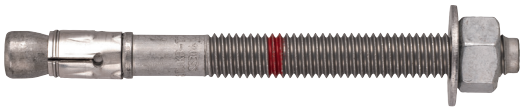
Developed as a total system, all SafeSet components feature intuitive elements that make installations simple, seamless, and faster than ever before.

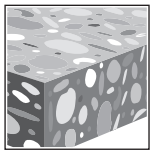
SAFESET

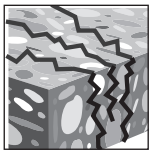
# 3.3.5 KWIK BOLT TZ2 EXPANSION ANCHOR

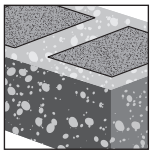
## PRODUCT DESCRIPTION

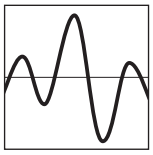
### KWIK BOLT TZ2 Expansion anchor

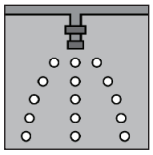
| Anchor System | Features and Benefits |
|---|---|
|  Carbon steel KB-TZ2<br><br>  Stainless Steel 304/316 KB-TZ2 | • IFU provides multiple installation methods including no hole cleaning with hammer drill, Hilti Dust Removal System (DRS) for virtually dustless installation (OSHA 1926.1153 Table 1 compliant) and core drilling installation.<br>• More accurate SafeSet™ installation when using the Hilti SIW-6AT-A22 impact wrench and the SI-AT-A22 Adaptive Torque Module.<br>• Product and length identification marks help facilitate quality control after installation.<br>• Maximized thread lengths and multiple embedment depths to accommodate various base plate thicknesses.<br>• Mechanical expansion allows immediate load application.<br>• Raised impact section (dog point) helps protect threads from damage during installation.<br>• Bolt meets ductility requirements of ACI 318 Section 2.3.<br>• Functional coatings and profile on expansion wedges provide increased reliability. |


Uncracked concrete


Cracked concrete


Grout-filled concrete masonry


Seismic Design Categories A-F


Fire sprinkler listings



Profis Engineering design software



Hollow Drill Bit and Adaptive Torque Tool (AT)

## Approvals/ Listings

| | |
|---|---|
| **ICC-ES (International Code Council)**<br>• 2021 International Building Code / International Residential Code (IBC/IRC)<br>• 2015 National Building Code of Canada (NBC-C) | ESR-4266 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193<br>ESR-4561 in grout-filled CMU per ICC-ES AC01<br>ELC-4266 in concrete per CSA A23.3 / ACI 355.2 |
| **City of Los Angeles** | 2020 LABC Supplement (within ESR-4266 & ESR-4561) |
| **Florida Building Code** | 2020 FBC Supplement with HVHZ (within ESR-4266 & ESR-4561) |
| **FM (Factory Mutual) — Carbon steel KB-TZ2 only** | Pipe hanger components for automatic sprinkler systems<br>3/8 (up to 4-inch nominal pipe diameter)<br>1/2[1] (up to 8-inch nominal pipe diameter)<br>3/4 (up to 12-inch nominal pipe diameter) |
| **UL and cUL (Underwriters Laboratory) — Carbon steel KB-TZ2 only** | Pipe hanger equipment for fire protection services<br>3/8 (up to 4-inch nominal pipe diameter)<br>1/2[1] (up to 8-inch nominal pipe diameter)<br>5/8 & 3/4 (up to 12-inch nominal pipe diameter) |
| **ANSI/MSS SP-58-2018** | Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information. |

ICC ES

CITY LA DBS

FM APPROVED

CLASSIFIED C UL US LISTED
Pipe Hanger 757G

1 1/2-inch dia. with 1-1/2-inch effective embedment does not have FM or UL certification.

# MATERIAL SPECIFICATIONS

### Carbon steel with electroplated zinc-nickel plating

- Carbon steel anchor components plated in accordance with ASTM F1941 to a minimum thickness of 5 µm.
- Nuts conform to the requirements of ASTM A563, Grade A, Hex.
- Washers meet the requirements of ASTM F844.
- Expansion sleeves (wedges) are manufactured from carbon or stainless steel.
- Nuts and bolts are finished with a proprietary coating. Only Hilti KB-TZ2 nuts can be used with KB-TZ2 bolts.
- Carbon steel bolts are manufactured from carbon steel.

### Stainless steel

- All nuts and washers for type 304 anchors are made from type 304 stainless.
- All nuts and washers for type 316 anchors are made from type 316 stainless.
- Nuts meet the dimensional requirements of ASTM F594.
- Washers meet the dimensional requirements of ANSI B18.22.1, Type A, plain.
- Expansion sleeve (wedges) are made from stainless steel.
- Nuts and bolts are finished with a proprietary coating. Only Hilti KB-TZ2 nuts can be used with KB-TZ2 bolts.
- Stainless steel 304 bolts are manufactured from AISI Type 304 stainless steel.
- Stainless steel 316 bolts are manufactured from AISI Type 316 stainless steel.

# INSTALLATION PARAMETERS



### Table 1 — Hilti KB-TZ2 setting information for installation in concrete and grout-filled concrete masonry units (CMU)[1]

| Setting information | | Symbol | Units | Nominal anchor diameter (in) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1/4 | 3/8 | | | 1/2 | | | | 5/8 | | | 3/4 | | | 1 | | |
| Nominal bit diameter | | $d_o$ | in. | 1/4 | 3/8 | | | 1/2 | | | | 5/8 | | | 3/4 | | | 1 | | |
| Effective minimum embedment | | $h_{ef}$ | in. | 1-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 [2] | 2 | 2-1/2 | 3-1/4 | 2-3/4 | 3-1/4 | 4 | 3-1/4 | 3-3/4 | 4-3/4 | 4 | 5-3/4 | |
| | | | (mm) | (38) | (38) | (51) | (64) | (38) | (51) | (64) | (83) | (70) | (83) | (102) | (83) | (95) | (121) | (102) | (146) | |
| Nominal minimum embedment | | $h_{nom}$ | in. | 1-3/4 | 1-7/8 | 2-1/2 | 3 | 2 2) | 2-1/2 | 3 | 3-3/4 | 3-1/4 | 3-3/4 | 4-1/2 | 4 | 4-1/2 | 5-1/2 | 4-5/8 | 6-3/8 | |
| | | | (mm) | (44) | (48) | (64) | (76) | (51) | (64) | (76) | (95) | (83) | (95) | (114) | (102) | (114) | (140) | (117) | (162) | |
| Min. hole depth | | $h_o$ | in. | 2 | 2 | 2-3/4 | 3-1/4 | 2-1/4 [2] | 2-3/4 | 3-1/4 | 4-1/4 | 3-3/4 | 4-1/4 | 4-3/4 | 4-1/4 | 4-3/4 | 5-3/4 | 5 | 6-3/4 | |
| | | | (mm) | (51) | (51) | (70) | (83) | (57) | (70) | (83) | (108) | (95) | (108) | (121) | (108) | (121) | (146) | (127) | (171) | |
| Fixture hole diameter | | $d_h$ | in. | 5/16 | 7/16 | | | 9/16 | | | | 11/16 | | | 13/16 | | | 1-1/8 | | |
| | | | (mm) | (7.9) | (11.1) | | | (14.3) | | | | (17.5) | | | (20.6) | | | (28.6) | | |
| Concrete | Installation torque Carbon steel | $T_{inst,conc}$ | ft-lb | 4 | 30 | | | 50 | | | | 40 | | | 110 | | | 185 | | |
| | | | (Nm) | (5) | (41) | | | (68) | | | | (54) | | | (149) | | | (251) | | |
| | Installation torque Stainless steel | $T_{inst,conc}$ | ft-lb | 6 | 30 | | | 40 | | | | 60 | | | 125 | | | 185 | | |
| | | | (Nm) | (8) | (41) | | | (54) | | | | (81) | | | (169) | | | (251) | | |
| Grout-filled CMU | Installation torque Carbon steel | $T_{inst,CMU}$ | ft-lb | 4 | 15 | | | 25 | | | | 30 | | | 50 | | | N/A | | |
| | | | (Nm) | (5) | (20) | | | (34) | | | | (41) | | | (68) | | | N/A | | |
| | Installation torque Stainless steel | $T_{inst,CMU}$ | ft-lb | 6 | 15 | | | 25 | | | | 35 | | | 50 | | | N/A | | |
| | | | (Nm) | (8) | (20) | | | (34) | | | | (48) | | | (68) | | | N/A | | |

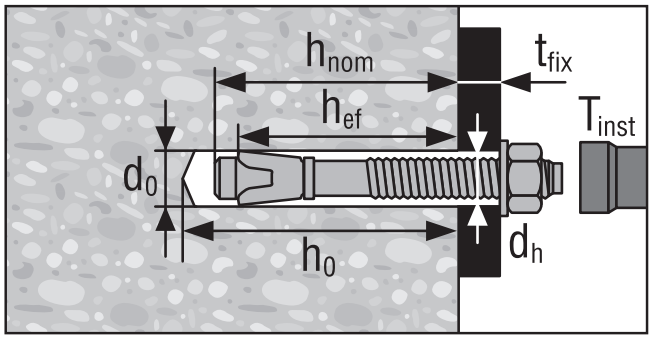
1 Shaded cells are not applicable for installations in grout-filled CMU.
2 Design information for $h_{ef}$ = 1-1/2 is only applicable to carbon steel (CS) KB-TZ2 bolts.

### Hilti KWIK Bolt TZ2 Fracture Load (lb)[1]

| Nominal Anchor Diameter (in) | Carbon Steel | Stainless Steel |
|---|---|---|
| 1/4 | 2920 | 2920 |
| 3/8 | 6490 | 6180 |
| 1/2 | 11240 | 11870 |
| 5/8 | 17535 | 18835 |
| 3/4 | 25335 | $f_{uta} \geq 105$, $f_y \geq 84$ [2] |
| 1 | $f_{uta} \geq 88$, $f_y \geq 75$ [2] | $f_{uta} \geq 99.9$, $f_y \geq 65$ [2] |

1 Bolt fracture loads are determined by testing in a universal tensile machine for quality control at the manufacturing facility. These loads are not intended for design use.
2 All 3/4-in. stainless steel, all 1-in. carbon steel and all 1-in. stainless steel material strengths specified by the tensile and yield strengths expressed in (ksi). Bolt fracture loads not applicable for these models.

**Figure 1 — Hilti KWIK Bolt TZ 2 specifications**




## DESIGN INFORMATION IN CONCRETE PER ACI 318

### ACI 318 Chapter 17 Design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ICC-ES ESR-4266 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables refer to section 3.1.8. Data tables from ESR-4266 are not contained in this section but can be found at www.icc-es.org or at www.hilti.com

**Table 2 — Hilti Carbon Steel KB-TZ2 design strength based on concrete failure modes in uncracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4]**

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension (lesser of concrete breakout / pullout) - $\Phi N_n$ | | | | Shear (lesser of concrete breakout or pryout) - $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 1/4 | 1-1/2 (38) | 1 3/4 (44) | 945 (4.2) | 980 (4.4) | 1,040 (4.6) | 1,125 (5.0) | 1,545 (6.9) | 1,690 (7.5) | 1,950 (8.7) | 2,390 (10.6) |
| 3/8 | 1-1/2 (38) | 1 7/8 (48) | 1,435 (6.4) | 1,570 (7.0) | 1,815 (8.1) | 2,220 (9.9) | 1,545 (6.9) | 1,690 (7.5) | 1,950 (8.7) | 2,390 (10.6) |
| | 2 (51) | 2 1/2 (64) | 2,205 (9.8) | 2,415 (10.7) | 2,790 (12.4) | 3,420 (15.2) | 2,375 (10.6) | 2,605 (11.6) | 3,005 (13.4) | 3,680 (16.4) |
| | 2-1/2 (64) | 3 (76) | 2,715 (12.1) | 2,895 (12.9) | 3,205 (14.3) | 3,690 (16.4) | 6,640 (29.5) | 7,275 (32.4) | 8,400 (37.4) | 10,290 (45.8) |
| 1/2 | 1-1/2 (38) | 2 (51) | 1,610 (7.2) | 1,765 (7.9) | 2,040 (9.1) | 2,495 (11.1) | 1,735 (7.7) | 1,900 (8.5) | 2,195 (9.8) | 2,690 (12.0) |
| | 2 (51) | 2 1/2 (64) | 2,480 (11.0) | 2,720 (12.1) | 3,140 (14.0) | 3,845 (17.1) | 2,675 (11.9) | 2,930 (13.0) | 3,380 (15.0) | 4,140 (18.4) |
| | 2-1/2 (64) | 3 (76) | 3,085 (13.7) | 3,375 (15.0) | 3,900 (17.3) | 4,775 (21.2) | 6,640 (29.5) | 7,275 (32.4) | 8,400 (37.4) | 10,290 (45.8) |
| | 3-1/4 (83) | 3 3/4 (95) | 4,570 (20.3) | 5,005 (22.3) | 5,780 (25.7) | 7,080 (31.5) | 9,845 (43.8) | 10,785 (48.0) | 12,450 (55.4) | 15,250 (67.8) |
| 5/8 | 2-3/4 (70) | 3 1/4 (83) | 3,495 (15.5) | 3,830 (17.0) | 4,425 (19.7) | 5,420 (24.1) | 7,660 (34.1) | 8,395 (37.3) | 9,690 (43.1) | 11,870 (52.8) |
| | 3-1/4 (83) | 3 3/4 (95) | 4,570 (20.3) | 5,005 (22.3) | 5,780 (25.7) | 7,080 (31.5) | 9,845 (43.8) | 10,785 (48.0) | 12,450 (55.4) | 15,250 (67.8) |
| | 4 (102) | 4 1/2 (114) | 5,845 (26.0) | 6,405 (28.5) | 7,395 (32.9) | 9,060 (40.3) | 13,440 (59.8) | 14,725 (65.5) | 17,000 (75.6) | 20,820 (92.6) |
| 3/4 | 3-1/4 (83) | 4 (102) | 5,140 (22.9) | 5,630 (25.0) | 6,505 (28.9) | 7,965 (35.4) | 11,075 (49.3) | 12,130 (54.0) | 14,005 (62.3) | 17,155 (76.3) |
| | 3-3/4[5] (95) | 4 1/2 (114) | 6,370 (28.3) | 6,980 (31.0) | 8,060 (35.9) | 9,870 (43.9) | 13,725 (61.1) | 15,035 (66.9) | 17,360 (77.2) | 21,265 (94.6) |
| | 4-3/4 (121) | 5 1/2 (140) | 8,075 (35.9) | 8,845 (39.3) | 10,215 (45.4) | 12,510 (55.6) | 17,390 (77.4) | 19,050 (84.7) | 22,000 (97.9) | 26,945 (119.9) |
| 1 | 4 (102) | 4 5/8 (117) | 7,020 (31.2) | 7,690 (34.2) | 8,880 (39.5) | 10,875 (48.4) | 15,120 (67.3) | 16,565 (73.7) | 19,125 (85.1) | 23,425 (104.2) |
| | 5-3/4 (146) | 6 3/8 (162) | 10,755 (47.8) | 11,780 (52.4) | 13,605 (60.5) | 16,660 (74.1) | 23,165 (103.0) | 25,375 (112.9) | 29,300 (130.3) | 35,885 (159.6) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 15 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60.
5 For core drilled installations of 3/4" anchors installed at 3-3/4" effective embedment, apply a reduction factor of 0.89 to the design tension strength.

## Table 3 — Hilti Carbon Steel KB-TZ2 design strength based on concrete failure modes in cracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4,5]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension (lesser of concrete breakout / pullout) - $\Phi N_n$ | | | | Shear (lesser of concrete breakout or pryout) - $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 1/4 | 1-1/2 (38) | 1 3/4 (44) | 280 (1.2) | 300 (1.3) | 340 (1.5) | 395 (1.8) | 1,095 (4.9) | 1,195 (5.3) | 1,385 (6.2) | 1,695 (7.5) |
| 3/8 | 1-1/2 (38) | 1 7/8 (48) | 1,255 (5.6) | 1,375 (6.1) | 1,585 (7.1) | 1,940 (8.6) | 1,350 (6.0) | 1,480 (6.6) | 1,710 (7.6) | 2,090 (9.3) |
| | 2 (51) | 2 1/2 (64) | 1,930 (8.6) | 2,115 (9.4) | 2,440 (10.9) | 2,990 (13.3) | 2,080 (9.3) | 2,275 (10.1) | 2,630 (11.7) | 3,220 (14.3) |
| | 2-1/2 (64) | 3 (76) | 2,185 (9.7) | 2,390 (10.6) | 2,765 (12.3) | 3,385 (15.1) | 4,705 (20.9) | 5,155 (22.9) | 5,950 (26.5) | 7,285 (32.4) |
| 1/2 | 1-1/2 (38) | 2 (51) | 1,435 (6.4) | 1,570 (7.0) | 1,815 (8.1) | 2,220 (9.9) | 1,545 (6.9) | 1,690 (7.5) | 1,950 (8.7) | 2,390 (10.6) |
| | 2 (51) | 2 1/2 (64) | 1,930 (8.6) | 2,115 (9.4) | 2,440 (10.9) | 2,990 (13.3) | 2,080 (9.3) | 2,275 (10.1) | 2,630 (11.7) | 3,220 (14.3) |
| | 2-1/2 (64) | 3 (76) | 2,700 (12.0) | 2,955 (13.1) | 3,415 (15.2) | 4,180 (18.6) | 5,810 (25.8) | 6,365 (28.3) | 7,350 (32.7) | 9,000 (40.0) |
| | 3-1/4 (83) | 3 3/4 (95) | 3,235 (14.4) | 3,545 (15.8) | 4,095 (18.2) | 5,015 (22.3) | 6,970 (31.0) | 7,640 (34.0) | 8,820 (39.2) | 10,800 (48.0) |
| 5/8 | 2-3/4 (70) | 3 1/4 (83) | 3,110 (13.8) | 3,410 (15.2) | 3,935 (17.5) | 4,820 (21.4) | 6,705 (29.8) | 7,345 (32.7) | 8,480 (37.7) | 10,385 (46.2) |
| | 3-1/4 (83) | 3 3/4 (95) | 4,000 (17.8) | 4,380 (19.5) | 5,060 (22.5) | 6,195 (27.6) | 8,615 (38.3) | 9,435 (42.0) | 10,895 (48.5) | 13,345 (59.4) |
| | 4 (102) | 4 1/2 (114) | 4,420 (19.7) | 4,840 (21.5) | 5,590 (24.9) | 6,845 (30.4) | 9,520 (42.3) | 10,430 (46.4) | 12,040 (53.6) | 14,750 (65.6) |
| 3/4 | 3-1/4 (83) | 4 (102) | 4,000 (17.8) | 4,380 (19.5) | 5,060 (22.5) | 6,195 (27.6) | 8,615 (38.3) | 9,435 (42.0) | 10,895 (48.5) | 13,345 (59.4) |
| | 3-3/4 (95) | 4 1/2 (114) | 4,955 (22.0) | 5,430 (24.2) | 6,270 (27.9) | 7,680 (34.2) | 10,675 (47.5) | 11,695 (52.0) | 13,505 (60.1) | 16,540 (73.6) |
| | 4-3/4 (121) | 5 1/2 (140) | 5,745 (25.6) | 6,055 (26.9) | 6,580 (29.3) | 7,405 (32.9) | 15,220 (67.7) | 16,670 (74.2) | 19,250 (85.6) | 23,575 (104.9) |
| 1 | 4 (102) | 4 5/8 (117) | 5,460 (24.3) | 5,980 (26.6) | 6,905 (30.7) | 8,460 (37.6) | 11,760 (52.3) | 12,880 (57.3) | 14,875 (66.2) | 18,220 (81.0) |
| | 5-3/4 (146) | 6 3/8 (162) | 7,675 (34.1) | 8,410 (37.4) | 9,710 (43.2) | 11,890 (52.9) | 20,270 (90.2) | 22,205 (98.8) | 25,640 (114.1) | 31,400 (139.7) |

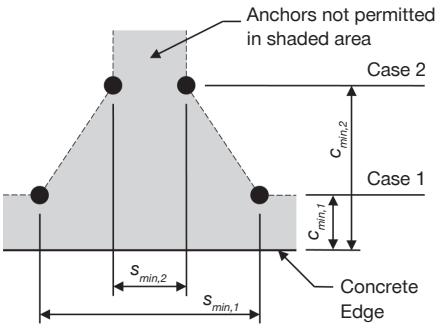
1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 17 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 $h_{ef}$ where $\alpha_{N,seis}$ = 0.73. No reduction needed for seismic shear. See Section 3.1.8 for additional information on seismic applications.

## Table 4 — Hilti Carbon Steel KB-TZ2 design strength based on steel failure per ACI 318 Ch. 17 [1,2]

| Nominal anchor diameter in. | Effective embedment depth in. (mm) | | | Tensile [3] $\Phi N_{sa}$ lb (kN) | Shear [4] $\Phi V_{sa}$ lb (kN) | Seismic Shear [5] $\Phi V_{sa}$ lb (kN) |
|---|---|---|---|---|---|---|
| 1/4 | 1-1/2 (38) | | | 2,190 (9.7) | 875 (3.9) | 875 (3.9) |
| 3/8 | 1-1/2 (38) | | | 4,870 (21.7) | 2,095 (9.3) | 2,095 (9.3) |
| 3/8 | 2 (51) | | 2-1/2 (64) | 4,870 (21.7) | 2,200 (9.8) | 2,200 (9.8) |
| 1/2 | 1-1/2 (38) | | 2 (51) | 8,430 (37.5) | 3,600 (16.0) | 3,600 (16.0) |
| 1/2 | 2-1/2 (64) | | 3-1/4 (83) | 8,430 (37.5) | 4,470 (19.9) | 4,470 (19.9) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 4 (102) | 13,150 (58.5) | 6,665 (29.6) | 6,665 (29.6) |
| 3/4 | 3-1/4 (83) | 3-3/4 (95) | 4-3/4 (121) | 19,000 (84.5) | 8,975 (39.9) | 8,975 (39.9) |
| 1 (25.4) | 4 (102) | | | 31,025 (138.0) | 12,215 (54.3) | 8,975 (39.9) |
| 1 (25.4) | 5-3/4 (146) | | | 31,025 (138.0) | 14,875 (66.2) | 8,975 (39.9) |

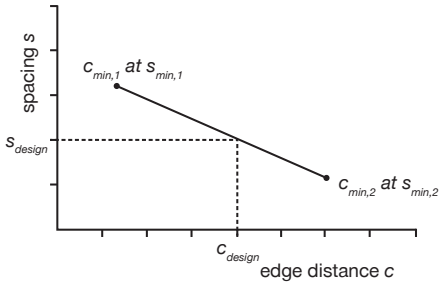
1 See Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KB-TZ2 carbon steel anchors are to be considered ductile steel elements.
3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Ch. 17.
4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17. See Section 3.1.8 for additional information on seismic applications.

## Figure 2




For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$




## Table 5 — Hilti KB-TZ2 carbon steel installation parameters [1]

| Setting information | Symbol | Units | Nominal Anchor diameter (in.) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | 3/8 | | | 1/2 | | | | 5/8 | | | 3/4 | | 1 | |
| Effective embedment | $h_{ef}$ | in. | 1-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 3 1/4 | 2-3/4 | 3-1/4 | 4 | 3-1/2 | 3-3/4 | 4-3/4 | 4 | 5-3/4 |
| | | (mm) | (38) | (38) | (51) | (64) | (38) | (51) | (64) | (83) | (70) | (83) | (102) | (83) | (95) | (121) | (102) | (146) |
| Min. member thickness | $h_{min}$ | in. | 3-1/4 | 3-1/4 | 4 | 5 | 3-1/2 | 4 | 5 | 5-1/2 | 5 | 5-1/2 | 6 | 5-1/2 | 6 | 8 | 8 | 10 |
| | | (mm) | (83) | (83) | (102) | (127) | (89) | (102) | (127) | (140) | (127) | (140) | (152) | (140) | (152) | (203) | (203) | (254) |
| Case 1 | $c_{min,1}$ | in. | 1-1/2 | 5 | 2-1/2 | 2-1/2 | 8 | 2-3/4 | 2-3/4 | 2-1/4 | 4-1/2 | 3-1/2 | 2-3/4 | 5 | 4 | 3-1/2 | 8 | 3 |
| | | (mm) | (38) | (127) | (64) | (64) | (203) | (70) | (70) | (57) | (114) | (89) | (70) | (127) | (102) | (89) | (203) | (76) |
| | for $s_{min,1} \geq$ | in. | 1-1/2 | 8 | 6 | 5 | 12 | 5-1/2 | 9-3/4 | 5-1/4 | 6-1/2 | 5-1/2 | 7-1/4 | 10 | 5-3/4 | 5-1/2 | 8 | 6-3/4 |
| | | (mm) | (38) | (203) | (152) | (127) | (305) | (140) | (248) | (133) | (165) | (140) | (184) | (254) | (146) | (140) | (203) | (171) |
| Case 2 | $c_{min,2}$ | in. | 1-1/2 | 8 | 3-1/2 | 4 | 8 | 10 | 8 | 4-3/4 | 5-1/2 | 7 | 4-1/4 | 6 | 7-1/4 | 4-3/4 | 8 | 3-3/4 |
| | | (mm) | (38) | (203) | (89) | (102) | (203) | (254) | (203) | (121) | (140) | (178) | (108) | (152) | (184) | (121) | (203) | (95) |
| | for $s_{min,2} \geq$ | in. | 1-1/2 | 5 | 2-1/4 | 2 | 12 | 3-1/2 | 3 | 2 | 4-1/2 | 2-3/4 | 2-1/4 | 4-1/2 | 3-3/4 | 3-3/4 | 8 | 4-3/4 |
| | | | (38) | (127) | (57) | (51) | (305) | (89) | (76) | (51) | (114) | (70) | (57) | (114) | (95) | (95) | (203) | (121) |

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$, will determine the permissible spacings.

## Table 6 — Load adjustment factors for Carbon Steel 1/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

| 1/4-in. KB-TZ2 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | Edge distance factor in tension $f_{RN}$ | Spacing factor in shear [3] $f_{AV}$ | ⊥ Toward edge $f_{RV}$ | ∥ To edge $f_{RV}$ | Concrete thickness factor in shear [4] $f_{HV}$ |
|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | in. | | 1-1/2 | 1-1/2 | 1-1/2 | 1-1/2 | 1-1/2 | 1-1/2 |
| | (mm) | | (38) | (38) | (38) | (38) | (38) | (38) |
| Nominal Embedment $h_{nom}$ | in. | | 1-3/4 | 1-3/4 | 1-3/4 | 1-3/4 | 1-3/4 | 1-3/4 |
| | (mm) | | (44) | (44) | (44) | (44) | (44) | (44) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 1-1/2 | (38) | 0.67 | 0.42 | 0.56 | 0.23 | 0.42 | n/a |
| | 2 | (51) | 0.72 | 0.51 | 0.58 | 0.35 | 0.51 | n/a |
| | 2-1/2 | (64) | 0.78 | 0.63 | 0.60 | 0.49 | 0.63 | n/a |
| | 3 | (76) | 0.83 | 0.75 | 0.63 | 0.65 | 0.75 | n/a |
| | 3-1/4 | (83) | 0.86 | 0.81 | 0.64 | 0.73 | 0.81 | 0.74 |
| | 3-1/2 | (89) | 0.89 | 0.88 | 0.65 | 0.82 | 0.88 | 0.76 |
| | 4 | (102) | 0.94 | 1.00 | 0.67 | 1.00 | 1.00 | 0.82 |
| | 5 | (127) | 1.00 | | 0.71 | | | 0.91 |
| | 6 | (152) | | | 0.75 | | | 1.00 |
| | 7 | (178) | | | 0.79 | | | |
| | 8 | (203) | | | 0.83 | | | |
| | 9 | (229) | | | 0.88 | | | |
| | > 12 | (305) | | | 1.00 | | | |

3.3.5

## Table 7 — Load adjustment factors for Carbon Steel 1/4-in. diameter KB-TZ2 in cracked concrete [1,2]

| 1/4-in. KB-TZ2 cracked concrete | | | Spacing factor in tension $f_{AN}$ | Edge distance factor in tension $f_{RN}$ | Spacing factor in shear [3] $f_{AV}$ | ⊥ Toward edge $f_{RV}$ | ∥ To edge $f_{RV}$ | Concrete thickness factor in shear [4] $f_{HV}$ |
|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_e$ | in. | | 1-1/2 | 1-1/2 | 1-1/2 | 1-1/2 | 1-1/2 | 1-1/2 |
| | (mm) | | (38) | (38) | (38) | (38) | (38) | (38) |
| Nominal Embedment $h_{nom}$ | in. | | 1-3/4 | 1-3/4 | 1-3/4 | 1-3/4 | 1-3/4 | 1-3/4 |
| | (mm) | | (44) | (44) | (44) | (44) | (44) | (44) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 1-1/2 | (38) | 0.67 | 0.75 | 0.57 | 0.29 | 0.59 | n/a |
| | 2 | (51) | 0.72 | 0.91 | 0.60 | 0.45 | 0.91 | n/a |
| | 2-1/2 | (64) | 0.78 | 1.00 | 0.62 | 0.63 | 1.00 | n/a |
| | 3 | (76) | 0.83 | | 0.65 | 0.83 | | n/a |
| | 3-1/4 | (83) | 0.86 | | 0.66 | 0.94 | | 0.80 |
| | 3-1/2 | (89) | 0.89 | | 0.67 | 1.00 | | 0.83 |
| | 4 | (102) | 0.94 | | 0.70 | | | 0.89 |
| | 5 | (127) | 1.00 | | 0.75 | | | 0.99 |
| | 6 | (152) | | | 0.80 | | | 1.00 |
| | 7 | (178) | | | 0.84 | | | |
| | 8 | (203) | | | 0.89 | | | |
| | 9 | (229) | | | 0.94 | | | |
| | > 12 | (305) | | | 1.00 | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

## Table 8 — Load adjustment factors for Carbon Steel 3/8-in. diameter KB-TZ2 in uncracked concrete [1,2]

| 3/8-in. KB-TZ2 uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | in. | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 |
| | (mm) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) |
| Nominal Embedment $h_{nom}$ | in. | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 |
| | (mm) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2 (51) | n/a | n/a | 0.63 | n/a | n/a | n/a | n/a | n/a | 0.54 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 2-1/4 (57) | n/a | 0.69 | 0.65 | n/a | n/a | n/a | n/a | 0.59 | 0.55 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 2-1/2 (64) | n/a | 0.71 | 0.67 | n/a | 0.60 | 0.51 | n/a | 0.60 | 0.55 | n/a | 0.43 | 0.18 | n/a | 0.60 | 0.37 | n/a | n/a | n/a |
| | 3 (76) | n/a | 0.75 | 0.70 | n/a | 0.69 | 0.58 | n/a | 0.61 | 0.56 | n/a | 0.57 | 0.24 | n/a | 0.69 | 0.48 | n/a | n/a | n/a |
| | 3-1/4 (83) | n/a | 0.77 | 0.72 | n/a | 0.74 | 0.61 | n/a | 0.62 | 0.57 | n/a | 0.64 | 0.27 | n/a | 0.74 | 0.54 | 0.66 | n/a | n/a |
| | 3-1/2 (89) | n/a | 0.79 | 0.73 | n/a | 0.80 | 0.65 | n/a | 0.63 | 0.58 | n/a | 0.72 | 0.30 | n/a | 0.80 | 0.61 | 0.68 | n/a | n/a |
| | 4 (102) | n/a | 0.83 | 0.77 | n/a | 0.91 | 0.73 | n/a | 0.65 | 0.59 | n/a | 0.87 | 0.37 | n/a | 0.91 | 0.73 | 0.73 | 0.78 | n/a |
| | 5 (127) | 1.00 | 0.92 | 0.83 | 1.00 | 1.00 | 0.91 | 0.67 | 0.69 | 0.61 | 1.00 | 1.00 | 0.52 | 1.00 | 1.00 | 0.91 | 0.82 | 0.87 | 0.66 |
| | 6 (152) | 1.00 | 1.00 | 0.90 | 1.00 | | 1.00 | 0.70 | 0.73 | 0.63 | 1.00 | | 0.68 | 1.00 | | 1.00 | 0.89 | 0.96 | 0.72 |
| | 8 (203) | 1.00 | | 1.00 | 1.00 | | | 0.77 | 0.80 | 0.67 | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 | 0.83 |
| | 12 (305) | | | | | | | 0.90 | 0.96 | 0.76 | | | | | | | | | 1.00 |
| | 18 (457) | | | | | | | 1.00 | 1.00 | 0.89 | | | | | | | | | |
| | > 24 (610) | | | | | | | | | 1.00 | | | | | | | | | |

## Table 9 — Load adjustment factors for Carbon Steel 3/8-in. diameter KB-TZ2 in cracked concrete [1,2]

| 3/8-in. KB-TZ2 cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | in. | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 |
| | (mm) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) |
| Nominal Embedment $h_{nom}$ | in. | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 |
| | (mm) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2 (51) | n/a | n/a | 0.63 | n/a | n/a | n/a | n/a | n/a | 0.54 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 2-1/4 (57) | n/a | 0.69 | 0.65 | n/a | n/a | n/a | n/a | 0.58 | 0.55 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 2-1/2 (64) | n/a | 0.71 | 0.67 | n/a | 0.87 | 0.75 | n/a | 0.59 | 0.55 | n/a | 0.40 | 0.18 | n/a | 0.80 | 0.37 | n/a | n/a | n/a |
| | 3 (76) | n/a | 0.75 | 0.70 | n/a | 1.00 | 0.85 | n/a | 0.61 | 0.56 | n/a | 0.52 | 0.24 | n/a | 1.00 | 0.48 | n/a | n/a | n/a |
| | 3-1/4 (83) | n/a | 0.77 | 0.72 | n/a | 1.00 | 0.90 | n/a | 0.62 | 0.57 | n/a | 0.59 | 0.27 | n/a | 1.00 | 0.55 | 0.78 | n/a | n/a |
| | 3-1/2 (89) | n/a | 0.79 | 0.73 | n/a | 1.00 | 0.95 | n/a | 0.63 | 0.58 | n/a | 0.66 | 0.31 | n/a | 1.00 | 0.61 | 0.81 | n/a | n/a |
| | 4 (102) | n/a | 0.83 | 0.77 | n/a | | 1.00 | n/a | 0.64 | 0.59 | n/a | 0.81 | 0.37 | n/a | | 0.75 | 0.86 | 0.76 | n/a |
| | 5 (127) | 1.00 | 0.92 | 0.83 | 1.00 | | | 0.73 | 0.68 | 0.61 | 1.00 | 1.00 | 0.52 | 1.00 | | 1.00 | 0.96 | 0.85 | 0.66 |
| | 6 (152) | 1.00 | 1.00 | 0.90 | 1.00 | | | 0.78 | 0.72 | 0.63 | 1.00 | | 0.69 | 1.00 | | | 1.00 | 0.93 | 0.72 |
| | 8 (203) | 1.00 | | 1.00 | 1.00 | | | 0.87 | 0.79 | 0.67 | 1.00 | | 1.00 | 1.00 | | | | 1.00 | 0.83 |
| | 12 (305) | | | | | | | 1.00 | 0.93 | 0.76 | | | | | | | | | 1.00 |
| | 18 (457) | | | | | | | | 1.00 | 0.89 | | | | | | | | | |
| | > 24 (610) | | | | | | | | | 1.00 | | | | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 10 — Load adjustment factors for Carbon Steel 1/2-in. diameter KB-TZ2 in uncracked concrete [1,2]

| 1/2-in. KB-TZ2 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear [3] $f_{AV}$ | | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | | Concrete thickness factor in shear [4] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | in. | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 1-1/2 | 2 | 2-1/2 | 3-1/4 |
| | (mm) | (38) | (51) | (64) | (83) | (38) | (51) | (64) | (83) | (38) | (51) | (64) | (83) | (38) | (51) | (64) | (83) | (38) | (51) | (64) | (83) | (38) | (51) | (64) | (83) |
| Nominal Embedment $h_{nom}$ | in. | 2 | 2-1/2 | 3 | 3-3/4 | 2 | 2-1/2 | 3 | 3-3/4 | 2 | 2-1/2 | 3 | 3-3/4 | 2 | 2-1/2 | 3 | 3-3/4 | 2 | 2-1/2 | 3 | 3-3/4 | 2 | 2-1/2 | 3 | 3-3/4 |
| | (mm) | (51) | (64) | (76) | (95) | (51) | (64) | (76) | (95) | (51) | (64) | (76) | (95) | (51) | (64) | (76) | (95) | (51) | (64) | (76) | (95) | (51) | (64) | (76) | (95) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | (51) | n/a | n/a | n/a | 0.60 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 0.53 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 2-1/4 | (57) | n/a | n/a | n/a | 0.62 | n/a | n/a | n/a | 0.30 | n/a | n/a | n/a | 0.54 | n/a | n/a | n/a | 0.11 | n/a | n/a | n/a | 0.21 | n/a | n/a | n/a | n/a |
| 2-3/4 | (70) | n/a | n/a | n/a | 0.64 | n/a | 0.51 | 0.44 | 0.33 | n/a | n/a | n/a | 0.55 | n/a | 0.35 | 0.23 | 0.14 | n/a | 0.51 | 0.44 | 0.29 | n/a | n/a | n/a | n/a |
| 3 | (76) | n/a | n/a | 0.70 | 0.65 | n/a | 0.55 | 0.47 | 0.35 | n/a | n/a | 0.57 | 0.55 | n/a | 0.40 | 0.26 | 0.16 | n/a | 0.55 | 0.47 | 0.33 | n/a | n/a | n/a | n/a |
| 3-1/4 | (83) | n/a | n/a | 0.72 | 0.67 | n/a | 0.59 | 0.50 | 0.37 | n/a | n/a | 0.57 | 0.55 | n/a | 0.45 | 0.30 | 0.19 | n/a | 0.59 | 0.50 | 0.37 | 0.52 | n/a | n/a | n/a |
| 3-1/2 | (89) | n/a | 0.79 | 0.73 | 0.68 | n/a | 0.64 | 0.53 | 0.38 | n/a | 0.61 | 0.58 | 0.56 | n/a | 0.51 | 0.33 | 0.21 | n/a | 0.64 | 0.53 | 0.38 | 0.54 | n/a | n/a | n/a |
| 4 | (102) | n/a | 0.83 | 0.77 | 0.71 | n/a | 0.73 | 0.59 | 0.42 | n/a | 0.62 | 0.59 | 0.57 | n/a | 0.62 | 0.40 | 0.25 | n/a | 0.73 | 0.59 | 0.42 | 0.58 | 0.70 | n/a | n/a |
| 4-3/4 | (121) | n/a | 0.90 | 0.82 | 0.74 | n/a | 0.86 | 0.70 | 0.48 | n/a | 0.64 | 0.61 | 0.58 | n/a | 0.80 | 0.52 | 0.33 | n/a | 0.86 | 0.70 | 0.48 | 0.63 | 0.76 | n/a | n/a |
| 5 | (127) | n/a | 0.92 | 0.83 | 0.76 | n/a | 0.91 | 0.74 | 0.50 | n/a | 0.65 | 0.61 | 0.58 | n/a | 0.87 | 0.56 | 0.35 | n/a | 0.91 | 0.74 | 0.50 | 0.65 | 0.78 | 0.67 | n/a |
| 5-1/4 | (133) | n/a | 0.94 | 0.85 | 0.77 | n/a | 0.95 | 0.78 | 0.53 | n/a | 0.66 | 0.62 | 0.59 | n/a | 0.93 | 0.61 | 0.38 | n/a | 0.95 | 0.78 | 0.53 | 0.66 | 0.80 | 0.69 | n/a |
| 5-1/2 | (140) | n/a | 0.96 | 0.87 | 0.78 | n/a | 1.00 | 0.81 | 0.55 | n/a | 0.67 | 0.63 | 0.59 | n/a | 1.00 | 0.65 | 0.41 | n/a | 1.00 | 0.81 | 0.55 | 0.68 | 0.82 | 0.71 | 0.61 |
| 6 | (152) | n/a | 1.00 | 0.90 | 0.81 | n/a | 1.00 | 0.89 | 0.60 | n/a | 0.68 | 0.64 | 0.60 | n/a | 1.00 | 0.74 | 0.46 | n/a | 1.00 | 0.89 | 0.60 | 0.71 | 0.85 | 0.74 | 0.63 |
| 8 | (203) | n/a | | 1.00 | 0.91 | 1.00 | 1.00 | 1.00 | 0.80 | n/a | 0.74 | 0.68 | 0.63 | 1.00 | 1.00 | 1.00 | 0.72 | 1.00 | 1.00 | 1.00 | 0.80 | 0.82 | 0.98 | 0.85 | 0.73 |
| 9-3/4 | (248) | n/a | | 1.00 | 1.00 | | 1.00 | | 0.98 | n/a | 0.80 | 0.72 | 0.66 | | 1.00 | | 0.96 | | 1.00 | | 0.98 | 0.90 | 1.00 | 0.94 | 0.81 |
| 10 | (254) | n/a | | | | | 1.00 | | 1.00 | n/a | 0.80 | 0.73 | 0.67 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | 0.91 | | 0.95 | 0.82 |
| 12 | (305) | 1.00 | | | | | | | | 0.75 | 0.86 | 0.77 | 0.70 | | | | | | | | | 1.00 | | 1.00 | 0.89 |
| 24 | (610) | | | | | | | | | 1.00 | 1.00 | 1.00 | 0.90 | | | | | | | | | | | | 1.00 |
| > 30 | (762) | | | | | | | | | | | | 1.00 | | | | | | | | | | | | |

## Table 11 — Load adjustment factors for Carbon Steel 1/2-in. diameter KB-TZ2 in cracked concrete [1,2]

| 1/2-in. KB-TZ2 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear [3] $f_{AV}$ | | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | | Concrete thickness factor in shear [4] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | in. | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 1-1/2 | 2 | 2-1/2 | 3-1/4 |
| | (mm) | (38) | (51) | (64) | (83) | (38) | (51) | (64) | (83) | (38) | (51) | (64) | (83) | (38) | (51) | (64) | (83) | (38) | (51) | (64) | (83) | (38) | (51) | (64) | (83) |
| Nominal Embedment $h_{nom}$ | in. | 2 | 2-1/2 | 3 | 3-3/4 | 2 | 2-1/2 | 3 | 3-3/4 | 2 | 2-1/2 | 3 | 3-3/4 | 2 | 2-1/2 | 3 | 3-3/4 | 2 | 2-1/2 | 3 | 3-3/4 | 2 | 2-1/2 | 3 | 3-3/4 |
| | (mm) | (51) | (64) | (76) | (95) | (51) | (64) | (76) | (95) | (51) | (64) | (76) | (95) | (51) | (64) | (76) | (95) | (51) | (64) | (76) | (95) | (51) | (64) | (76) | (95) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | (51) | n/a | n/a | n/a | 0.60 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 0.54 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 2-1/4 | (57) | n/a | n/a | n/a | 0.62 | n/a | n/a | n/a | 0.61 | n/a | n/a | n/a | 0.54 | n/a | n/a | n/a | 0.12 | n/a | n/a | n/a | 0.24 | n/a | n/a | n/a | n/a |
| 2-3/4 | (70) | n/a | n/a | n/a | 0.64 | n/a | 0.93 | 0.80 | 0.68 | n/a | n/a | n/a | 0.55 | n/a | 0.50 | 0.19 | 0.16 | n/a | 0.93 | 0.38 | 0.33 | n/a | n/a | n/a | n/a |
| 3 | (76) | n/a | n/a | 0.70 | 0.65 | n/a | 1.00 | 0.85 | 0.71 | n/a | n/a | 0.56 | 0.55 | n/a | 0.57 | 0.21 | 0.19 | n/a | 1.00 | 0.43 | 0.38 | n/a | n/a | n/a | n/a |
| 3-1/4 | (83) | n/a | n/a | 0.72 | 0.67 | n/a | 1.00 | 0.90 | 0.75 | n/a | n/a | 0.56 | 0.56 | n/a | 0.64 | 0.24 | 0.21 | n/a | 1.00 | 0.48 | 0.42 | 0.76 | n/a | n/a | n/a |
| 3-1/2 | (89) | n/a | 0.79 | 0.73 | 0.68 | n/a | 1.00 | 0.95 | 0.79 | n/a | 0.63 | 0.57 | 0.56 | n/a | 0.72 | 0.27 | 0.24 | n/a | 1.00 | 0.54 | 0.47 | 0.79 | n/a | n/a | n/a |
| 4 | (102) | n/a | 0.83 | 0.77 | 0.71 | n/a | 1.00 | 1.00 | 0.86 | n/a | 0.65 | 0.58 | 0.57 | n/a | 0.88 | 0.33 | 0.29 | n/a | 1.00 | 0.66 | 0.58 | 0.85 | 0.78 | n/a | n/a |
| 4-3/4 | (121) | n/a | 0.90 | 0.82 | 0.74 | n/a | 1.00 | 1.00 | 0.98 | n/a | 0.68 | 0.59 | 0.59 | n/a | 1.00 | 0.43 | 0.37 | n/a | 1.00 | 0.85 | 0.75 | 0.92 | 0.85 | n/a | n/a |
| 5 | (127) | n/a | 0.92 | 0.83 | 0.76 | n/a | 1.00 | 1.00 | 1.00 | n/a | 0.69 | 0.60 | 0.59 | n/a | 1.00 | 0.46 | 0.40 | n/a | 1.00 | 0.92 | 0.81 | 0.95 | 0.87 | 0.63 | n/a |
| 5-1/4 | (133) | n/a | 0.94 | 0.85 | 0.77 | n/a | 1.00 | 1.00 | | n/a | 0.70 | 0.60 | 0.60 | n/a | 1.00 | 0.49 | 0.43 | n/a | 1.00 | 0.99 | 0.87 | 0.97 | 0.90 | 0.65 | n/a |
| 5-1/2 | (140) | n/a | 0.96 | 0.87 | 0.78 | n/a | 1.00 | 1.00 | | n/a | 0.71 | 0.61 | 0.60 | n/a | 1.00 | 0.53 | 0.47 | n/a | 1.00 | 1.00 | 0.93 | 0.99 | 0.92 | 0.66 | 0.63 |
| 6 | (152) | n/a | 1.00 | 0.90 | 0.81 | n/a | 1.00 | 1.00 | | n/a | 0.73 | 0.62 | 0.61 | n/a | 1.00 | 0.60 | 0.53 | n/a | 1.00 | 1.00 | 1.00 | 1.00 | 0.96 | 0.69 | 0.66 |
| 8 | (203) | n/a | | 1.00 | 0.91 | 1.00 | 1.00 | 1.00 | | n/a | 0.81 | 0.66 | 0.65 | 1.00 | 1.00 | 0.93 | 0.82 | 1.00 | 1.00 | 1.00 | | | 1.00 | 0.80 | 0.76 |
| 9-3/4 | (248) | n/a | | 1.00 | 1.00 | | 1.00 | | | n/a | 0.87 | 0.69 | 0.68 | | 1.00 | 1.00 | 1.00 | | 1.00 | | | | | 0.88 | 0.84 |
| 10 | (254) | n/a | | | | | 1.00 | | | n/a | 0.88 | 0.70 | 0.68 | | 1.00 | | | | 1.00 | | | | | 0.89 | 0.85 |
| 12 | (305) | 1.00 | | | | | | | | 1.00 | 0.96 | 0.74 | 0.72 | | | | | | | | | | | 0.98 | 0.94 |
| 24 | (610) | | | | | | | | | | 1.00 | 0.98 | 0.94 | | | | | | | | | | | 1.00 | 1.00 |
| > 30 | (762) | | | | | | | | | | | 1.00 | 1.00 | | | | | | | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 12 — Load adjustment factors for Carbon Steel 5/8-in. diameter KB-TZ2 in uncracked concrete [1,2]

| 5/8-in. KB-TZ2 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 |
| | | (mm) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) |
| Nominal Embedment $h_{nom}$ | | in. | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 |
| | | (mm) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2-1/4 | (57) | n/a | 0.62 | n/a | n/a | n/a | 0.38 | n/a | 0.53 | n/a | n/a | n/a | 0.10 | n/a | n/a | 0.20 | n/a | n/a | n/a |
| | 2-3/4 | (70) | n/a | 0.64 | 0.61 | n/a | n/a | 0.42 | n/a | 0.54 | 0.54 | n/a | n/a | 0.13 | n/a | n/a | 0.27 | n/a | n/a | n/a |
| | 3 | (76) | n/a | 0.65 | 0.63 | n/a | 0.30 | 0.44 | n/a | 0.54 | 0.55 | n/a | 0.13 | 0.15 | n/a | 0.27 | 0.30 | n/a | n/a | n/a |
| | 3-1/2 | (89) | n/a | 0.68 | 0.65 | n/a | 0.33 | 0.48 | n/a | 0.55 | 0.56 | n/a | 0.17 | 0.19 | n/a | 0.33 | 0.38 | n/a | n/a | n/a |
| | 4 | (102) | 0.74 | 0.71 | 0.67 | 0.40 | 0.37 | 0.51 | 0.57 | 0.56 | 0.56 | 0.25 | 0.21 | 0.23 | 0.40 | 0.37 | 0.47 | n/a | n/a | n/a |
| | 4-1/2 | (114) | 0.77 | 0.73 | 0.69 | 0.45 | 0.40 | 0.56 | 0.58 | 0.57 | 0.57 | 0.30 | 0.24 | 0.28 | 0.45 | 0.40 | 0.56 | n/a | n/a | n/a |
| | 5 | (127) | 0.80 | 0.76 | 0.71 | 0.50 | 0.43 | 0.60 | 0.58 | 0.57 | 0.58 | 0.35 | 0.29 | 0.33 | 0.50 | 0.43 | 0.60 | 0.58 | n/a | n/a |
| | 5-1/2 | (140) | 0.83 | 0.78 | 0.73 | 0.55 | 0.48 | 0.64 | 0.59 | 0.58 | 0.59 | 0.41 | 0.33 | 0.38 | 0.55 | 0.48 | 0.64 | 0.61 | 0.56 | n/a |
| | 6 | (152) | 0.86 | 0.81 | 0.75 | 0.60 | 0.52 | 0.69 | 0.60 | 0.59 | 0.59 | 0.46 | 0.38 | 0.43 | 0.60 | 0.52 | 0.69 | 0.63 | 0.59 | 0.62 |
| | 6-1/2 | (165) | 0.89 | 0.83 | 0.77 | 0.65 | 0.57 | 0.74 | 0.61 | 0.59 | 0.60 | 0.52 | 0.42 | 0.48 | 0.65 | 0.57 | 0.74 | 0.66 | 0.61 | 0.64 |
| | 7 | (178) | 0.92 | 0.86 | 0.79 | 0.70 | 0.61 | 0.80 | 0.62 | 0.60 | 0.61 | 0.59 | 0.47 | 0.54 | 0.70 | 0.61 | 0.80 | 0.68 | 0.64 | 0.67 |
| | 7-1/4 | (184) | 0.94 | 0.87 | 0.80 | 0.73 | 0.63 | 0.83 | 0.62 | 0.61 | 0.61 | 0.62 | 0.50 | 0.57 | 0.73 | 0.63 | 0.83 | 0.70 | 0.65 | 0.68 |
| | 12 | (305) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.70 | 0.67 | 0.69 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.89 | 0.83 | 0.87 |
| | 24 | (610) | | | | | | | 0.90 | 0.85 | 0.88 | | | | | | | 1.00 | 1.00 | 1.00 |
| | > 36 | (914) | | | | | | | 1.00 | 1.00 | 1.00 | | | | | | | | | |

## Table 13 — Load adjustment factors for Carbon Steel 5/8-in. diameter KB-TZ2 in cracked concrete [1,2]

| 5/8-in. KB-TZ2 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 |
| | | (mm) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) |
| Nominal Embedment $h_{nom}$ | | in. | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 |
| | | (mm) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2-1/4 | (57) | n/a | 0.62 | n/a | n/a | n/a | 0.56 | n/a | 0.54 | n/a | n/a | n/a | 0.10 | n/a | n/a | 0.20 | n/a | n/a | n/a |
| | 2-3/4 | (70) | n/a | 0.64 | 0.61 | n/a | n/a | 0.61 | n/a | 0.55 | 0.54 | n/a | n/a | 0.13 | n/a | n/a | 0.27 | n/a | n/a | n/a |
| | 3 | (76) | n/a | 0.65 | 0.63 | n/a | 0.71 | 0.64 | n/a | 0.55 | 0.55 | n/a | 0.16 | 0.15 | n/a | 0.32 | 0.31 | n/a | n/a | n/a |
| | 3-1/2 | (89) | n/a | 0.68 | 0.65 | n/a | 0.79 | 0.69 | n/a | 0.56 | 0.56 | n/a | 0.20 | 0.19 | n/a | 0.41 | 0.39 | n/a | n/a | n/a |
| | 4 | (102) | 0.74 | 0.71 | 0.67 | 0.98 | 0.86 | 0.75 | 0.58 | 0.57 | 0.56 | 0.31 | 0.25 | 0.24 | 0.62 | 0.50 | 0.47 | n/a | n/a | n/a |
| | 4-1/2 | (114) | 0.77 | 0.73 | 0.69 | 1.00 | 0.94 | 0.81 | 0.59 | 0.57 | 0.57 | 0.37 | 0.30 | 0.28 | 0.74 | 0.60 | 0.56 | n/a | n/a | n/a |
| | 5 | (127) | 0.80 | 0.76 | 0.71 | 1.00 | 1.00 | 0.87 | 0.60 | 0.58 | 0.58 | 0.43 | 0.35 | 0.33 | 0.87 | 0.70 | 0.66 | 0.62 | n/a | n/a |
| | 5-1/2 | (140) | 0.83 | 0.78 | 0.73 | 1.00 | 1.00 | 0.93 | 0.61 | 0.59 | 0.59 | 0.50 | 0.40 | 0.38 | 1.00 | 0.81 | 0.76 | 0.65 | 0.60 | n/a |
| | 6 | (152) | 0.86 | 0.81 | 0.75 | | 1.00 | 1.00 | 0.61 | 0.60 | 0.60 | 0.57 | 0.46 | 0.43 | | 0.92 | 0.87 | 0.68 | 0.63 | 0.62 |
| | 6-1/2 | (165) | 0.89 | 0.83 | 0.77 | | 1.00 | | 0.62 | 0.61 | 0.60 | 0.64 | 0.52 | 0.49 | | 1.00 | 0.98 | 0.71 | 0.66 | 0.64 |
| | 7 | (178) | 0.92 | 0.86 | 0.79 | | 1.00 | | 0.63 | 0.62 | 0.61 | 0.72 | 0.58 | 0.55 | | 1.00 | 1.00 | 0.73 | 0.68 | 0.67 |
| | 7-1/4 | (184) | 0.94 | 0.87 | 0.80 | | | | 0.64 | 0.62 | 0.62 | 0.76 | 0.61 | 0.58 | | | | 0.74 | 0.69 | 0.68 |
| | 12 | (305) | 1.00 | 1.00 | 1.00 | | | | 0.73 | 0.70 | 0.69 | 1.00 | 1.00 | 1.00 | | | | 0.96 | 0.89 | 0.87 |
| | 24 | (610) | | | | | | | 0.96 | 0.90 | 0.88 | | | | | | | 1.00 | 1.00 | 1.00 |
| | > 36 | (914) | | | | | | | 1.00 | 1.00 | 1.00 | | | | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 14 — Load adjustment factors for Carbon Steel 3/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

| 3/4-in. KB-TZ2 uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | in. | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 |
| | (mm) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) |
| Nominal Embedment $h_{nom}$ | in. | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 |
| | (mm) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | | | | | | | | | | | | | | | | | | | |
| 3-1/2 | (89) | n/a | n/a | n/a | n/a | n/a | 0.50 | n/a | n/a | n/a | n/a | n/a | 0.16 | n/a | n/a | 0.32 | n/a | n/a | n/a |
| 3-3/4 | (95) | n/a | 0.67 | 0.63 | n/a | n/a | 0.52 | n/a | 0.56 | 0.55 | n/a | n/a | 0.18 | n/a | n/a | 0.36 | n/a | n/a | n/a |
| 4 | (102) | n/a | 0.68 | 0.64 | n/a | 0.44 | 0.54 | n/a | 0.56 | 0.56 | n/a | 0.24 | 0.20 | n/a | 0.44 | 0.40 | n/a | n/a | n/a |
| 4-1/2 | (114) | 0.73 | 0.70 | 0.66 | n/a | 0.48 | 0.57 | 0.56 | 0.57 | 0.56 | n/a | 0.29 | 0.24 | n/a | 0.48 | 0.47 | n/a | n/a | n/a |
| 4-3/4 | (121) | 0.74 | 0.71 | 0.67 | n/a | 0.49 | 0.59 | 0.57 | 0.58 | 0.57 | n/a | 0.31 | 0.26 | n/a | 0.49 | 0.51 | n/a | n/a | n/a |
| 5 | (127) | 0.76 | 0.72 | 0.68 | 0.42 | 0.51 | 0.61 | 0.57 | 0.58 | 0.57 | 0.27 | 0.33 | 0.28 | 0.42 | 0.51 | 0.55 | n/a | n/a | n/a |
| 5-1/2 | (140) | 0.78 | 0.74 | 0.69 | 0.46 | 0.55 | 0.65 | 0.58 | 0.59 | 0.58 | 0.31 | 0.39 | 0.32 | 0.46 | 0.55 | 0.64 | 0.55 | n/a | n/a |
| 5-3/4 | (146) | 0.79 | 0.76 | 0.70 | 0.48 | 0.58 | 0.67 | 0.58 | 0.59 | 0.58 | 0.33 | 0.41 | 0.34 | 0.48 | 0.58 | 0.67 | 0.57 | n/a | n/a |
| 6 | (152) | 0.81 | 0.77 | 0.71 | 0.50 | 0.60 | 0.69 | 0.58 | 0.60 | 0.58 | 0.35 | 0.44 | 0.36 | 0.50 | 0.60 | 0.69 | 0.58 | 0.62 | n/a |
| 7 | (178) | 0.86 | 0.81 | 0.75 | 0.58 | 0.70 | 0.78 | 0.60 | 0.61 | 0.60 | 0.45 | 0.55 | 0.46 | 0.58 | 0.70 | 0.78 | 0.62 | 0.67 | n/a |
| 7-1/4 | (184) | 0.87 | 0.82 | 0.75 | 0.60 | 0.73 | 0.81 | 0.60 | 0.62 | 0.60 | 0.47 | 0.58 | 0.48 | 0.60 | 0.73 | 0.81 | 0.63 | 0.68 | n/a |
| 8 | (203) | 0.91 | 0.86 | 0.78 | 0.67 | 0.80 | 0.89 | 0.61 | 0.63 | 0.61 | 0.54 | 0.68 | 0.56 | 0.67 | 0.80 | 0.89 | 0.67 | 0.72 | 0.67 |
| 9 | (229) | 0.96 | 0.90 | 0.82 | 0.75 | 0.90 | 1.00 | 0.63 | 0.64 | 0.63 | 0.65 | 0.81 | 0.67 | 0.75 | 0.90 | 1.00 | 0.71 | 0.76 | 0.71 |
| 10 | (254) | 1.00 | 0.94 | 0.85 | 0.83 | 1.00 | | 0.64 | 0.66 | 0.64 | 0.76 | 0.94 | 0.78 | 0.83 | 1.00 | | 0.75 | 0.80 | 0.75 |
| 11 | (279) | | 0.99 | 0.89 | 0.92 | | | 0.65 | 0.68 | 0.66 | 0.88 | 1.00 | 0.90 | 0.92 | | | 0.78 | 0.84 | 0.79 |
| 12 | (305) | | 1.00 | 0.92 | 1.00 | | | 0.67 | 0.69 | 0.67 | 1.00 | | 1.00 | 1.00 | | | 0.82 | 0.88 | 0.82 |
| 16 | (406) | | | 1.00 | | | | 0.72 | 0.76 | 0.73 | | | | | | | 0.94 | 1.00 | 0.95 |
| 18 | (457) | | | | | | | 0.75 | 0.79 | 0.75 | | | | | | | 1.00 | | 1.00 |
| 24 | (610) | | | | | | | 0.83 | 0.89 | 0.84 | | | | | | | | | |
| > 36 | (914) | | | | | | | 1.00 | 1.00 | 1.00 | | | | | | | | | |

## Table 15 — Load adjustment factors for Carbon Steel 3/4-in. diameter KB-TZ2 in cracked concrete [1,2]

| 3/4-in. KB-TZ2 cracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | in. | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 |
| | (mm) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) |
| Nominal Embedment $h_{nom}$ | in. | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 |
| | (mm) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | | | | | | | | | | | | | | | | | | | |
| 3-1/2 | (89) | n/a | n/a | n/a | n/a | n/a | 0.63 | n/a | n/a | n/a | n/a | n/a | 0.13 | n/a | n/a | 0.26 | n/a | n/a | n/a |
| 3-3/4 | (95) | n/a | 0.67 | 0.63 | n/a | n/a | 0.65 | n/a | 0.56 | 0.55 | n/a | n/a | 0.15 | n/a | n/a | 0.29 | n/a | n/a | n/a |
| 4 | (102) | n/a | 0.68 | 0.64 | n/a | 0.78 | 0.68 | n/a | 0.56 | 0.55 | n/a | 0.22 | 0.16 | n/a | 0.44 | 0.32 | n/a | n/a | n/a |
| 4-1/2 | (114) | 0.73 | 0.70 | 0.66 | n/a | 0.85 | 0.73 | 0.58 | 0.57 | 0.56 | n/a | 0.26 | 0.19 | n/a | 0.52 | 0.39 | n/a | n/a | n/a |
| 4-3/4 | (121) | 0.74 | 0.71 | 0.67 | n/a | 0.88 | 0.75 | 0.58 | 0.57 | 0.56 | n/a | 0.28 | 0.21 | n/a | 0.57 | 0.42 | n/a | n/a | n/a |
| 5 | (127) | 0.76 | 0.72 | 0.68 | 1.00 | 0.91 | 0.77 | 0.59 | 0.58 | 0.56 | 0.37 | 0.31 | 0.23 | 0.74 | 0.61 | 0.45 | n/a | n/a | n/a |
| 5-1/2 | (140) | 0.78 | 0.74 | 0.69 | 1.00 | 0.98 | 0.83 | 0.59 | 0.58 | 0.57 | 0.43 | 0.35 | 0.26 | 0.85 | 0.71 | 0.52 | 0.61 | n/a | n/a |
| 5-3/4 | (146) | 0.79 | 0.76 | 0.70 | 1.00 | 1.00 | 0.85 | 0.60 | 0.59 | 0.57 | 0.46 | 0.38 | 0.28 | 0.91 | 0.76 | 0.56 | 0.63 | n/a | n/a |
| 6 | (152) | 0.81 | 0.77 | 0.71 | 1.00 | 1.00 | 0.88 | 0.60 | 0.59 | 0.57 | 0.49 | 0.40 | 0.30 | 0.97 | 0.81 | 0.59 | 0.64 | 0.60 | n/a |
| 7 | (178) | 0.86 | 0.81 | 0.75 | | 1.00 | 0.99 | 0.62 | 0.61 | 0.59 | 0.61 | 0.51 | 0.37 | 1.00 | 1.00 | 0.75 | 0.69 | 0.65 | n/a |
| 7-1/4 | (184) | 0.87 | 0.82 | 0.75 | | | 1.00 | 0.62 | 0.61 | 0.59 | 0.64 | 0.54 | 0.39 | 1.00 | 1.00 | 0.79 | 0.71 | 0.66 | n/a |
| 8 | (203) | 0.91 | 0.86 | 0.78 | | | | 0.64 | 0.62 | 0.60 | 0.75 | 0.62 | 0.46 | | | 0.91 | 0.74 | 0.70 | 0.63 |
| 9 | (229) | 0.96 | 0.90 | 0.82 | | | | 0.65 | 0.64 | 0.61 | 0.89 | 0.74 | 0.54 | | | 1.00 | 0.79 | 0.74 | 0.67 |
| 10 | (254) | 1.00 | 0.94 | 0.85 | | | | 0.67 | 0.65 | 0.62 | 1.00 | 0.87 | 0.64 | | | | 0.83 | 0.78 | 0.70 |
| 11 | (279) | | 0.99 | 0.89 | | | | 0.69 | 0.67 | 0.64 | | 1.00 | 0.74 | | | | 0.87 | 0.82 | 0.74 |
| 12 | (305) | | 1.00 | 0.92 | | | | 0.71 | 0.68 | 0.65 | | | 0.84 | | | | 0.91 | 0.85 | 0.77 |
| 16 | (406) | | | 1.00 | | | | 0.77 | 0.74 | 0.70 | | | 1.00 | | | | 1.00 | 0.98 | 0.89 |
| 18 | (457) | | | | | | | 0.81 | 0.77 | 0.72 | | | | | | | | 1.00 | 0.94 |
| 24 | (610) | | | | | | | 0.91 | 0.86 | 0.80 | | | | | | | | | 1.00 |
| > 36 | (914) | | | | | | | 1.00 | 1.00 | 0.94 | | | | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 16 — Load adjustment factors for Carbon Steel 1-in. diameter KB-TZ2 in uncracked concrete [1,2]

| 1-in. KB-TZ2 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear | | | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | ∥ To edge $f_{RV}$ | | | |
| Effective Embedment $h_{ef}$ | | in. | 4 | 5-3/4 | 4 | 5-3/4 | 4 | 5-3/4 | 4 | 5-3/4 | 4 | 5-3/4 | 4 | 5-3/4 |
| | | (mm) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) |
| Nominal Embedment $h_{nom}$ | | in. | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 |
| | | (mm) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 3 | (76) | n/a | n/a | n/a | 0.292 | n/a | n/a | n/a | 0.081 | n/a | 0.162 | n/a | n/a |
| | 3-3/4 | (95) | n/a | n/a | n/a | 0.321 | n/a | n/a | n/a | 0.113 | n/a | 0.227 | n/a | n/a |
| | 4 | (102) | n/a | n/a | n/a | 0.331 | n/a | n/a | n/a | 0.125 | n/a | 0.250 | n/a | n/a |
| | 4-1/4 | (108) | n/a | n/a | n/a | 0.341 | n/a | n/a | n/a | 0.137 | n/a | 0.274 | n/a | n/a |
| | 4-3/4 | (121) | n/a | 0.638 | n/a | 0.362 | n/a | 0.549 | n/a | 0.162 | n/a | 0.324 | n/a | n/a |
| | 5 | (127) | n/a | 0.645 | n/a | 0.372 | n/a | 0.552 | n/a | 0.175 | n/a | 0.349 | n/a | n/a |
| | 6 | (152) | n/a | 0.674 | n/a | 0.415 | n/a | 0.563 | n/a | 0.230 | n/a | 0.415 | n/a | n/a |
| | 6-3/4 | (171) | n/a | 0.696 | n/a | 0.449 | n/a | 0.570 | n/a | 0.274 | n/a | 0.449 | n/a | n/a |
| | 8 | (203) | 0.833 | 0.732 | 0.727 | 0.508 | 0.621 | 0.583 | 0.620 | 0.354 | 0.727 | 0.508 | 0.696 | n/a |
| | 10 | (254) | 0.917 | 0.790 | 0.909 | 0.625 | 0.652 | 0.604 | 0.867 | 0.494 | 0.909 | 0.625 | 0.778 | 0.645 |
| | 12 | (305) | 1.000 | 0.848 | 1.000 | 0.750 | 0.682 | 0.625 | 1.000 | 0.650 | 1.000 | 0.750 | 0.853 | 0.707 |
| | 18 | (457) | | 1.000 | | 1.000 | 0.773 | 0.688 | | 1.000 | | 1.000 | 1.000 | 0.866 |
| | 24 | (610) | | | | | 0.864 | 0.750 | | | | | | 1.000 |
| | 36 | (914) | | | | | 1.000 | 0.875 | | | | | | |
| | > 48 | (1219) | | | | | | 1.000 | | | | | | |

## Table 17 — Load adjustment factors for Carbon Steel 1-in. diameter KB-TZ2 in cracked concrete [1,2]

| 1-in. KB-TZ2 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear | | | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ Toward edge $f_{RV}$ | | ∥ To edge $f_{RV}$ | | | |
| Effective Embedment $h_{ef}$ | | in. | 4 | 5-3/4 | 4 | 5-3/4 | 4 | 5-3/4 | 4 | 5-3/4 | 4 | 5-3/4 | 4 | 5-3/4 |
| | | (mm) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) |
| Nominal Embedment $h_{nom}$ | | in. | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 |
| | | (mm) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 3 | (76) | n/a | n/a | n/a | 0.542 | n/a | n/a | n/a | 0.081 | n/a | 0.162 | n/a | n/a |
| | 3-3/4 | (95) | n/a | n/a | n/a | 0.596 | n/a | n/a | n/a | 0.113 | n/a | 0.226 | n/a | n/a |
| | 4 | (102) | n/a | n/a | n/a | 0.614 | n/a | n/a | n/a | 0.124 | n/a | 0.249 | n/a | n/a |
| | 4-1/4 | (108) | n/a | n/a | n/a | 0.633 | n/a | n/a | n/a | 0.136 | n/a | 0.272 | n/a | n/a |
| | 4-3/4 | (121) | n/a | 0.638 | n/a | 0.671 | n/a | 0.549 | n/a | 0.161 | n/a | 0.322 | n/a | n/a |
| | 5 | (127) | n/a | 0.645 | n/a | 0.690 | n/a | 0.552 | n/a | 0.174 | n/a | 0.348 | n/a | n/a |
| | 6 | (152) | n/a | 0.674 | n/a | 0.770 | n/a | 0.562 | n/a | 0.228 | n/a | 0.457 | n/a | n/a |
| | 6-3/4 | (171) | n/a | 0.696 | n/a | 0.833 | n/a | 0.570 | n/a | 0.273 | n/a | 0.545 | n/a | n/a |
| | 8 | (203) | 0.833 | 0.732 | 1.000 | 0.943 | 0.619 | 0.583 | 0.606 | 0.352 | 1.000 | 0.703 | 0.691 | n/a |
| | 10 | (254) | 0.917 | 0.790 | | 1.000 | 0.649 | 0.604 | 0.847 | 0.491 | | 0.983 | 0.773 | 0.644 |
| | 12 | (305) | 1.000 | 0.848 | | | 0.679 | 0.625 | 1.000 | 0.646 | | 1.000 | 0.846 | 0.706 |
| | 18 | (457) | | 1.000 | | | 0.769 | 0.687 | | 1.000 | | | 1.000 | 0.864 |
| | 24 | (610) | | | | | 0.858 | 0.749 | | | | | | 0.998 |
| | 36 | (914) | | | | | 1.000 | 0.874 | | | | | | 1.000 |
| | > 48 | (1219) | | | | | | 0.998 | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 18 — Hilti Stainless Steel KB-TZ2 design strength based on concrete failure modes in uncracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension (lesser of concrete breakout / pullout) - $\Phi N_n$ | | | | Shear (lesser of concrete breakout or pryout) - $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 1/4 | 1-1/2 (38) | 1 3/4 (44) | 705 (3.1) | 760 (3.4) | 850 (3.8) | 995 (4.4) | 1,545 (6.9) | 1,690 (7.5) | 1,950 (8.7) | 2,390 (10.6) |
| 3/8 | 1-1/2 (38) | 1 7/8 (48) | 1,435 (6.4) | 1,570 (7.0) | 1,815 (8.1) | 2,220 (9.9) | 1,545 (6.9) | 1,690 (7.5) | 1,950 (8.7) | 2,390 (10.6) |
| | 2 (51) | 2 1/2 (64) | 2,205 (9.8) | 2,415 (10.7) | 2,790 (12.4) | 3,420 (15.2) | 2,375 (10.6) | 2,605 (11.6) | 3,005 (13.4) | 3,680 (16.4) |
| | 2-1/2 (64) | 3 (76) | 2,720 (12.1) | 2,910 (12.9) | 3,235 (14.4) | 3,760 (16.7) | 6,640 (29.5) | 7,275 (32.4) | 8,400 (37.4) | 10,290 (45.8) |
| 1/2 | 2 (51) | 2 1/2 (64) | 2,195 (9.8) | 2,390 (10.6) | 2,725 (12.1) | 3,285 (14.6) | 2,375 (10.6) | 2,605 (11.6) | 3,005 (13.4) | 3,680 (16.4) |
| | 2-1/2 (64) | 3 (76) | 2,605 (11.6) | 2,855 (12.7) | 3,295 (14.7) | 4,040 (18.0) | 6,640 (29.5) | 7,275 (32.4) | 8,400 (37.4) | 10,290 (45.8) |
| | 3-1/4 (83) | 3 3/4 (95) | 3,575 (15.9) | 3,915 (17.4) | 4,520 (20.1) | 5,540 (24.6) | 9,845 (43.8) | 10,785 (48.0) | 12,450 (55.4) | 15,250 (67.8) |
| 5/8 | 2-3/4 (70) | 3 1/4 (83) | 2,655 (11.8) | 2,910 (12.9) | 3,360 (14.9) | 4,115 (18.3) | 7,660 (34.1) | 8,395 (37.3) | 9,690 (43.1) | 11,870 (52.8) |
| | 3-1/4 (83) | 3 3/4 (95) | 3,910 (17.4) | 4,220 (18.8) | 4,765 (21.2) | 5,645 (25.1) | 9,845 (43.8) | 10,785 (48.0) | 12,450 (55.4) | 15,250 (67.8) |
| | 4 (102) | 4 1/2 (114) | 5,235 (23.3) | 5,700 (25.4) | 6,525 (29.0) | 7,895 (35.1) | 13,440 (59.8) | 14,725 (65.5) | 17,000 (75.6) | 20,820 (92.6) |
| 3/4 | 3-1/4 (83) | 4 (102) | 4,570 (20.3) | 5,005 (22.3) | 5,780 (25.7) | 7,080 (31.5) | 9,845 (43.8) | 10,785 (48.0) | 12,450 (55.4) | 15,250 (67.8) |
| | 3-3/4[6] (95) | 4 1/2 (114) | 6,370 (28.3) | 6,980 (31.0) | 8,060 (35.9) | 9,870 (43.9) | 13,725 (61.1) | 15,035 (66.9) | 17,360 (77.2) | 21,265 (94.6) |
| | 4-3/4 (121) | 5 1/2 (140) | 8,075 (35.9) | 8,845 (39.3) | 10,215 (45.4) | 12,510 (55.6) | 17,390 (77.4) | 19,050 (84.7) | 22,000 (97.9) | 26,945 (119.9) |
| 1 | 4 (102) | 4 5/8 (117) | 7,020 (31.2) | 7,690 (34.2) | 8,880 (39.5) | 10,875 (48.4) | 15,120 (67.3) | 16,565 (73.7) | 19,125 (85.1) | 23,425 (104.2) |
| | 5-3/4 (146) | 6 3/8 (162) | 12,100 (53.8) | 13,255 (59.0) | 15,305 (68.1) | 18,745 (83.4) | 26,060 (115.9) | 28,545 (127.0) | 32,965 (146.6) | 40,370 (179.6) |

## Table 19 — Hilti Stainless Steel KB-TZ2 design strength based on concrete failure modes in cracked concrete per ACI 318 Ch. 17, applicable for both hammer and core drilled installations [1,2,3,4,5]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension (lesser of concrete breakout / pullout) - $\Phi N_n$ | | | | Shear (lesser of concrete breakout or pryout) - $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 1/4 | 1-1/2 (38) | 1 3/4 (44) | 300 (1.3) | 330 (1.5) | 380 (1.7) | 465 (2.1) | 1,095 (4.9) | 1,195 (5.3) | 1,385 (6.2) | 1,695 (7.5) |
| 3/8 | 1-1/2 (38) | 1 7/8 (48) | 1,255 (5.6) | 1,375 (6.1) | 1,585 (7.1) | 1,940 (8.6) | 1,350 (6.0) | 1,480 (6.6) | 1,710 (7.6) | 2,090 (9.3) |
| | 2 (51) | 2 1/2 (64) | 1,930 (8.6) | 2,115 (9.4) | 2,440 (10.9) | 2,990 (13.3) | 2,080 (9.3) | 2,275 (10.1) | 2,630 (11.7) | 3,220 (14.3) |
| | 2-1/2 (64) | 3 (76) | 2,185 (9.7) | 2,390 (10.6) | 2,765 (12.3) | 3,385 (15.1) | 4,705 (20.9) | 5,155 (22.9) | 5,950 (26.5) | 7,285 (32.4) |
| 1/2 | 2 (51) | 2 1/2 (64) | 1,565 (7.0) | 1,710 (7.6) | 1,975 (8.8) | 2,420 (10.8) | 1,685 (7.5) | 1,845 (8.2) | 2,130 (9.5) | 2,605 (11.6) |
| | 2-1/2 (64) | 3 (76) | 2,700 (12.0) | 2,955 (13.1) | 3,415 (15.2) | 4,180 (18.6) | 5,810 (25.8) | 6,365 (28.3) | 7,350 (32.7) | 9,000 (40.0) |
| | 3-1/4[8] (83) | 3 3/4 (95) | 3,235 (14.4) | 3,545 (15.8) | 4,095 (18.2) | 5,015 (22.3) | 6,970 (31.0) | 7,640 (34.0) | 8,820 (39.2) | 10,800 (48.0) |
| 5/8 | 2-3/4 (70) | 3 1/4 (83) | 3,110 (13.8) | 3,410 (15.2) | 3,935 (17.5) | 4,820 (21.4) | 6,705 (29.8) | 7,345 (32.7) | 8,480 (37.7) | 10,385 (46.2) |
| | 3-1/4 (83) | 3 3/4 (95) | 4,000 (17.8) | 4,380 (19.5) | 5,060 (22.5) | 6,195 (27.6) | 8,615 (38.3) | 9,435 (42.0) | 10,895 (48.5) | 13,345 (59.4) |
| | 4 (102) | 4 1/2 (114) | 4,420 (19.7) | 4,840 (21.5) | 5,590 (24.9) | 6,845 (30.4) | 9,520 (42.3) | 10,430 (46.4) | 12,040 (53.6) | 14,750 (65.6) |
| 3/4 | 3-1/4 (83) | 4 (102) | 4,000 (17.8) | 4,380 (19.5) | 5,060 (22.5) | 6,195 (27.6) | 8,615 (38.3) | 9,435 (42.0) | 10,895 (48.5) | 13,345 (59.4) |
| | 3-3/4[7] (95) | 4 1/2 (114) | 4,955 (22.0) | 5,430 (24.2) | 6,270 (27.9) | 7,680 (34.2) | 10,675 (47.5) | 11,695 (52.0) | 13,505 (60.1) | 16,540 (73.6) |
| | 4-3/4 (121) | 5 1/2 (140) | 5,715 (25.4) | 6,260 (27.8) | 7,230 (32.2) | 8,855 (39.4) | 15,220 (67.7) | 16,670 (74.2) | 19,250 (85.6) | 23,575 (104.9) |
| 1 | 4 (102) | 4 5/8 (117) | 6,240 (27.8) | 6,835 (30.4) | 7,895 (35.1) | 9,665 (43.0) | 13,440 (59.8) | 14,725 (65.5) | 17,000 (75.6) | 20,820 (92.6) |
| | 5-3/4 (146) | 6 3/8 (162) | 9,410 (41.9) | 10,310 (45.9) | 11,905 (53.0) | 14,580 (64.9) | 20,270 (90.2) | 22,205 (98.8) | 25,640 (114.1) | 31,400 (139.7) |

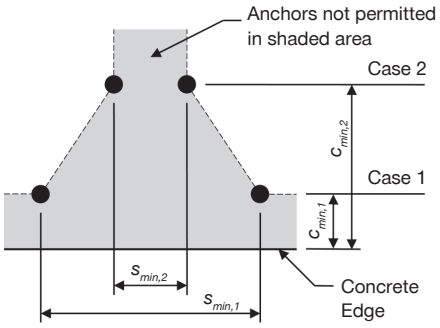
1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 22 to 33 as necessary. Compare to the steel values in Table 20. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75.
No reduction needed for seismic shear, except for the 3/4 bolts where $\alpha_{V,seis}$ = 0.81. See Section 3.1.8 for additional information on seismic applications.
6 For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.89 to the design tension strength.
7 For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.81 to the design tension strength.
8 For core drilled installations of 1/2" anchors installed at 3-1/4 effective embedment, apply a reduction factor of 0.85 to the design tension strength.

## Table 20 — Hilti Stainless Steel KB-TZ2 design strength based on steel failure per ACI 318 Ch. 17 [1,2]

| Nominal anchor diameter in. | Effective embedment depth in. (mm) | | | Tensile [3] $\Phi N_{sa}$ lb (kN) | Shear [4] $\Phi V_{sa}$ lb (kN) | Seismic Shear [5] $\Phi V_{sa}$ lb (kN) |
|---|---|---|---|---|---|---|
| 1/4 | 1-1/2 (38) | | | 2,190 (9.7) | 950 (4.2) | 720 (3.2) |
| 3/8 | 1-1/2 (38) | | | 4,635 (20.6) | 3,000 (13.3) | 3,000 (13.3) |
| 3/8 | 2 (51) | | 2-1/2 (64) | 4,635 (20.6) | 3,175 (14.1) | 3,175 (14.1) |
| 1/2 | 2 (51) | 2-1/2 (64) | 3-1/4 (83) | 8,905 (39.6) | 5,425 (24.1) | 5,425 (24.1) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 4 (102) | 14,125 (62.8) | 8,030 (35.7) | 8,030 (35.7) |
| 3/4 | 3-1/4 (83) | 3-3/4 (95) | 4-3/4 (121) | 18,035 (80.2) | 10,765 (47.9) | 8,755 (38.9) |
| 1 (25.4) | 4 (102) | | | 35,215 (156.6) | 14,920 (66.4) | 8,755 (38.9) |
| 1 (25.4) | 5-3/4 (146) | | | 35,215 (156.6) | 20,410 (90.8) | 8,755 (38.9) |

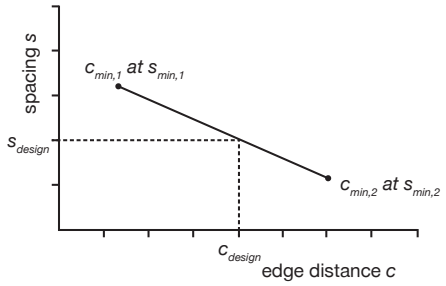
1 See Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KB-TZ2 stainless steel anchors are to be considered ductile steel elements.
3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Ch. 17.
4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17. See Section 3.1.8 for additional information on seismic applications.

## Figure 3




For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$




## Table 21 — Hilti KB-TZ2 stainless steel installation parameters[1]

| Setting information | Symbol | Units | Nominal Anchor diameter (in.) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | 3/8 | | | 1/2 | | | 5/8 | | | 3/4 | | | 1 | |
| Effective embedment | $h_{ef}$ | in. | 1-1/2 | 1-1/2 | 2 | 2-1/2 | 2 | 2-1/2 | 3 1/4 | 2-3/4 | 3-1/4 | 4 | 3-1/4 | 3-3/4 | 4-3/4 | 4 | 5-3/4 |
| | | (mm) | (38) | (38) | (51) | (64) | (51) | (64) | (83) | (70) | (83) | (102) | (83) | (95) | (121) | (102) | (146) |
| Min. member thickness | $h_{min}$ | in. | 3-1/4 | 3-1/4 | 4 | 5 | 4 | 5 | 5-1/2 | 5 | 5-1/2 | 6 | 5-1/2 | 6 | 8 | 8 | 10 |
| | | (mm) | (83) | (83) | (102) | (127) | (102) | (127) | (140) | (127) | (140) | (152) | (140) | (152) | (203) | (203) | (254) |
| Case 1 | $c_{min,1}$ | in. | 1-1/2 | 5 | 2-1/2 | 2-1/2 | 2-3/4 | 2-1/2 | 2-1/4 | 4 | 3-1/4 | 2-1/4 | 5 | 4 | 3 3/4 | 3-3/4 | 3 |
| | | (mm) | (38) | (127) | (64) | (64) | (70) | (64) | (57) | (102) | (83) | (57) | (127) | (102) | (95) | (95) | (76) |
| | for $s_{min,1} \geq$ | in. | 1-1/2 | 8 | 5 | 5 | 5-1/2 | 4-1/2 | 5-1/4 | 7 | 5-1/2 | 7 | 11 | 7-1/2 | 5 3/4 | 10 | 6-3/4 |
| | | (mm) | (38) | (203) | (127) | (127) | (140) | (114) | (133) | (178) | (140) | (178) | (279) | (191) | (146) | (254) | (171) |
| Case 2 | $c_{min,2}$ | in. | 1-1/2 | 8 | 4 | 3-1/2 | 4-1/8 | 4-1/2 | 4-1/2 | 5-1/2 | 4 | 4-1/4 | 8 | 6 | 5-1/4 | 4-1/4 | 3-3/4 |
| | | (mm) | (38) | (203) | (102) | (89) | (105) | (114) | (114) | (140) | (102) | (108) | (203) | (152) | (133) | (108) | (95) |
| | for $s_{min,2} \geq$ | in. | 1-1/2 | 5 | 2-1/4 | 2-1/4 | 2-3/4 | 2-1/2 | 2 | 5-1/2 | 2-3/4 | 3 | 5 | 4 | 4 | 5 | 4-3/4 |
| | | (mm) | (38) | (127) | (57) | (57) | (70) | (64) | (51) | (140) | (70) | (76) | (127) | (102) | (102) | (127) | (121) |

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$, will determine the permissible spacings.

## Table 22 — Load adjustment factors for Stainless Steel 1/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

| 1/4-in. KB-TZ2 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | Edge distance factor in tension $f_{RN}$ | Spacing factor in shear [3] $f_{AV}$ | Edge distance in shear | | Conc. thickness factor in shear [4] $f_{HV}$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | ⊥ Toward edge $f_{RV}$ | ∥ To edge $f_{RV}$ | |
| Effective Embedment $h_{ef}$ | | in. (mm) | 1-1/2 (38) | 1-1/2 (38) | 1-1/2 (38) | 1-1/2 (38) | 1-1/2 (38) | 1-1/2 (38) |
| Nominal Embedment $h_{nom}$ | | in. (mm) | 1-3/4 (44) | 1-3/4 (44) | 1-3/4 (44) | 1-3/4 (44) | 1-3/4 (44) | 1-3/4 (44) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 1-1/2 | (38) | 0.67 | 0.42 | 0.56 | 0.23 | 0.42 | n/a |
| | 2 | (51) | 0.72 | 0.51 | 0.58 | 0.35 | 0.51 | n/a |
| | 2-1/2 | (64) | 0.78 | 0.63 | 0.60 | 0.49 | 0.63 | n/a |
| | 3 | (76) | 0.83 | 0.75 | 0.63 | 0.65 | 0.75 | n/a |
| | 3-1/4 | (83) | 0.86 | 0.81 | 0.64 | 0.73 | 0.81 | 0.74 |
| | 3-1/2 | (89) | 0.89 | 0.88 | 0.65 | 0.82 | 0.88 | 0.76 |
| | 4 | (102) | 0.94 | 1.00 | 0.67 | 1.00 | 1.00 | 0.82 |
| | 5 | (127) | 1.00 | | 0.71 | | | 0.91 |
| | 6 | (152) | | | 0.75 | | | 1.00 |
| | 7 | (178) | | | 0.79 | | | |
| | 8 | (203) | | | 0.83 | | | |
| | 9 | (229) | | | 0.88 | | | |
| | > 12 | (305) | | | 1.00 | | | |

3.3.5

## Table 23 — Load adjustment factors for Stainless Steel 1/4-in. diameter KB-TZ2 in cracked concrete [1,2]

| 1/4-in. KB-TZ2 cracked concrete | | | Spacing factor in tension $f_{AN}$ | Edge distance factor in tension $f_{RN}$ | Spacing factor in shear [3] $f_{AV}$ | Edge distance in shear | | Conc. thickness factor in shear [4] $f_{HV}$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | ⊥ Toward edge $f_{RV}$ | ∥ To edge $f_{RV}$ | |
| Effective Embedment $h_{ef}$ | | in. (mm) | 1-1/2 (38) | 1-1/2 (38) | 1-1/2 (38) | 1-1/2 (38) | 1-1/2 (38) | 1-1/2 (38) |
| Nominal Embedment $h_{nom}$ | | in. (mm) | 1-3/4 (44) | 1-3/4 (44) | 1-3/4 (44) | 1-3/4 (44) | 1-3/4 (44) | 1-3/4 (44) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 1-1/2 | (38) | 0.67 | 0.75 | 0.57 | 0.29 | 0.59 | n/a |
| | 2 | (51) | 0.72 | 0.91 | 0.60 | 0.45 | 0.91 | n/a |
| | 2-1/2 | (64) | 0.78 | 1.00 | 0.62 | 0.63 | 1.00 | n/a |
| | 3 | (76) | 0.83 | | 0.65 | 0.83 | | n/a |
| | 3-1/4 | (83) | 0.86 | | 0.66 | 0.94 | | 0.80 |
| | 3-1/2 | (89) | 0.89 | | 0.67 | 1.00 | | 0.83 |
| | 4 | (102) | 0.94 | | 0.70 | | | 0.89 |
| | 5 | (127) | 1.00 | | 0.75 | | | 0.99 |
| | 6 | (152) | | | 0.80 | | | 1.00 |
| | 7 | (178) | | | 0.84 | | | |
| | 8 | (203) | | | 0.89 | | | |
| | 9 | (229) | | | 0.94 | | | |
| | > 12 | (305) | | | 1.00 | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

## Table 24 — Load adjustment factors for Stainless Steel 3/8-in. diameter KB-TZ2 in uncracked concrete [1,4]

| 3/8-in. KB-TZ2 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 |
| | | (mm) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) |
| Nominal Embedment $h_{nom}$ | | in. | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 |
| | | (mm) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2-1/4 | (57) | n/a | 0.69 | 0.65 | n/a | n/a | n/a | n/a | 0.57 | 0.55 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 2-1/2 | (64) | n/a | 0.71 | 0.67 | n/a | 0.48 | 0.68 | n/a | 0.58 | 0.55 | n/a | 0.31 | 0.18 | n/a | 0.48 | 0.37 | n/a | n/a | n/a |
| | 3 | (76) | n/a | 0.75 | 0.70 | n/a | 0.55 | 0.77 | n/a | 0.59 | 0.56 | n/a | 0.40 | 0.24 | n/a | 0.55 | 0.48 | n/a | n/a | n/a |
| | 3-1/4 | (83) | n/a | 0.77 | 0.72 | n/a | 0.59 | 0.81 | n/a | 0.60 | 0.57 | n/a | 0.45 | 0.27 | n/a | 0.59 | 0.54 | 0.69 | n/a | n/a |
| | 3-1/2 | (89) | n/a | 0.79 | 0.73 | n/a | 0.64 | 0.86 | n/a | 0.61 | 0.58 | n/a | 0.51 | 0.30 | n/a | 0.64 | 0.61 | 0.72 | n/a | n/a |
| | 4 | (102) | n/a | 0.83 | 0.77 | n/a | 0.73 | 0.97 | n/a | 0.62 | 0.59 | n/a | 0.62 | 0.37 | n/a | 0.73 | 0.74 | 0.77 | 0.70 | n/a |
| | 5 | (127) | 1.00 | 0.92 | 0.83 | 1.00 | 0.91 | 1.00 | 0.69 | 0.65 | 0.61 | 1.00 | 0.87 | 0.52 | 1.00 | 0.91 | 1.00 | 0.86 | 0.78 | 0.66 |
| | 6 | (152) | 1.00 | 1.00 | 0.90 | 1.00 | 1.00 | | 0.72 | 0.68 | 0.63 | 1.00 | 1.00 | 0.68 | 1.00 | 1.00 | | 0.94 | 0.85 | 0.72 |
| | 8 | (203) | 1.00 | | 1.00 | 1.00 | | | 0.80 | 0.74 | 0.67 | 1.00 | | 1.00 | 1.00 | | | 1.00 | 0.98 | 0.83 |
| | 10 | (254) | | | | | | | 0.87 | 0.80 | 0.71 | | | | | | | | 1.00 | 0.93 |
| | 12 | (305) | | | | | | | 0.94 | 0.86 | 0.76 | | | | | | | | | 1.00 |
| | 18 | (457) | | | | | | | 1.00 | 1.00 | 0.89 | | | | | | | | | |
| | > 24 | (610) | | | | | | | | | 1.00 | | | | | | | | | |

## Table 25 — Load adjustment factors for Stainless Steel 3/8-in. diameter KB-TZ2 in cracked concrete [1,4]

| 3/8-in. KB-TZ2 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 |
| | | (mm) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) | (38) | (51) | (64) |
| Nominal Embedment $h_{nom}$ | | in. | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 | 1-7/8 | 2-1/2 | 3 |
| | | (mm) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) | (48) | (64) | (76) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2-1/4 | (57) | n/a | 0.69 | 0.65 | n/a | n/a | n/a | n/a | 0.58 | 0.55 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 2-1/2 | (64) | n/a | 0.71 | 0.67 | n/a | 0.87 | 0.75 | n/a | 0.59 | 0.55 | n/a | 0.40 | 0.18 | n/a | 0.80 | 0.37 | n/a | n/a | n/a |
| | 3 | (76) | n/a | 0.75 | 0.70 | n/a | 1.00 | 0.85 | n/a | 0.61 | 0.56 | n/a | 0.52 | 0.24 | n/a | 1.00 | 0.48 | n/a | n/a | n/a |
| | 3-1/4 | (83) | n/a | 0.77 | 0.72 | n/a | 1.00 | 0.90 | n/a | 0.62 | 0.57 | n/a | 0.59 | 0.27 | n/a | 1.00 | 0.55 | 0.78 | n/a | n/a |
| | 3-1/2 | (89) | n/a | 0.79 | 0.73 | n/a | 1.00 | 0.95 | n/a | 0.63 | 0.58 | n/a | 0.66 | 0.31 | n/a | 1.00 | 0.61 | 0.81 | n/a | n/a |
| | 4 | (102) | n/a | 0.83 | 0.77 | n/a | 1.00 | 1.00 | n/a | 0.64 | 0.59 | n/a | 0.81 | 0.37 | n/a | 1.00 | 0.75 | 0.86 | 0.76 | n/a |
| | 5 | (127) | 1.00 | 0.92 | 0.83 | 1.00 | | | 0.73 | 0.68 | 0.61 | 1.00 | 1.00 | 0.52 | 1.00 | | 1.00 | 0.96 | 0.85 | 0.66 |
| | 6 | (152) | 1.00 | 1.00 | 0.90 | 1.00 | | | 0.78 | 0.72 | 0.63 | 1.00 | | 0.69 | 1.00 | | | 1.00 | 0.93 | 0.72 |
| | 8 | (203) | 1.00 | | 1.00 | 1.00 | | | 0.87 | 0.79 | 0.67 | 1.00 | | 1.00 | 1.00 | | | | 1.00 | 0.83 |
| | 10 | (254) | | | | | | | 0.96 | 0.86 | 0.72 | | | | | | | | | 0.93 |
| | 12 | (305) | | | | | | | 1.00 | 0.93 | 0.76 | | | | | | | | | 1.00 |
| | 18 | (457) | | | | | | | | 1.00 | 0.89 | | | | | | | | | |
| | > 24 | (610) | | | | | | | | | 1.00 | | | | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 26 — Load adjustment factors for Stainless Steel 1/2-in. diameter KB-TZ2 in uncracked concrete [1,2]

| 1/2-in. KB-TZ2 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 |
| | | (mm) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) |
| Nominal Embedment $h_{nom}$ | | in. | 2-1/2 | 3 | 3-3/4 | 2-1/2 | 3 | 3-3/4 | 2-1/2 | 3 | 3-3/4 | 2-1/2 | 3 | 3-3/4 | 2-1/2 | 3 | 3-3/4 | 2-1/2 | 3 | 3-3/4 |
| | | (mm) | (64) | (76) | (95) | (64) | (76) | (95) | (64) | (76) | (95) | (64) | (76) | (95) | (64) | (76) | (95) | (64) | (76) | (95) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2 | (51) | n/a | n/a | 0.60 | n/a | n/a | n/a | n/a | n/a | 0.54 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 2-1/4 | (57) | n/a | n/a | 0.62 | n/a | n/a | 0.40 | n/a | n/a | 0.54 | n/a | n/a | 0.12 | n/a | n/a | 0.24 | n/a | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | 0.63 | n/a | 0.45 | 0.42 | n/a | n/a | 0.55 | n/a | 0.20 | 0.14 | n/a | 0.40 | 0.28 | n/a | n/a | n/a |
| | 2-3/4 | (70) | n/a | 0.68 | 0.64 | 0.51 | 0.48 | 0.44 | n/a | 0.56 | 0.55 | 0.35 | 0.23 | 0.16 | 0.51 | 0.46 | 0.33 | n/a | n/a | n/a |
| | 3 | (76) | 0.75 | 0.70 | 0.65 | 0.55 | 0.51 | 0.46 | 0.59 | 0.57 | 0.55 | 0.40 | 0.26 | 0.19 | 0.55 | 0.51 | 0.37 | n/a | n/a | n/a |
| | 4 | (102) | 0.83 | 0.77 | 0.71 | 0.73 | 0.64 | 0.56 | 0.62 | 0.59 | 0.57 | 0.62 | 0.40 | 0.29 | 0.73 | 0.64 | 0.56 | 0.70 | n/a | n/a |
| | 4-1/8 | (105) | 0.84 | 0.78 | 0.71 | 0.75 | 0.66 | 0.57 | 0.63 | 0.59 | 0.57 | 0.65 | 0.42 | 0.30 | 0.75 | 0.66 | 0.57 | 0.71 | n/a | n/a |
| | 4-1/2 | (114) | 0.88 | 0.80 | 0.73 | 0.82 | 0.72 | 0.61 | 0.64 | 0.60 | 0.58 | 0.74 | 0.48 | 0.34 | 0.82 | 0.72 | 0.61 | 0.74 | n/a | n/a |
| | 4-3/4 | (121) | 0.90 | 0.82 | 0.74 | 0.86 | 0.76 | 0.64 | 0.64 | 0.61 | 0.59 | 0.80 | 0.52 | 0.37 | 0.86 | 0.76 | 0.64 | 0.76 | n/a | n/a |
| | 5 | (127) | 0.92 | 0.83 | 0.76 | 0.91 | 0.80 | 0.67 | 0.65 | 0.61 | 0.59 | 0.87 | 0.56 | 0.40 | 0.91 | 0.80 | 0.67 | 0.78 | 0.67 | n/a |
| | 5-1/4 | (133) | 0.94 | 0.85 | 0.77 | 0.95 | 0.84 | 0.70 | 0.66 | 0.62 | 0.60 | 0.93 | 0.61 | 0.43 | 0.95 | 0.84 | 0.70 | 0.80 | 0.69 | n/a |
| | 5-1/2 | (140) | 0.96 | 0.87 | 0.78 | 1.00 | 0.88 | 0.73 | 0.67 | 0.63 | 0.60 | 1.00 | 0.65 | 0.46 | 1.00 | 0.88 | 0.73 | 0.82 | 0.71 | 0.63 |
| | 6 | (152) | 1.00 | 0.90 | 0.81 | | 0.96 | 0.80 | 0.68 | 0.64 | 0.61 | | 0.74 | 0.53 | | 0.96 | 0.80 | 0.85 | 0.74 | 0.66 |
| | 8 | (203) | | 1.00 | 0.91 | | 1.00 | 1.00 | 0.74 | 0.68 | 0.64 | | 1.00 | 0.81 | | 1.00 | 1.00 | 0.98 | 0.85 | 0.76 |
| | 12 | (305) | | | 1.00 | | | | 0.86 | 0.77 | 0.72 | | | 1.00 | | | | 1.00 | 1.00 | 0.93 |
| | 18 | (457) | | | | | | | 1.00 | 0.91 | 0.83 | | | | | | | | | 1.00 |
| | 24 | (610) | | | | | | | | 1.00 | 0.93 | | | | | | | | | |
| | > 30 | (762) | | | | | | | | | 1.00 | | | | | | | | | |

3.3.5

## Table 27 — Load adjustment factors for Stainless Steel 1/2-in. diameter KB-TZ2 in cracked concrete [1,2]

| 1/2-in. KB-TZ2 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 |
| | | (mm) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) |
| Nominal Embedment $h_{nom}$ | | in. | 2-1/2 | 3 | 3-3/4 | 2-1/2 | 3 | 3-3/4 | 2-1/2 | 3 | 3-3/4 | 2-1/2 | 3 | 3-3/4 | 2-1/2 | 3 | 3-3/4 | 2-1/2 | 3 | 3-3/4 |
| | | (mm) | (64) | (76) | (95) | (64) | (76) | (95) | (64) | (76) | (95) | (64) | (76) | (95) | (64) | (76) | (95) | (64) | (76) | (95) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2 | (51) | n/a | n/a | 0.60 | n/a | n/a | n/a | n/a | n/a | 0.54 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| | 2-1/4 | (57) | n/a | n/a | 0.62 | n/a | n/a | 0.61 | n/a | n/a | 0.54 | n/a | n/a | 0.12 | n/a | n/a | 0.24 | n/a | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | 0.63 | n/a | 0.75 | 0.65 | n/a | n/a | 0.55 | n/a | 0.16 | 0.14 | n/a | 0.33 | 0.29 | n/a | n/a | n/a |
| | 2-3/4 | (70) | n/a | 0.68 | 0.64 | 0.93 | 0.80 | 0.68 | n/a | 0.55 | 0.55 | 0.62 | 0.19 | 0.16 | 0.93 | 0.38 | 0.33 | n/a | n/a | n/a |
| | 3 | (76) | 0.75 | 0.70 | 0.65 | 1.00 | 0.85 | 0.71 | 0.63 | 0.56 | 0.55 | 0.71 | 0.21 | 0.19 | 1.00 | 0.43 | 0.38 | n/a | n/a | n/a |
| | 4 | (102) | 0.83 | 0.77 | 0.71 | 1.00 | 1.00 | 0.86 | 0.68 | 0.58 | 0.57 | 1.00 | 0.33 | 0.29 | 1.00 | 0.66 | 0.58 | 0.84 | n/a | n/a |
| | 4-1/8 | (105) | 0.84 | 0.78 | 0.71 | 1.00 | 1.00 | 0.88 | 0.68 | 0.58 | 0.58 | 1.00 | 0.34 | 0.30 | 1.00 | 0.69 | 0.61 | 0.85 | n/a | n/a |
| | 4-1/2 | (114) | 0.88 | 0.80 | 0.73 | | 1.00 | 0.94 | 0.70 | 0.59 | 0.58 | | 0.39 | 0.34 | | 0.79 | 0.69 | 0.89 | n/a | n/a |
| | 4-3/4 | (121) | 0.90 | 0.82 | 0.74 | | | 0.98 | 0.71 | 0.59 | 0.59 | | 0.43 | 0.37 | | 0.85 | 0.75 | 0.91 | n/a | n/a |
| | 5 | (127) | 0.92 | 0.83 | 0.76 | | | 1.00 | 0.72 | 0.60 | 0.59 | | 0.46 | 0.40 | | 0.92 | 0.81 | 0.94 | 0.63 | n/a |
| | 5-1/4 | (133) | 0.94 | 0.85 | 0.77 | | | | 0.73 | 0.60 | 0.60 | | 0.49 | 0.43 | | 0.99 | 0.87 | 0.96 | 0.65 | n/a |
| | 5-1/2 | (140) | 0.96 | 0.87 | 0.78 | | | | 0.74 | 0.61 | 0.60 | | 0.53 | 0.47 | | 1.00 | 0.93 | 0.98 | 0.66 | 0.63 |
| | 6 | (152) | 1.00 | 0.90 | 0.81 | | | | 0.76 | 0.62 | 0.61 | | 0.60 | 0.53 | | | 1.00 | 1.00 | 0.69 | 0.66 |
| | 8 | (203) | | 1.00 | 0.91 | | | | 0.85 | 0.66 | 0.65 | | 0.93 | 0.82 | | | | | 0.80 | 0.76 |
| | 12 | (305) | | | 1.00 | | | | 1.00 | 0.74 | 0.72 | | 1.00 | 1.00 | | | | | 0.98 | 0.94 |
| | 18 | (457) | | | | | | | | 0.86 | 0.83 | | | | | | | | 1.00 | 1.00 |
| | 24 | (610) | | | | | | | | 0.98 | 0.94 | | | | | | | | | |
| | > 30 | (762) | | | | | | | | 1.00 | 1.00 | | | | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 28 — Load adjustment factors for Stainless Steel 5/8-in. diameter KB-TZ2 in uncracked concrete [1,2]

| 5/8-in. KB-TZ2 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 |
| | | (mm) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) |
| Nominal Embedment $h_{nom}$ | | in. | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 |
| | | (mm) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2-1/4 | (57) | n/a | n/a | n/a | n/a | n/a | 0.38 | n/a | n/a | n/a | n/a | n/a | 0.10 | n/a | n/a | 0.20 | n/a | n/a | n/a |
| | 2-3/4 | (70) | n/a | 0.64 | n/a | n/a | n/a | 0.42 | n/a | 0.55 | n/a | n/a | n/a | 0.13 | n/a | n/a | 0.27 | n/a | n/a | n/a |
| | 3 | (76) | n/a | 0.65 | 0.63 | n/a | n/a | 0.44 | n/a | 0.56 | 0.55 | n/a | n/a | 0.15 | n/a | n/a | 0.30 | n/a | n/a | n/a |
| | 3-1/4 | (83) | n/a | 0.67 | 0.64 | n/a | 0.56 | 0.46 | n/a | 0.56 | 0.55 | n/a | 0.22 | 0.17 | n/a | 0.45 | 0.34 | n/a | n/a | n/a |
| | 4 | (102) | n/a | 0.71 | 0.67 | 0.40 | 0.65 | 0.51 | n/a | 0.58 | 0.56 | 0.25 | 0.31 | 0.23 | 0.40 | 0.61 | 0.47 | n/a | n/a | n/a |
| | 4-1/4 | (108) | n/a | 0.72 | 0.68 | 0.43 | 0.67 | 0.53 | n/a | 0.58 | 0.57 | 0.28 | 0.34 | 0.26 | 0.43 | 0.67 | 0.51 | n/a | n/a | n/a |
| | 5 | (127) | n/a | 0.76 | 0.71 | 0.50 | 0.77 | 0.60 | n/a | 0.59 | 0.58 | 0.35 | 0.43 | 0.33 | 0.50 | 0.77 | 0.60 | 0.58 | n/a | n/a |
| | 5-1/2 | (140) | 0.83 | 0.78 | 0.73 | 0.55 | 0.85 | 0.64 | 0.59 | 0.60 | 0.59 | 0.41 | 0.49 | 0.38 | 0.55 | 0.85 | 0.64 | 0.61 | 0.65 | n/a |
| | 6 | (152) | 0.86 | 0.81 | 0.75 | 0.60 | 0.92 | 0.69 | 0.60 | 0.61 | 0.59 | 0.46 | 0.56 | 0.43 | 0.60 | 0.92 | 0.69 | 0.63 | 0.67 | 0.62 |
| | 7 | (178) | 0.92 | 0.86 | 0.79 | 0.70 | 1.00 | 0.80 | 0.62 | 0.63 | 0.61 | 0.59 | 0.71 | 0.54 | 0.70 | 1.00 | 0.80 | 0.68 | 0.73 | 0.67 |
| | 8 | (203) | 0.98 | 0.91 | 0.83 | 0.80 | | 0.91 | 0.63 | 0.65 | 0.63 | 0.72 | 0.87 | 0.66 | 0.80 | | 0.91 | 0.73 | 0.78 | 0.71 |
| | 10 | (254) | 1.00 | 1.00 | 0.92 | 1.00 | | 1.00 | 0.67 | 0.69 | 0.66 | 1.00 | 1.00 | 0.92 | 1.00 | | 1.00 | 0.82 | 0.87 | 0.80 |
| | 12 | (305) | | | 1.00 | | | | 0.70 | 0.73 | 0.69 | | | 1.00 | | | | 0.89 | 0.95 | 0.87 |
| | 24 | (610) | | | | | | | 0.90 | 0.95 | 0.88 | | | | | | | 1.00 | 1.00 | 1.00 |
| | > 36 | (914) | | | | | | | 1.00 | 1.00 | 1.00 | | | | | | | | | |

## Table 29 — Load adjustment factors for Stainless Steel 5/8-in. diameter KB-TZ2 in cracked concrete [1,2]

| 5/8-in. KB-TZ2 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 | 2-3/4 | 3-1/4 | 4 |
| | | (mm) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) | (70) | (83) | (102) |
| Nominal Embedment $h_{nom}$ | | in. | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 | 3-1/4 | 3-3/4 | 4-1/2 |
| | | (mm) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) | (83) | (95) | (114) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2-1/4 | (57) | n/a | n/a | n/a | n/a | n/a | 0.56 | n/a | n/a | n/a | n/a | n/a | 0.10 | n/a | n/a | 0.20 | n/a | n/a | n/a |
| | 2-3/4 | (70) | n/a | 0.64 | n/a | n/a | n/a | 0.61 | n/a | 0.55 | n/a | n/a | n/a | 0.13 | n/a | n/a | 0.27 | n/a | n/a | n/a |
| | 3 | (76) | n/a | 0.65 | 0.63 | n/a | n/a | 0.64 | n/a | 0.55 | 0.55 | n/a | n/a | 0.15 | n/a | n/a | 0.31 | n/a | n/a | n/a |
| | 3-1/4 | (83) | n/a | 0.67 | 0.64 | n/a | 0.75 | 0.66 | n/a | 0.55 | 0.55 | n/a | 0.18 | 0.17 | n/a | 0.37 | 0.35 | n/a | n/a | n/a |
| | 4 | (102) | n/a | 0.71 | 0.67 | 0.98 | 0.86 | 0.75 | n/a | 0.57 | 0.56 | 0.31 | 0.25 | 0.24 | 0.62 | 0.50 | 0.47 | n/a | n/a | n/a |
| | 4-1/4 | (108) | n/a | 0.72 | 0.68 | 1.00 | 0.90 | 0.78 | n/a | 0.57 | 0.57 | 0.34 | 0.27 | 0.26 | 0.68 | 0.55 | 0.52 | n/a | n/a | n/a |
| | 5 | (127) | n/a | 0.76 | 0.71 | 1.00 | 1.00 | 0.87 | n/a | 0.58 | 0.58 | 0.43 | 0.35 | 0.33 | 0.87 | 0.70 | 0.66 | 0.62 | n/a | n/a |
| | 5-1/2 | (140) | 0.83 | 0.78 | 0.73 | 1.00 | | 0.93 | 0.61 | 0.59 | 0.59 | 0.50 | 0.40 | 0.38 | 1.00 | 0.81 | 0.76 | 0.65 | 0.60 | n/a |
| | 6 | (152) | 0.86 | 0.81 | 0.75 | | | 1.00 | 0.61 | 0.60 | 0.60 | 0.57 | 0.46 | 0.43 | | 0.92 | 0.87 | 0.68 | 0.63 | 0.62 |
| | 7 | (178) | 0.92 | 0.86 | 0.79 | | | | 0.63 | 0.62 | 0.61 | 0.72 | 0.58 | 0.55 | | 1.00 | 1.00 | 0.73 | 0.68 | 0.67 |
| | 8 | (203) | 0.98 | 0.91 | 0.83 | | | | 0.65 | 0.63 | 0.63 | 0.88 | 0.71 | 0.67 | | | | 0.78 | 0.73 | 0.71 |
| | 10 | (254) | 1.00 | 1.00 | 0.92 | | | | 0.69 | 0.67 | 0.66 | 1.00 | 0.99 | 0.93 | | | | 0.87 | 0.81 | 0.80 |
| | 12 | (305) | | | 1.00 | | | | 0.73 | 0.70 | 0.69 | | 1.00 | 1.00 | | | | 0.96 | 0.89 | 0.87 |
| | 24 | (610) | | | | | | | 0.96 | 0.90 | 0.88 | | | | | | | 1.00 | 1.00 | 1.00 |
| | > 36 | (914) | | | | | | | 1.00 | 1.00 | 1.00 | | | | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 30 — Load adjustment factors for Stainless Steel 3/4-in. diameter KB-TZ2 in uncracked concrete [1,2]

| 3/4-in. KB-TZ2 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 |
| | | (mm) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) |
| Nominal Embedment $h_{nom}$ | | in. | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 |
| | | (mm) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 3-3/4 | (95) | n/a | n/a | n/a | n/a | n/a | 0.47 | n/a | n/a | n/a | n/a | n/a | 0.18 | n/a | n/a | 0.36 | n/a | n/a | n/a |
| | 4 | (102) | n/a | 0.68 | 0.64 | n/a | 0.44 | 0.48 | n/a | 0.56 | 0.56 | n/a | 0.24 | 0.20 | n/a | 0.44 | 0.40 | n/a | n/a | n/a |
| | 4-1/2 | (114) | n/a | 0.70 | 0.66 | n/a | 0.48 | 0.52 | n/a | 0.57 | 0.56 | n/a | 0.29 | 0.24 | n/a | 0.48 | 0.47 | n/a | n/a | n/a |
| | 5 | (127) | 0.76 | 0.72 | 0.68 | 0.42 | 0.51 | 0.55 | 0.57 | 0.58 | 0.57 | 0.27 | 0.33 | 0.28 | 0.42 | 0.51 | 0.55 | n/a | n/a | n/a |
| | 5-1/4 | (133) | 0.77 | 0.73 | 0.68 | 0.44 | 0.53 | 0.57 | 0.57 | 0.58 | 0.57 | 0.29 | 0.36 | 0.30 | 0.44 | 0.53 | 0.57 | n/a | n/a | n/a |
| | 5-1/2 | (140) | 0.78 | 0.74 | 0.69 | 0.46 | 0.55 | 0.59 | 0.58 | 0.59 | 0.58 | 0.31 | 0.39 | 0.32 | 0.46 | 0.55 | 0.59 | 0.55 | n/a | n/a |
| | 5-3/4 | (146) | 0.79 | 0.76 | 0.70 | 0.48 | 0.58 | 0.61 | 0.58 | 0.59 | 0.58 | 0.33 | 0.41 | 0.34 | 0.48 | 0.58 | 0.61 | 0.57 | n/a | n/a |
| | 6 | (152) | 0.81 | 0.77 | 0.71 | 0.50 | 0.60 | 0.63 | 0.58 | 0.60 | 0.58 | 0.35 | 0.44 | 0.36 | 0.50 | 0.60 | 0.63 | 0.58 | 0.62 | n/a |
| | 7 | (178) | 0.86 | 0.81 | 0.75 | 0.58 | 0.70 | 0.70 | 0.60 | 0.61 | 0.60 | 0.45 | 0.55 | 0.46 | 0.58 | 0.70 | 0.70 | 0.62 | 0.67 | n/a |
| | 7-1/2 | (191) | 0.88 | 0.83 | 0.76 | 0.63 | 0.75 | 0.75 | 0.60 | 0.62 | 0.61 | 0.49 | 0.61 | 0.51 | 0.63 | 0.75 | 0.75 | 0.65 | 0.69 | n/a |
| | 8 | (203) | 0.91 | 0.86 | 0.78 | 0.67 | 0.80 | 0.80 | 0.61 | 0.63 | 0.61 | 0.54 | 0.68 | 0.56 | 0.67 | 0.80 | 0.80 | 0.67 | 0.72 | 0.67 |
| | 9 | (229) | 0.96 | 0.90 | 0.82 | 0.75 | 0.90 | 0.90 | 0.63 | 0.64 | 0.63 | 0.65 | 0.81 | 0.67 | 0.75 | 0.90 | 0.90 | 0.71 | 0.76 | 0.71 |
| | 10 | (254) | 1.00 | 0.94 | 0.85 | 0.83 | 1.00 | 1.00 | 0.64 | 0.66 | 0.64 | 0.76 | 0.94 | 0.78 | 0.83 | 1.00 | 1.00 | 0.75 | 0.80 | 0.75 |
| | 11 | (279) | 1.00 | 0.99 | 0.89 | 0.92 | | | 0.65 | 0.68 | 0.66 | 0.88 | 1.00 | 0.90 | 0.92 | | | 0.78 | 0.84 | 0.79 |
| | 12 | (305) | | 1.00 | 0.92 | 1.00 | | | 0.67 | 0.69 | 0.67 | 1.00 | | 1.00 | 1.00 | | | 0.82 | 0.88 | 0.82 |
| | 16 | (406) | | | 1.00 | | | | 0.72 | 0.76 | 0.73 | | | | | | | 0.94 | 1.00 | 0.95 |
| | 18 | (457) | | | | | | | 0.75 | 0.79 | 0.75 | | | | | | | 1.00 | | 1.00 |
| | 24 | (610) | | | | | | | 0.83 | 0.89 | 0.84 | | | | | | | | | |
| | > 36 | (914) | | | | | | | 1.00 | 1.00 | 1.00 | | | | | | | | | |

3.3.5

## Table 31 — Load adjustment factors for Stainless Steel 3/4-in. diameter KB-TZ2 in cracked concrete [1,2]

| 3/4-in. KB-TZ2 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | | Edge distance in shear ∥ To edge $f_{RV}$ | | | Concrete thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 | 3-1/4 | 3-3/4 | 4-3/4 |
| | | (mm) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) | (83) | (95) | (121) |
| Nominal Embedment $h_{nom}$ | | in. | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 | 4 | 4-1/2 | 5-1/2 |
| | | (mm) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) | (102) | (114) | (140) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 3-3/4 | (95) | n/a | n/a | n/a | n/a | n/a | 0.65 | n/a | n/a | n/a | n/a | n/a | 0.15 | n/a | n/a | 0.29 | n/a | n/a | n/a |
| | 4 | (102) | n/a | 0.68 | 0.64 | n/a | 0.78 | 0.68 | n/a | 0.56 | 0.55 | n/a | 0.22 | 0.16 | n/a | 0.44 | 0.32 | n/a | n/a | n/a |
| | 4-1/2 | (114) | n/a | 0.70 | 0.66 | n/a | 0.85 | 0.73 | n/a | 0.57 | 0.56 | n/a | 0.26 | 0.19 | n/a | 0.52 | 0.39 | n/a | n/a | n/a |
| | 5 | (127) | 0.76 | 0.72 | 0.68 | 1.00 | 0.91 | 0.77 | 0.59 | 0.58 | 0.56 | 0.37 | 0.31 | 0.23 | 0.74 | 0.61 | 0.45 | n/a | n/a | n/a |
| | 5-1/4 | (133) | 0.77 | 0.73 | 0.68 | 1.00 | 0.95 | 0.80 | 0.59 | 0.58 | 0.56 | 0.40 | 0.33 | 0.24 | 0.79 | 0.66 | 0.49 | n/a | n/a | n/a |
| | 5-1/2 | (140) | 0.78 | 0.74 | 0.69 | 1.00 | 0.98 | 0.83 | 0.59 | 0.58 | 0.57 | 0.43 | 0.35 | 0.26 | 0.85 | 0.71 | 0.52 | 0.61 | n/a | n/a |
| | 5-3/4 | (146) | 0.79 | 0.76 | 0.70 | 1.00 | 1.00 | 0.85 | 0.60 | 0.59 | 0.57 | 0.46 | 0.38 | 0.28 | 0.91 | 0.76 | 0.56 | 0.63 | n/a | n/a |
| | 6 | (152) | 0.81 | 0.77 | 0.71 | 1.00 | 1.00 | 0.88 | 0.60 | 0.59 | 0.57 | 0.49 | 0.40 | 0.30 | 0.97 | 0.81 | 0.59 | 0.64 | 0.60 | n/a |
| | 7 | (178) | 0.86 | 0.81 | 0.75 | 1.00 | | 0.99 | 0.62 | 0.61 | 0.59 | 0.61 | 0.51 | 0.37 | 1.00 | 1.00 | 0.75 | 0.69 | 0.65 | n/a |
| | 7-1/2 | (191) | 0.88 | 0.83 | 0.76 | 1.00 | | 1.00 | 0.63 | 0.61 | 0.59 | 0.68 | 0.56 | 0.41 | 1.00 | | 0.83 | 0.72 | 0.67 | n/a |
| | 8 | (203) | 0.91 | 0.86 | 0.78 | 1.00 | | | 0.64 | 0.62 | 0.60 | 0.75 | 0.62 | 0.46 | 1.00 | | 0.91 | 0.74 | 0.70 | 0.63 |
| | 9 | (229) | 0.96 | 0.90 | 0.82 | | | | 0.65 | 0.64 | 0.61 | 0.89 | 0.74 | 0.54 | | | 1.00 | 0.79 | 0.74 | 0.67 |
| | 10 | (254) | 1.00 | 0.94 | 0.85 | | | | 0.67 | 0.65 | 0.62 | 1.00 | 0.87 | 0.64 | | | | 0.83 | 0.78 | 0.70 |
| | 11 | (279) | 1.00 | 0.99 | 0.89 | | | | 0.69 | 0.67 | 0.64 | | 1.00 | 0.74 | | | | 0.87 | 0.82 | 0.74 |
| | 12 | (305) | | 1.00 | 0.92 | | | | 0.71 | 0.68 | 0.65 | | | 0.84 | | | | 0.91 | 0.85 | 0.77 |
| | 16 | (406) | | | 1.00 | | | | 0.77 | 0.74 | 0.70 | | | 1.00 | | | | 1.00 | 0.98 | 0.89 |
| | 18 | (457) | | | | | | | 0.81 | 0.77 | 0.72 | | | | | | | | 1.00 | 0.94 |
| | 24 | (610) | | | | | | | 0.91 | 0.86 | 0.80 | | | | | | | | | 1.00 |
| | > 36 | (914) | | | | | | | 1.00 | 1.00 | 0.94 | | | | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 32 — Load adjustment factors for Stainless Steel 1-in. diameter KB-TZ2 in uncracked concrete [1,4]

| 1-in. KB-TZ2 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | Edge distance in shear ∥ To edge $f_{RV}$ | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 4.00 | 5.75 | 4.00 | 5.75 | 4.00 | 5.75 | 4.00 | 5.75 | 4.00 | 5.75 | 4.00 | 5.75 |
| | | (mm) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) |
| Nominal Embedment $h_{nom}$ | | in. | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 |
| | | (mm) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 3 | (76) | n/a | n/a | n/a | 0.302 | n/a | n/a | n/a | 0.085 | n/a | 0.170 | n/a | n/a |
| | 3-3/4 | (95) | n/a | n/a | 0.393 | 0.332 | n/a | n/a | 0.199 | 0.119 | 0.393 | 0.238 | n/a | n/a |
| | 4 | (102) | n/a | n/a | 0.409 | 0.342 | n/a | n/a | 0.219 | 0.131 | 0.409 | 0.262 | n/a | n/a |
| | 4-1/4 | (108) | n/a | n/a | 0.425 | 0.352 | n/a | n/a | 0.240 | 0.144 | 0.425 | 0.287 | n/a | n/a |
| | 4-3/4 | (121) | n/a | 0.638 | 0.458 | 0.373 | n/a | 0.551 | 0.284 | 0.170 | 0.458 | 0.339 | n/a | n/a |
| | 5 | (127) | 0.708 | 0.645 | 0.475 | 0.384 | 0.576 | 0.554 | 0.306 | 0.183 | 0.475 | 0.366 | n/a | n/a |
| | 6 | (152) | 0.750 | 0.674 | 0.545 | 0.429 | 0.591 | 0.565 | 0.403 | 0.241 | 0.545 | 0.429 | n/a | n/a |
| | 6-3/4 | (171) | 0.781 | 0.696 | 0.614 | 0.464 | 0.602 | 0.573 | 0.481 | 0.287 | 0.614 | 0.464 | n/a | n/a |
| | 8 | (203) | 0.833 | 0.732 | 0.727 | 0.525 | 0.621 | 0.586 | 0.620 | 0.371 | 0.727 | 0.525 | 0.696 | n/a |
| | 10 | (254) | 0.917 | 0.790 | 0.909 | 0.645 | 0.652 | 0.608 | 0.867 | 0.518 | 0.909 | 0.645 | 0.778 | 0.656 |
| | 12 | (305) | 1.000 | 0.848 | 1.000 | 0.774 | 0.682 | 0.629 | 1.000 | 0.681 | 1.000 | 0.774 | 0.853 | 0.718 |
| | 18 | (457) | | 1.000 | | 1.000 | 0.773 | 0.694 | | 1.000 | | 1.000 | 1.000 | 0.880 |
| | 24 | (610) | | | | | 0.864 | 0.758 | | | | | | 1.000 |
| | 36 | (914) | | | | | 1.000 | 0.887 | | | | | | |
| | > 48 | (1219) | | | | | | 1.000 | | | | | | |

## Table 33 — Load adjustment factors for Stainless Steel 1-in. diameter KB-TZ2 in cracked concrete [1,4]

| 1-in. KB-TZ2 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | Edge distance in shear ∥ To edge $f_{RV}$ | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective Embedment $h_{ef}$ | | in. | 4.00 | 5.75 | 4.00 | 5.75 | 4.00 | 5.75 | 4.00 | 5.75 | 4.00 | 5.75 | 4.00 | 5.75 |
| | | (mm) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) | (102) | (146) |
| Nominal Embedment $h_{nom}$ | | in. | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 | 4-5/8 | 6-3/8 |
| | | (mm) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) | (117) | (162) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 3 | (76) | n/a | n/a | n/a | 0.542 | n/a | n/a | n/a | 0.081 | n/a | 0.162 | n/a | n/a |
| | 3-3/4 | (95) | n/a | n/a | 0.721 | 0.596 | n/a | n/a | 0.170 | 0.113 | 0.340 | 0.226 | n/a | n/a |
| | 4 | (102) | n/a | n/a | 0.750 | 0.614 | n/a | n/a | 0.188 | 0.124 | 0.375 | 0.249 | n/a | n/a |
| | 4-1/4 | (108) | n/a | n/a | 0.779 | 0.633 | n/a | n/a | 0.205 | 0.136 | 0.411 | 0.272 | n/a | n/a |
| | 4-3/4 | (121) | n/a | 0.638 | 0.840 | 0.671 | n/a | 0.549 | 0.243 | 0.161 | 0.485 | 0.322 | n/a | n/a |
| | 5 | (127) | 0.708 | 0.645 | 0.871 | 0.690 | 0.568 | 0.552 | 0.262 | 0.174 | 0.524 | 0.348 | n/a | n/a |
| | 6 | (152) | 0.750 | 0.674 | 1.000 | 0.770 | 0.582 | 0.562 | 0.344 | 0.228 | 0.689 | 0.457 | n/a | n/a |
| | 6-3/4 | (171) | 0.781 | 0.696 | | 0.833 | 0.592 | 0.570 | 0.411 | 0.273 | 0.822 | 0.545 | n/a | n/a |
| | 8 | (203) | 0.833 | 0.732 | | 0.943 | 0.609 | 0.583 | 0.530 | 0.352 | 1.000 | 0.703 | 0.661 | n/a |
| | 10 | (254) | 0.917 | 0.790 | | 1.000 | 0.636 | 0.604 | 0.741 | 0.491 | | 0.983 | 0.739 | 0.644 |
| | 12 | (305) | 1.000 | 0.848 | | | 0.664 | 0.625 | 0.974 | 0.646 | | 1.000 | 0.809 | 0.706 |
| | 18 | (457) | | 1.000 | | | 0.746 | 0.687 | 1.000 | 1.000 | | | 0.991 | 0.864 |
| | 24 | (610) | | | | | 0.828 | 0.749 | | | | | 1.000 | 0.998 |
| | 36 | (914) | | | | | 0.991 | 0.874 | | | | | | 1.000 |
| | > 48 | (1219) | | | | | 1.000 | 0.998 | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 3 and Table 21 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 34 — Hilti Carbon Steel KB-TZ2 in the soffit of uncracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations [1,2,3,4,5,6]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Installation per Figure 4 | | | | Installation per Figure 5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min. conc. thickness [8] in. (mm) | Tension - $\Phi N_n$ | | Shear - $\Phi V_n$ | Min. conc. thickness [8] in. (mm) | Tension - $\Phi N_n$ | | Shear - $\Phi V_n$ |
| | | | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) |
| 1/4 | 1-1/2 (38) | 1-3/4 (44) | 2-1/2 (64) | 775 (3.4) | 820 (3.6) | 1,060 (4.7) | 2-1/4 (57) | 620 (2.8) | 655 (2.9) | 730 (3.2) |
| 3/8 | 1-1/2 (38) | 1-7/8 (48) | 2-1/2 (64) | 1,205 (5.4) | 1,285 (5.7) | 880 (3.9) | 2-1/4 (57) | 645 (2.9) | 685 (3.0) | 1,540 (6.9) |
| | 2 (51) | 2-1/2 (64) | 2-1/2 (64) | 1,705 (7.6) | 1,830 (8.1) | 1,380 (6.1) | 2-1/4 (57) | 1,615 (7.2) | 1,730 (7.7) | 1,630 (7.3) |
| | 2-1/2 (64) | 3 (76) | 2-1/2 (64) | 1,945 (8.7) | 2,155 (9.6) | 1,380 (6.1) | N/A | N/A | N/A | N/A |
| 1/2 | 1-1/2 (38) | 2 (51) | 2-1/2 (64) | 1,205 (5.4) | 1,390 (6.2) | 1,165 (5.2) | 2-1/4 (57) | 1,180 (5.2) | 1,365 (6.1) | 1,740 (7.7) |
| | 2 (51) | 2-1/2 (64) | 2-1/2 (64) | 1,790 (8.0) | 2,015 (9.0) | 1,470 (6.5) | 2-1/4 (57) | 1,235 (5.5) | 1,395 (6.2) | 2,065 (9.2) |
| | 2-1/2 (64) | 3 (76) | 2-1/2 (64) | 2,435 (10.8) | 2,645 (11.8) | 2,135 (9.5) | N/A | N/A | N/A | N/A |
| | 3-1/4 (83) | 3-3/4 (95) | 2-1/2 (64) | 3,065 (13.6) | 3,390 (15.1) | 2,755 (12.3) | 3-1/4 (83) | 1,730 (7.7) | 1,915 (8.5) | 2,250 (10.0) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 2-1/2 (64) | 2,870 (12.8) | 3,315 (14.7) | 2,480 (11.0) | 3-1/4 (83) | 1,925 (8.6) | 2,225 (9.9) | 2,655 (11.8) |
| | 4 (102) | 4-1/2 (114) | 2-1/2 (64) | 3,780 (16.8) | 4,365 (19.4) | 3,025 (13.5) | N/A | N/A | N/A | N/A |
| 3/4 | 3-1/4 (83) | 4 (102) | 2-1/2 (64) | 2,470 (11.0) | 2,730 (12.1) | 2,655 (11.8) | N/A | N/A | N/A | N/A |
| | 3-3/4[9] (95) | 4-1/2 (114) | 3-1/4 (83) | 3,115 (13.9) | 3,405 (15.1) | 5,110 (22.7) | N/A | N/A | N/A | N/A |

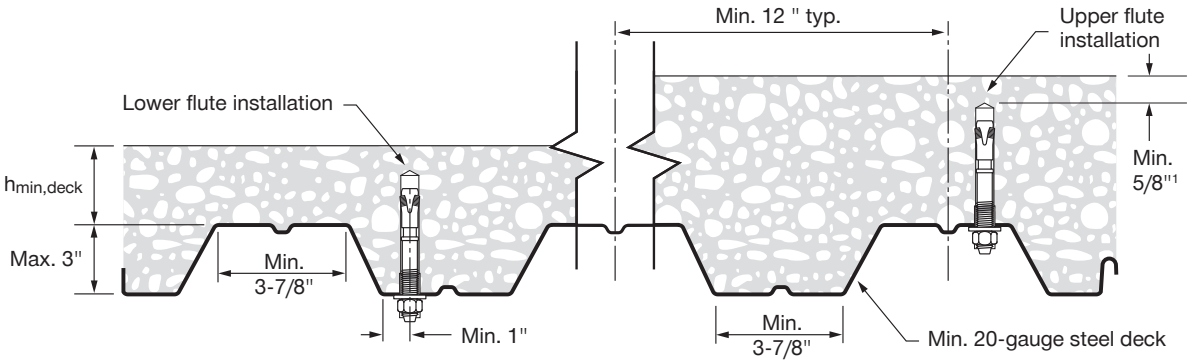
3.3.5

## Table 35 — Hilti Carbon Steel KB-TZ2 in the soffit of cracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations [1,2,3,4,5,6,7]

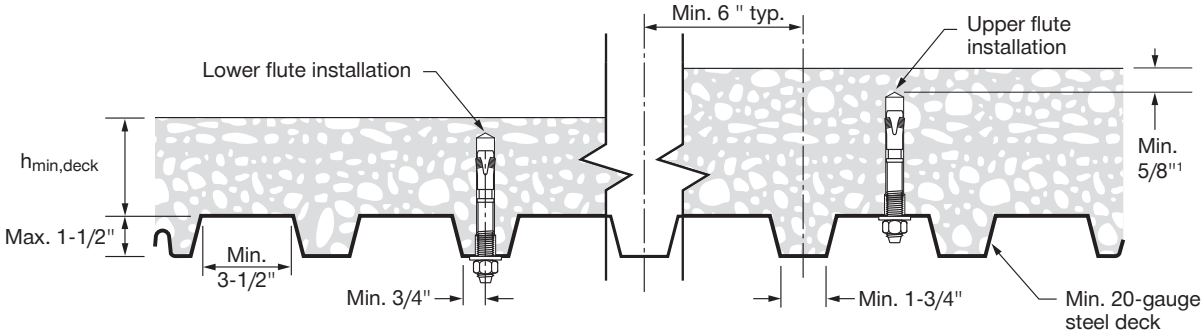
| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Installation per Figure 4 | | | | Installation per Figure 5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min. conc. thickness [8] in. (mm) | Tension - $\Phi N_n$ | | Shear - $\Phi V_n$ | Min. conc. thickness [8] in. (mm) | Tension - $\Phi N_n$ | | Shear - $\Phi V_n$ |
| | | | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) |
| 1/4 | 1-1/2 (38) | 1-3/4 (44) | 2-1/2 (64) | 230 (1.0) | 260 (1.2) | 1,060 (4.7) | 2-1/4 (57) | 185 (0.8) | 205 (0.9) | 730 (3.2) |
| 3/8 | 1-1/2 (38) | 1-7/8 (48) | 2-1/2 (64) | 1,055 (4.7) | 1,220 (5.4) | 880 (3.9) | 2-1/4 (57) | 565 (2.5) | 650 (2.9) | 1,540 (6.9) |
| | 2 (51) | 2-1/2 (64) | 2-1/2 (64) | 1,490 (6.6) | 1.705 (7.6) | 1,380 (6.1) | 2-1/4 (57) | 1,385 (6.2) | 1,580 (7.0) | 1,630 (7.3) |
| | 2-1/2 (64) | 3 (76) | 2-1/2 (64) | 1,565 (7.0) | 1.695 (7.5) | 1,380 (6.1) | N/A | N/A | N/A | N/A |
| 1/2 | 1-1/2 (38) | 2 (51) | 2-1/2 (64) | 1,075 (4.8) | 1.230 (5.5) | 1,165 (5.2) | 2-1/4 (57) | 960 (4.3) | 1,100 (4.9) | 1,740 (7.7) |
| | 2 (51) | 2-1/2 (64) | 2-1/2 (64) | 1,390 (6.2) | 1.600 (7.1) | 1,470 (6.5) | 2-1/4 (57) | 960 (4.3) | 1,110 (4.9) | 2,065 (9.2) |
| | 2-1/2 (64) | 3 (76) | 2-1/2 (64) | 2,130 (9.5) | 2,435 (10.9) | 2,135 (9.5) | N/A | N/A | N/A | N/A |
| | 3-1/4 (83) | 3-3/4 (95) | 2-1/2 (64) | 2,170 (9.7) | 2,435 (10.8) | 2,755 (12.3) | 3-1/4 (83) | 1,230 (5.5) | 1,380 (6.1) | 2,250 (10.0) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 2-1/2 (64) | 2,555 (11.4) | 2,950 (13.1) | 2,480 (11.0) | 3-1/4 (83) | 1,715 (7.6) | 1,980 (8.8) | 2,655 (11.8) |
| | 4 (102) | 4-1/2 (114) | 2-1/2 (64) | 2,855 (12.7) | 3,300 (14.7) | 3,025 (13.5) | N/A | N/A | N/A | N/A |
| 3/4 | 3-1/4 (83) | 4 (102) | 2-1/2 (64) | 2,160 (9.6) | 2,395 (10.7) | 2,655 (11.8) | N/A | N/A | N/A | N/A |
| | 3-3/4 (95) | 4-1/2 (114) | 3-1/4 (83) | 2,425 (10.8) | 2,735 (12.2) | 5,110 (22.7) | N/A | N/A | N/A | N/A |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 $h_{ef}$ where $\alpha_{N,seis}$ = 0.73. See Section 3.1.8 for additional information on seismic applications.
8 Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 4 and 5.
9 For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.89 to the design tension strength of anchors installed in uncracked concrete.

## Figure 4 — Installation of Hilti KB-TZ2 carbon steel in the soffit of concrete over metal deck floor and roof assemblies – W deck[2]




## Figure 5 — Installation of Hilti KB-TZ2 carbon steel in the soffit of concrete over metal deck floor and roof assemblies – B deck



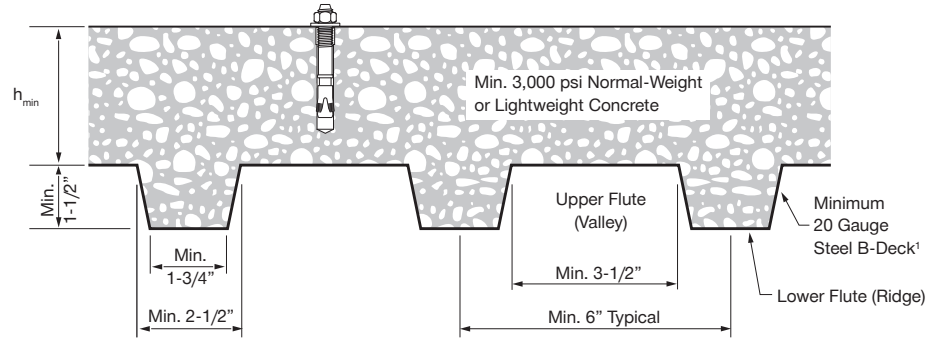

1 5/8" clearance between the bottom of the drilled hole and the concrete surface is only applicable for upper flute installations. Refer to Tables 34 and 35 for minimum concrete thicknesses for installations into the lower flute.
2 For flute widths greater or equal to 4-1/2", the shear strength may be increased. Refer to ESR-4266 for more information.

## Table 36 — Hilti KB-TZ2 carbon steel anchors setting information for installation on the top of concrete-filled profile steel deck asseblies according to figure 6 [1,2,3]

| Design information | Symbol | Units | Nominal anchor diameter (in) | | | |
|---|---|---|---|---|---|---|
| | | | 1/4 | 3/8 | | 1/2 |
| Effective minimum embedment | $h_{ef}$ | in. | 1-1/2 | 1-1/2 | 2 | 2 |
| Nominal minimum embedment | $h_{nom}$ | in. | 1-3/4 | 1-7/8 | 2-1/2 | 2-1/2 |
| Minimum hole depth | $h_0$ | in. | 2 | 2 | 2-1/2 | 2-3/4 |
| Minimum concrete thickness [4] | $h_{min,deck}$ | in. | 2-1/2 | 2-1/2 | 2-1/2 | 3-2/4 |
| Critical edge distance | $c_{ac,deck,top}$ | in. | 5 | 8 | 4-1/2 | 6 |
| Minimum edge distance | $c_{min,deck,top}$ | in. | 3 | 16 | | 7-1/2 |
| Minimum spacing | $s_{min,deck,top}$ | in. | 3 | 8 | | 9 |
| Required installation torque | $T_{inst}$ | ft-lb | 4 | 30 | | 50 |

1 Installation must comply with Figure 6 of this report.
2 Design capacity shall be based on calculations according to values in Tables 2 and 3 of this report.
3 Applicable for $h_{min,deck}$ < 4-in. For $h_{min,deck}$ ≥ 4-in, use setting information in Tables 1 and 5 of this section.
4 Minimun concrete thickness refers to concrete thickness above the upper flute. See Figure 6.

## Figure 6 — KB-TZ2 Installation in the top of concrete filled profile steel deck assemblies




1 1-1/2-in B-deck as a minimum profile size. Other deck profiles meeting the B-deck minimum dimensions are also permitted

# DESIGN DATA IN CONCRETE PER CSA A23.3

### CSA A23.3 Annex D Design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. Tables 37, 38, 42 and 43 in this section contains the Limit State Design tables that are based on the published loads in ICC-ES Evaluation Report ESR 4266 and converted for use with CSA A23.3 Annex D. Tables 40, 41, 45 and 46 are Hilti Simplified Design Tables which are pre-factored resistance tables based on the design parameters and variables in Tables 37, 38, 42 and 43. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363 4458 or at www.hilti.ca.

### Table 37 — Hilti KB-TZ2 carbon steel tension design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations[1]

| Design parameter | Symbol | Units | Nominal anchor diameter (in.) | | | | | | | | | | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | 3/8 | | | 1/2 | | | | 5/8 | | | 3/4 | | | 1 | | A23.3 |
| Effective min. embedment [2] | $h_{ef}$ | in. (mm) | 1-1/2 (38) | 1-1/2 (38) | 2 (51) | 2-1/2 (64) | 1-1/2 (38) | 2 (51) | 2-1/2 (64) | 3-1/4 (83) | 2-3/4 (70) | 3-1/4 (83) | 4 (102) | 3-1/4 (83) | 3-3/4 (95) | 4-3/4 (121) | 4 (102) | 5-3/4 (146) | |
| Min. concrete thickness | $h_{min}$ | in. (mm) | See Table 5 | | | | | | | | | | | | | | | | |
| Minimum edge distance | $c_{min}$ | in. (mm) | See Table 5 | | | | | | | | | | | | | | | | |
| Minimum anchor spacing | $s_{min}$ | in. (mm) | See Table 5 | | | | | | | | | | | | | | | | |
| **Tension, steel failure modes** | | | | | | | | | | | | | | | | | | | |
| Steel embed. material resistance factor for reinforcement | $\Phi_s$ | - | 0.85 | 0.85 | | | 0.85 | | | | 0.85 | | | 0.85 | | | 0.85 | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes[3] | R | - | 0.80 | 0.80 | | | 0.80 | | | | 0.80 | | | 0.80 | | | 0.80 | | D.5.3 |
| Min. specified yield strength | $f_{ya}$ | psi ($N/mm^2$) | 100,900 (696) | 100,900 (696) | | | 96,300 (664) | | | | 87,000 (600) | | | 84,700 (584) | | | 75,000 (517) | | |
| Min. specified ult. strength | $f_{ut}$ | psi ($N/mm^2$) | 122,400 (844) | 126,200 (870) | | | 114,000 (786) | | | | 106,700 (736) | | | 105,900 (730) | | | 88,000 (607) | | |
| Effective tensile stress area | $A_{se,N}$ | $in^2$ ($mm^2$) | 0.024 (15.4) | 0.051 (33.2) | | | 0.099 (63.6) | | | | 0.164 (106.0) | | | 0.239 (154.4) | | | 0.470 (303.2) | | |
| Factored steel resistance in tension | $N_{sar}$ | lb (kN) | 1,985 (8.8) | 4,420 (19.7) | | | 7,645 (34.0) | | | | 11,925 (53.0) | | | 17,230 (76.6) | | | 28,145 (125.2) | | D.6.1.2 |
| **Tension, concrete failure modes** | | | | | | | | | | | | | | | | | | | |
| Anchor category | - | - | 3 | 1 | | | 1 | | | | 1 | | | 1 | | | 1 | | D.5.3 (c ) |
| Concrete material resistance factor | $\Phi_c$ | - | 0.65 | 0.65 | | | 0.65 | | | | 0.65 | | | 0.65 | | | 0.65 | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B [5] | R | - | 0.75 | 1.00 | | | 1.00 | | | | 1.00 | | | 1.00 | | | 1.00 | | D.5.3 (c ) |
| Coeff. for factored conc. breakout resistance, uncracked concrete | $k_{c,uncr}$ | - | 10.0 | 10.0 | 10.0 | 10.0 | 11.3 | 11.3 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 11.3 | 11.3[7] | 10.0 | 11.3 | 10.0 | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete | $k_{c,cr}$ | - | 7.1 | 8.8 | 8.8 | 7.1 | 10.0 | 8.8 | 8.8 | 7.1 | 8.8 | 8.8 | 7.1 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked conc. [4] | $\Psi_{c,N}$ | - | 1.0 | 1.0 | | | 1.0 | | | | 1.0 | | | 1.0 | | | 1.0 | | |
| Critical edge distance | $c_{ac}$ | in. (mm) | 4 (102) | 5 (127) | 4-3/8 (111) | 5-1/2 (140) | 8 (203) | 5-1/2 (140) | 6-3/4 (171) | 10 (254) | 10 (254) | 11-1/2 (292) | 8-3/4 (222) | 12 (305) | 10 (254) | 9 (229) | 11 (279) | 16 (406) | |
| Factored pullout resistance in 20 MPa uncracked concrete [6] | $N_{pr,uncr}$ | lb (kN) | 1,055 (4.7) | N/A | N/A | 2,865 (12.7) | N/A | N/A | N/A | N/A | 3,770 (16.8) | N/A | 6,300 (28.0 | N/A | N/A | N/A | N/A | N/A | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete [6] | $N_{pr,cr}$ | lb (kN) | 325 (1.4) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 6,000 (26.7) | N/A | 8,275 (36.8) | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete, seismic [6] | $N_{pr,eq}$ | lb (kN) | 325 (1.4) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 5,880 (26.1) | N/A | 8,275 (36.8) | D.6.3.2 |
| Normalization factor, uncracked concrete | $n_{uncr}$ | - | 0.20 | 0.22 | 0.24 | 0.35 | 0.50 | 0.42 | 0.29 | 0.35 | 0.50 | 0.48 | 0.50 | 0.35 | 0.31 | 0.39 | N/A | 0.38 | |
| Normalization factor, cracked concrete, seismic | $n_{cr}$ | - | 0.39 | 0.50 | 0.46 | 0.28 | 0.47 | 0.50 | 0.48 | 0.40 | 0.50 | 0.47 | 0.50 | 0.36 | 0.42 | 0.29 | N/A | 0.50 | |

1 Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 4 and 6, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB-TZ2 carbon steel anchor is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 For all design cases, $\Psi_{c,P}$ = 1.0. Tabular value for pullout strength is for a concrete compressive strength of 2,900 psi (20.0 M Pa). Pullout strength for concrete compressive strength greater than 2,900 psi (20.2 MPa) may be increased by multiplying the tabular pullout strength by $(f'_c / 2{,}900)^n$ for psi, or $(f'_c / 20.2)^n$ for MPa,
7 For core drilled installation $k_{c,uncr}$ = 10.0 for 3/4" diameter installed at 3-3/4" effective embedment.

## Table 38 — Hilti KB-TZ2 carbon steel shear design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations [1]

| Design parameter | Symbol | Units | Nominal anchor diameter (in.) | | | | | | | | | | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | 3/8 | | | 1/2 | | | | 5/8 | | | 3/4 | | | 1 | | A23.3 |
| Anchor O.D. | $d_a$ | in. | 0.25 | 0.375 | | | 0.5 | | | | 0.625 | | | 0.75 | | | 1.00 | | |
| | | (mm) | (6.4) | (9.5) | | | (12.7) | | | | (15.9) | | | (19.1) | | | (25.4) | | |
| Effective min. embedment [2] | $h_{ef}$ | in. | 1-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 2-3/4 | 3-1/4 | 4 | 3-1/4 | 3-3/4 | 4-3/4 | 4 | 5-3/4 | |
| | | (mm) | (38) | (38) | (51) | (64) | (38) | (51) | (64) | (83) | (70) | (83) | (102) | (83) | (95) | (121) | (102) | (146) | |
| **Shear, steel failure modes** | | | | | | | | | | | | | | | | | | | |
| Steel embed. material resistance factor for reinforcement | $\Phi_s$ | - | 0.85 | 0.85 | | | 0.85 | | | | 0.85 | | | 0.85 | | | 0.85 | | 8.4.3 |
| Resistance modification factor for shear, steel failure modes [3] | R | - | 0.75 | 0.75 | | | 0.75 | | | | 0.75 | | | 0.75 | | | 0.75 | | D.5.3 |
| Factored steel resistance in shear | $V_{sar}$ | lb | 855 | 2,055 | | | 3,530 | | | | 6,540 | | | 8,800 | | | 11,980 | 14,550 | D.7.1.2 |
| | | (kN) | (3.8) | (9.1) | | | (15.7) | | | | (29.1) | | | (39.1) | | | (53.3) | (64.7) | |
| Factored steel resistance in shear, seismic | $V_{sar,eq}$ | lb | 855 | 2,055 | | | 3,530 | | | | 6,540 | | | 8,800 | | | 8,800 | | |
| | | (kN) | (3.8) | (9.1) | | | (15.7) | | | | (29.1) | | | (39.1) | | | (39.1) | | |
| **Shear, concrete failure modes** | | | | | | | | | | | | | | | | | | | |
| Concrete material resistance factor | $\Phi_c$ | - | 0.65 | 0.65 | | | 0.65 | | | | 0.65 | | | 0.65 | | | 0.65 | | 8.4.2 |
| Resistance modification factor for shear, concrete failure modes [4] | R | - | 1.00 | 1.00 | | | 1.00 | | | | 1.00 | | | 1.00 | | | 1.00 | | D.5.3 |
| Load bearing length of anchor in shear | $\ell_e$ | in. | 1-1/2 | 1-1/2 | 2 | 2-1/2 | 1-1/2 | 2 | 2-1/2 | 3-1/4 | 2-3/4 | 3-1/4 | 4 | 3-1/4 | 3-3/4 | 4-3/4 | 4 | 5-3/4 | |
| | | (mm) | (38) | (38) | (51) | (64) | (38) | (51) | (64) | (83) | (70) | (83) | (102) | (83) | (95) | (121) | (102) | (146) | |
| Effectiveness factor for pryout | $k_{cp}$ | - | 1.0 | 1.0 | 1.0 | 2.0 | 1.0 | 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | |

1 Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 4 and 6, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB-TZ2 carbon steel anchor is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

## Table 39 — Steel resistance for Hilti KB-TZ2 carbon steel anchors [1,2]

| Nominal anchor diameter in. | Effective embedment depth in. (mm) | Tensile [3] $\Phi N_{sar}$ lb (kN) | Shear [4] $\Phi V_{sar}$ lb (kN) | Seismic Shear [5] $\Phi V_{sar,eq}$ lb (kN) |
|---|---|---|---|---|
| 1/4 | 1-1/2 (38) | 1,985 (8.8) | 855 (3.8) | 855 (3.8) |
| 3/8 | 1-1/2 (38) | 4,420 (19.7) | 2,055 (9.1) | 2,055 (9.1) |
| 3/8 | 2 (51) | 4,420 (19.7) | 2,160 (9.6) | 2,160 (9.6) |
| | 2-1/2 (64) | | | |
| 1/2 | 1-1/2 (38) | 7,645 (34.0) | 3,530 (15.7) | 3,530 (15.7) |
| | 2 (51) | | | |
| 1/2 | 2-1/2 (64) | 7,645 (34.0) | 4,385 (19.5) | 4,385 (19.5) |
| | 3-1/4 (83) | | | |
| 5/8 | 2-3/4 (70) | 11,925 (53.0) | 6,540 (29.1) | 6,540 (29.1) |
| | 3-1/4 (83) | | | |
| | 4 (102) | | | |
| 3/4 | 3-1/4 (83) | 17,230 (76.6) | 8,800 (39.1) | 8,800 (39.1) |
| | 3-3/4 (95) | | | |
| | 4-3/4 (121) | | | |
| 1 | 4 (102) | 28,145 (125.2) | 11,980 (53.3) | 8,800 (39.1) |
| 1 | 5-3/4 (146) | 28,145 (125.2) | 14,550 (64.7) | 8,800 (39.1) |

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Hilti KB-TZ2 carbon steel anchors are to be considered ductile steel elements.
3 Tensile $N_{sar} = A_{se,N}\ \Phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with $V_{sar} < 0.6\ A_{se,V}\ \Phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \leq 0.60\ A_{se,V}\ \Phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D. See Section 3.1.8 for additional information on seismic applications.

## Table 40 — Hilti KB-TZ2 carbon steel factored resistance based on concrete failure modes in uncracked concrete, applicable for both hammer and core drilled installations [1,2,3,4]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4 | 1 1/2 (38) | 1 3/4 (44) | 1,055 (4.7) | 1,105 (4.9) | 1,145 (5.1) | 1,210 (5.4) | 1,535 (6.8) | 1,720 (7.6) | 1,880 (8.4) | 2,175 (9.7) |
| 3/8 | 1 1/2 (38) | 1 7/8 (48) | 1,535 (6.8) | 1,720 (7.6) | 1,880 (8.4) | 2,175 (9.7) | 1,535 (6.8) | 1,720 (7.6) | 1,880 (8.4) | 2,175 (9.7) |
| | 2 (51) | 2 1/2 (64) | 2,365 (10.5) | 2,645 (11.8) | 2,900 (12.9) | 3,345 (14.9) | 2,365 (10.5) | 2,645 (11.8) | 2,900 (12.9) | 3,345 (14.9) |
| | 2 1/2 (64) | 3 (76) | 2,865 (12.7) | 3,095 (13.8) | 3,300 (14.7) | 3,650 (16.2) | 3,305 (14.7) | 3,695 (16.4) | 4,050 (18.0) | 4,675 (20.8) |
| 1/2 | 1 1/2 (38) | 2 (51) | 1,735 (7.7) | 1,940 (8.6) | 2,125 (9.5) | 2,455 (10.9) | 1,735 (7.7) | 1,940 (8.6) | 2,125 (9.5) | 2,455 (10.9) |
| | 2 (51) | 2 1/2 (64) | 2,675 (11.9) | 2,990 (13.3) | 3,275 (14.6) | 3,780 (16.8) | 2,675 (11.9) | 2,990 (13.3) | 3,275 (14.6) | 3,780 (16.8) |
| | 2 1/2 (64) | 3 (76) | 3,305 (14.7) | 3,695 (16.4) | 4,050 (18.0) | 4,675 (20.8) | 3,305 (14.7) | 3,695 (16.4) | 4,050 (18.0) | 4,675 (20.8) |
| | 3 1/4 (83) | 3 3/4 (95) | 4,900 (21.8) | 5,480 (24.4) | 6,005 (26.7) | 6,930 (30.8) | 9,805 (43.6) | 10,960 (48.8) | 12,005 (53.4) | 13,865 (61.7) |
| 5/8 | 2 3/4 (70) | 3 1/4 (83) | 3,770 (16.8) | 4,215 (18.7) | 4,615 (20.5) | 5,330 (23.7) | 7,630 (33.9) | 8,530 (37.9) | 9,345 (41.6) | 10,790 (48.0) |
| | 3 1/4 (83) | 3 3/4 (95) | 4,900 (21.8) | 5,480 (24.4) | 6,005 (26.7) | 6,930 (30.8) | 9,805 (43.6) | 10,960 (48.8) | 12,005 (53.4) | 13,865 (61.7) |
| | 4 (102) | 4 1/2 (114) | 6,300 (28.0) | 7,045 (31.3) | 7,720 (34.3) | 8,910 (39.6) | 13,385 (59.5) | 14,965 (66.6) | 16,395 (72.9) | 18,930 (84.2) |
| 3/4 | 3 1/4 (83) | 4 (102) | 4,900 (21.8) | 5,480 (24.4) | 6,005 (26.7) | 6,930 (30.8) | 9,805 (43.6) | 10,960 (48.8) | 12,005 (53.4) | 13,865 (61.7) |
| | 3 3/4[6] (95) | 4 1/2 (114) | 6,865 (30.5) | 7,675 (34.1) | 8,405 (37.4) | 9,710 (43.2) | 13,730 (61.1) | 15,350 (68.3) | 16,815 (74.8) | 19,415 (86.4) |
| | 4 3/4 (121) | 5 1/2 (140) | 8,660 (38.5) | 9,685 (43.1) | 10,605 (47.2) | 12,250 (54.5) | 17,320 (77.0) | 19,365 (86.1) | 21,215 (94.4) | 24,495 (109.0) |
| 1 | 4 (102) | 4 5/8 (117) | 7,560 (33.6) | 8,455 (37.6) | 9,260 (41.2) | 10,695 (47.6) | 15,125 (67.3) | 16,910 (75.2) | 18,525 (82.4) | 21,390 (95.1) |
| | 5 3/4 (146) | 6 3/8 (162) | 11,535 (51.3) | 12,895 (57.4) | 14,125 (62.8) | 16,310 (72.6) | 23,070 (102.6) | 25,790 (114.7) | 28,255 (125.7) | 32,625 (145.1) |

## Table 41 — Hilti KB-TZ2 carbon steel factored resistance based on concrete failure modes in cracked concrete, applicable for both hammer and core drilled installations [1,2,3,4,5]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4 | 1 1/2 (38) | 1 3/4 (44) | 325 (1.4) | 350 (1.6) | 380 (1.7) | 425 (1.9) | 1,090 (4.9) | 1,220 (5.4) | 1,335 (5.9) | 1,545 (6.9) |
| 3/8 | 1 1/2 (38) | 1 7/8 (48) | 1,350 (6.0) | 1,510 (6.7) | 1,655 (7.4) | 1,915 (8.5) | 1,350 (6.0) | 1,510 (6.7) | 1,655 (7.4) | 1,915 (8.5) |
| | 2 (51) | 2 1/2 (64) | 2,080 (9.3) | 2,330 (10.4) | 2,550 (11.3) | 2,945 (13.1) | 2,080 (9.3) | 2,330 (10.4) | 2,550 (11.3) | 2,945 (13.1) |
| | 2 1/2 (64) | 3 (76) | 2,350 (10.4) | 2,625 (11.7) | 2,875 (12.8) | 3,320 (14.8) | 2,350 (10.4) | 2,625 (11.7) | 2,875 (12.8) | 3,320 (14.8) |
| 1/2 | 1 1/2 (38) | 2 (51) | 1,535 (6.8) | 1,720 (7.6) | 1,880 (8.4) | 2,175 (9.7) | 1,535 (6.8) | 1,720 (7.6) | 1,880 (8.4) | 2,175 (9.7) |
| | 2 (51) | 2 1/2 (64) | 2,080 (9.3) | 2,330 (10.4) | 2,550 (11.3) | 2,945 (13.1) | 2,080 (9.3) | 2,330 (10.4) | 2,550 (11.3) | 2,945 (13.1) |
| | 2 1/2 (64) | 3 (76) | 2,910 (12.9) | 3,255 (14.5) | 3,565 (15.9) | 4,115 (18.3) | 2,910 (12.9) | 3,255 (14.5) | 3,565 (15.9) | 4,115 (18.3) |
| | 3 1/4 (83) | 3 3/4 (95) | 3,480 (15.5) | 3,890 (17.3) | 4,260 (19.0) | 4,920 (21.9) | 6,960 (31.0) | 7,780 (34.6) | 8,525 (37.9) | 9,845 (43.8) |
| 5/8 | 2 3/4 (70) | 3 1/4 (83) | 3,355 (14.9) | 3,755 (16.7) | 4,110 (18.3) | 4,750 (21.1) | 6,715 (29.9) | 7,505 (33.4) | 8,225 (36.6) | 9,495 (42.2) |
| | 3 1/4 (83) | 3 3/4 (95) | 4,315 (19.2) | 4,820 (21.5) | 5,285 (23.5) | 6,100 (27.1) | 8,625 (38.4) | 9,645 (42.9) | 10,565 (47.0) | 12,200 (54.3) |
| | 4 (102) | 4 1/2 (114) | 4,750 (21.1) | 5,310 (23.6) | 5,820 (25.9) | 6,720 (29.9) | 9,505 (42.3) | 10,625 (47.3) | 11,640 (51.8) | 13,440 (59.8) |
| 3/4 | 3 1/4 (83) | 4 (102) | 4,315 (19.2) | 4,820 (21.5) | 5,285 (23.5) | 6,100 (27.1) | 8,625 (38.4) | 9,645 (42.9) | 10,565 (47.0) | 12,200 (54.3) |
| | 3 3/4 (95) | 4 1/2 (114) | 5,345 (23.8) | 5,975 (26.6) | 6,545 (29.1) | 7,335 (33.6) | 10,690 (47.6) | 11,955 (53.2) | 13,095 (58.2) | 15,120 (67.3) |
| | 4 3/4 (121) | 5 1/2 (140) | 6,000 (26.7) | 6,400 (28.5) | 6,745 (30.0) | 7,335 (32.6) | 15,240 (67.8) | 17,040 (75.8) | 18,670 (83.0) | 21,555 (95.9) |
| 1 | 4 (102) | 4 5/8 (117) | 5,890 (26.2) | 6,585 (29.3) | 7,215 (32.1) | 8,330 (37.0) | 11,780 (52.4) | 13,170 (58.6) | 14,425 (64.2) | 16,660 (74.1) |
| | 5 3/4 (146) | 6 3/8 (162) | 8,275 (36.8) | 9,250 (41.1) | 10,135 (45.1) | 11,700 (52.0) | 20,300 (90.3) | 22,695 (101.0) | 24,865 (110.6) | 28,710 (127.7) |

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 17 as necessary. Compare to the steel values in Table 39. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 $h_{ef}$ where $\alpha_{N,seis}$ = 0.73. No reduction needed for seismic shear. See Section 3.1.8 for additional information on seismic applications.
6 For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.89 to the design tension strength

## Table 42 — Hilti KB-TZ2 stainless steel tension design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations [1]

| Design parameter | Symbol | Units | Nominal anchor diameter (in.) | | | | | | | | | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | 3/8 | | | 1/2 | | | 5/8 | | | 3/4 | | | 1 | | A23.3 |
| Effective min. embedment [2] | $h_{ef}$ | in. (mm) | 1-1/2 (38) | 1-1/2 (38) | 2 (51) | 2-1/2 (64) | 2 (51) | 2-1/2 (64) | 3-1/4 (83) | 2-3/4 (70) | 3-1/4 (83) | 4 (102) | 3-1/4 (83) | 3-3/4 (95) | 4-3/4 (121) | 4 (102) | 5-3/4 (146) | |
| Min. concrete thickness | $h_{min}$ | in. (mm) | See Table 19 | | | | | | | | | | | | | | | |
| Minimum edge distance | $c_{min}$ | in. (mm) | See Table 19 | | | | | | | | | | | | | | | |
| Minimum anchor spacing | $s_{min}$ | in. (mm) | See Table 19 | | | | | | | | | | | | | | | |
| **Tension, steel failure modes** | | | | | | | | | | | | | | | | | | |
| Steel embed. material resistance factor for reinforcement | $\Phi_s$ | - | 0.85 | 0.85 | | | 0.85 | | | 0.85 | | | 0.85 | | | 0.85 | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes [3] | R | - | 0.80 | 0.80 | | | 0.80 | | | 0.80 | | | 0.80 | | | 0.80 | | |
| Min. specified yield strength | $f_{ya}$ | psi ($N/mm^2$) | 100,900 (696) | 96,300 (664) | | | 96,300 (664) | | | 91,600 (632) | | | 84,100 (580) | | | 65,000 (448) | | |
| Min. specified ult. strength | $f_{ut}$ | psi ($N/mm^2$) | 122,400 (844) | 120,100 (828) | | | 120,400 | | | 114,600 (790) | | | 100,500 (693) | | | 99,900 (689) | | |
| Effective tensile stress area | $A_{se,N}$ | $in^2$ ($mm^2$) | 0.024 (15.4) | 0.051 (33.2) | | | 0.099 (63.6) | | | 0.164 (106.0) | | | 0.239 (154.4) | | | 0.470 (303.2) | | |
| Factored steel resistance in tension | $N_{sar}$ | lb (kN) | 2,050 (9.1) | 4,210 (18.7) | | | 8,070 (35.9) | | | 12,810 (57.0) | | | 16,350 (72.7) | | | 31,930 (142.0) | | D.6.1.2 |
| **Tension, concrete failure modes** | | | | | | | | | | | | | | | | | | |
| Anchor category | - | - | 3 | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | D.5.3 (c ) |
| Concrete material resistance factor | $\Phi_c$ | - | 0.65 | 0.65 | | | 0.65 | | | 0.65 | | | 0.65 | | | 0.65 | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B [5] | R | - | 0.75 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | | D.5.3 (c ) |
| Coeff. for factored conc. breakout resistance, uncracked concrete | $k_{c,uncr}$ | - | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 11.3[7] | 10.0 | 11.3 | 11.3 | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete | $k_{c,cr}$ | - | 7.1 | 8.8 | 8.8 | 7.1 | 7.1 | 8.8 | 7.1 | 8.8 | 8.8 | 7.1 | 8.8 | 8.8[7] | 8.8 | 10.0 | 8.8 | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked conc. [4] | $\Psi_{c,N}$ | - | 1.0 | 1.0 | | | 1.0 | | | 1.0 | | | 1.0 | | | 1.0 | | |
| Critical edge distance | $c_{ac}$ | in. (mm) | 4 (102) | 4-1/2 (114) | 5-1/2 (140) | 4-1/8 (105) | 5-1/2 (140) | 6-1/4 (159) | 7-1/2 (191) | 10 (254) | 7 (178) | 9 (229) | 12 (305) | 10 (254) | 10 (254) | 11 (279) | 15-1/2 (394) | |
| Factored pullout resistance in 20 MPa uncracked concrete [6] | $N_{pr,uncr}$ | lb (kN) | 810 (3.6) | N/A | N/A | 2,875 (12.8) | 2,355 (10.5) | 2,810 (12.5) | 3,855 (17.1) | 2,860 (12.7) | 4,165 (18.5) | 5,615 (25.0) | N/A | N/A | N/A | N/A | N/A | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete [6] | $N_{pr,cr}$ | lb (kN) | 360 (1.6) | N/A | N/A | N/A | N/A | N/A | N/A[8] | N/A | N/A | N/A | N/A | N/A | 6,160 (27.4) | N/A | N/A | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete, seismic [6] | $N_{pr,eq}$ | lb (kN) | 360 (1.6) | N/A | N/A | N/A | N/A | N/A | N/A[8] | N/A | N/A | N/A | N/A | N/A | 6,160 (27.4) | N/A | N/A | D.6.3.2 |
| Normalization factor, uncracked concrete | $n_{uncr}$ | - | 0.39 | N/A | N/A | 0.37 | 0.46 | 0.50 | 0.50 | 0.50 | 0.42 | 0.47 | N/A | N/A | 0.30 | N/A | N/A | |
| Normalization factor, cracked concrete, seismic | $n_{cr}$ | - | 0.50 | N/A | N/A | N/A | N/A | N/A | 0.50 | N/A | N/A | N/A | N/A | N/A | 0.50 | N/A | N/A | |

1 Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 5 and 7, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB-TZ2 stainless steel anchor is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 For all design cases, $\Psi_{c,P}$ = 1.0. Tabular value for pullout strength is for a concrete compressive strength of 2,900 psi (20.0 MPa). Pullout strength for concrete compressive strength greater than 2,900 psi (20.2 MPa) may be increased by multiplying the tabular pullout strength by $(f'_c / 2{,}900)n$ for psi, or $(f'_c / 20.2)^n$ for MPa.
7 For core drilled installation $k_{c,uncr}$ = 10.0 and $k_{c,cr}$ = 7.1 for 3/4" diameter installed at 3-3/4" effective embedment
8 For core drilled installation, $N_{p,c}r$ = 4245 lb (18.9 kN) and $N_{p,eq}$ = 4245 lb (18.9 kN) for 1/2-inch diameter anchors installed at 3-3/4 inches (95 mm) effective embedment.

## Table 43 — Hilti KB-TZ2 stainless steel shear design information in accordance with CSA A23.3 Annex D, applicable for both hammer and core drilled installations[1]

| Design parameter | Symbol | Units | Nominal anchor diameter (in.) | | | | | | | | | | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | 3/8 | | | 1/2 | | | 5/8 | | | 3/4 | | | 1 | | | A23.3 |
| Anchor O.D. | $d_a$ | in. | 0.25 | 0.375 | | | 0.5 | | | 0.625 | | | 0.75 | | | 1.00 | | | |
| | | (mm) | (6.4) | (9.5) | | | (12.7) | | | (15.9) | | | (19.1) | | | (25.4) | | | |
| Effective min. embedment [2] | $h_{ef}$ | in. | 1-1/2 | 1-1/2 | 2 | 2-1/2 | 2 | 2-1/2 | 3-1/4 | 2-3/4 | 3-1/4 | 4 | 3-1/4 | 3-3/4 | 4-3/4 | 4 | 5-3/4 | | |
| | | (mm) | (38) | (38) | (51) | (64) | (51) | (64) | (83) | (70) | (83) | (102) | (83) | (95) | (121) | (102) | (146) | | |
| Shear, steel failure modes | | | | | | | | | | | | | | | | | | | |
| Steel embed. material resistance factor for reinforcement | $\Phi_s$ | - | 0.85 | 0.85 | | | 0.85 | | | 0.85 | | | 0.85 | | | 0.85 | | | 8.4.3 |
| Resistance modification factor for shear, steel failure modes [3] | R | - | 0.75 | 0.75 | | | 0.75 | | | 0.75 | | | 0.75 | | | 0.75 | | | |
| Factored steel resistance in shear | $V_{sar}$ | lb | 930 | 2,940 | 3,115 | | 5,320 | | | 7,875 | | | 10,555 | | | 14,635 | 20,020 | | D.7.1.2 |
| | | (kN) | (4.1) | (13.1) | (13.9) | | (23.7) | | | (35.0) | | | (47.0) | | | (65.1) | (89.1) | | |
| Factored steel resistance in shear, seismic | $V_{sar,eq}$ | lb | 710 | 2,940 | 3,115 | | 5,320 | | | 7,875 | | | 8,585 | | | 8,585 | | | |
| | | (kN) | (3.2) | (13.1) | (13.9) | | (23.7) | | | (35.0) | | | (38.2) | | | (38.2) | | | |
| Shear, concrete failure modes | | | | | | | | | | | | | | | | | | | |
| Concrete material resistance factor | $\Phi_c$ | - | 0.65 | 0.65 | | | 0.65 | | | 0.65 | | | 0.65 | | | 0.65 | | | 8.4.2 |
| Resistance modification factor for shear, concrete failure modes [4] | R | - | 0.75 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | | | D.5.3 (c ) |
| Load bearing length of anchor in shear | $\ell_e$ | in. | 1-1/2 | 1-1/2 | 2 | 2-1/2 | 2 | 2-1/2 | 3-1/4 | 2-3/4 | 3-1/4 | 4 | 3-1/4 | 3-3/4 | 4-3/4 | 4 | 5-3/4 | | |
| | | (mm) | (38) | (38) | (51) | (64) | (51) | (64) | (83) | (70) | (83) | (102) | (83) | (95) | (121) | (102) | (146) | | |
| Effectiveness factor for pryout | $k_{cp}$ | - | 1.0 | 1.0 | 1.0 | 2.0 | 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | | |

1 Design information in this table is taken from ICC-ES ESR-4266, dated December, 2020, and revised July, 2021 Tables 5 and 7, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB-TZ2 stainless steel anchor is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.

## Table 44 — Steel resistance for Hilti KB-TZ2 stainless steel anchors [1,2]

| Nominal anchor diameter in. | Effective embedment depth in. (mm) | | | Tensile [3] $N_{sar}$ lb (kN) | Shear [4] $V_{sar}$ lb (kN) | Seismic Shear [5] $V_{sar,eq}$ lb (kN) |
|---|---|---|---|---|---|---|
| 1/4 | 1-1/2 (38) | | | 2,050 (9.1) | 930 (4.1) | 710 (3.2) |
| 3/8 | 1-1/2 (38) | | | 4,210 (18.7) | 2,940 (13.1) | 2,940 (13.1) |
| 3/8 | 2 (51) | 2-1/2 (64) | | 4,210 (18.7) | 3,115 (13.9) | 3,115 (13.9) |
| 1/2 | 2 (51) | 2-1/2 (64) | 3-1/4 (83) | 8,070 (35.9) | 5,320 (23.7) | 5,320 (23.7) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 4 (102) | 12,810 (57.0) | 7,875 (35.0) | 7,875 (35.0) |
| 3/4 | 3-1/4 (83) | 3-3/4 (95) | 4-3/4 (121) | 16,350 (72.7) | 10,555 (47.0) | 8,585 (38.2) |
| 1 | 4 (102) | | | 31,930 (142.0) | 14,635 (65.1) | 8,585 (38.2) |
| 1 | 5-3/4 (146) | | | 31,930 (142.0) | 20,020 (89.1) | 8,585 (38.2) |

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Hilti KB-TZ2 stainless steel anchors are to be considered ductile steel elements.
3 Tensile Nsar = Ase,N fs futa R as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with Vsar < 0.6 Ase,V fs futa R as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with Vsar,eq < 0.60 Ase,V fs futa R as noted in CSA A23.3 Annex D. See Section 3.1.8 for additional information on seismic applications.

## Table 45 — Hilti KB-TZ2 stainless steel factored resistance based on concrete failure modes in uncracked concrete, applicable for both hammer and core drilled installations [1,2,3,4]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4 | 1 1/2 (38) | 1 3/4 (44) | 810 (3.6) | 885 (3.9) | 950 (4.2) | 1,065 (4.7) | 1,535 (6.8) | 1,720 (7.6) | 1,880 (8.4) | 2,175 (9.7) |
| 3/8 | 1 1/2 (38) | 1 7/8 (48) | 1,535 (6.8) | 1,720 (7.6) | 1,880 (8.4) | 2,175 (9.7) | 1,535 (6.8) | 1,720 (7.6) | 1,880 (8.4) | 2,175 (9.7) |
| | 2 (51) | 2 1/2 (64) | 2,365 (10.5) | 2,645 (11.8) | 2,900 (12.9) | 3,345 (14.9) | 2,365 (10.5) | 2,645 (11.8) | 2,900 (12.9) | 3,345 (14.9) |
| | 2 1/2 (64) | 3 (76) | 2,875 (12.8) | 3,125 (13.9) | 3,340 (14.9) | 3,715 (16.5) | 6,615 (29.4) | 7,395 (32.9) | 8,100 (36.0) | 9,355 (41.6) |
| 1/2 | 2 (51) | 2 1/2 (64) | 2,355 (10.5) | 2,610 (11.6) | 2,835 (12.6) | 3,240 (14.4) | 2,365 (10.5) | 2,645 (11.8) | 2,900 (12.9) | 3,345 (14.9) |
| | 2-1/2 (64) | 3 (76) | 2,810 (12.5) | 3,140 (14.0) | 3,440 (15.3) | 3,975 (17.7) | 6,615 (29.4) | 7,395 (32.9) | 8,100 (36.0) | 9,355 (41.6) |
| | 3 1/4 (83) | 3 3/4 (95) | 3,855 (17.1) | 4,310 (19.2) | 4,720 (21.0) | 5,450 (24.2) | 9,805 (43.6) | 10,960 (48.8) | 12,005 (53.4) | 13,865 (61.7) |
| 5/8 | 2 3/4 (70) | 3 1/4 (83) | 2,860 (12.7) | 3,200 (14.2) | 3,505 (15.6) | 4,045 (18.0) | 7,630 (33.9) | 8,530 (37.9) | 9,345 (41.6) | 10,790 (48.0) |
| | 3 1/4 (83) | 3 3/4 (95) | 4,165 (18.5) | 4,575 (20.3) | 4,935 (22.0) | 5,570 (24.8) | 9,805 (43.6) | 10,960 (48.8) | 12,005 (53.4) | 13,865 (61.7) |
| | 4 (102) | 4 1/2 (114) | 5,615 (25.0) | 6,235 (27.7) | 6,795 (30.2) | 7,775 (34.6) | 13,385 (59.5) | 14,965 (66.6) | 16,395 (72.9) | 18,930 (84.2) |
| 3/4 | 3 1/4 (83) | 4 (102) | 4,900 (21.8) | 5,480 (24.4) | 6,005 (26.7) | 6,930 (30.8) | 9,805 (43.6) | 10,960 (48.8) | 12,005 (53.4) | 13,865 (61.7) |
| | 3 3/4[6] (95) | 4 1/2 (114) | 6,865 (30.5) | 7,675 (34.1) | 8,405 (37.4) | 9,710 (43.2) | 13,730 (61.1) | 15,350 (68.3) | 16,815 (74.8) | 19,415 (86.4) |
| | 4 3/4 (121) | 5 1/2 (140) | 8,660 (38.5) | 9,685 (43.1) | 10,605 (47.2) | 12,250 (54.5) | 17,320 (77.0) | 19,365 (86.1) | 21,215 (94.4) | 24,495 (109.0) |
| 1 | 4 (102) | 4 5/8 (117) | 7,560 (33.6) | 8,455 (37.6) | 9,260 (41.2) | 10,695 (47.6) | 15,125 (67.3) | 16,910 (75.2) | 18,525 (82.4) | 21,390 (95.1) |
| | 5 3/4 (146) | 6 3/8 (162) | 13,035 (58.0) | 14,570 (64.8) | 15,965 (71.0) | 18,435 (82.0) | 26,070 (116.0) | 29,145 (129.6) | 31,925 (142.0) | 36,865 (164.0) |

## Table 46 — Hilti KB-TZ2 stainless steel factored resistance based on concrete failure modes in cracked concrete, applicable for both hammer and core drilled installations [1,2,3,4]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4 | 1 1/2 (38) | 1 3/4 (44) | 470 (2.1) | 525 (2.3) | 575 (2.6) | 665 (3.0) | 820 (3.6) | 915 (4.1) | 1,000 (4.5) | 1,155 (5.1) |
| 3/8 | 1 1/2 (38) | 1 7/8 (48) | 1,350 (6.0) | 1,510 (6.7) | 1,655 (7.4) | 1,915 (8.5) | 1,350 (6.0) | 1,510 (6.7) | 1,655 (7.4) | 1,915 (8.5) |
| | 2 (51) | 2 1/2 (64) | 2,080 (9.3) | 2,330 (10.4) | 2,550 (11.3) | 2,945 (13.1) | 2,080 (9.3) | 2,330 (10.4) | 2,550 (11.3) | 2,945 (13.1) |
| | 2 1/2 (64) | 3 (76) | 2,350 (10.4) | 2,625 (11.7) | 2,875 (12.8) | 3,320 (14.8) | 4,695 (20.9) | 5,250 (23.4) | 5,750 (25.6) | 6,640 (29.5) |
| 1/2 | 2 (51) | 2 1/2 (64) | 1,680 (7.5) | 1,880 (8.4) | 2,060 (9.2) | 2,375 (10.6) | 1,680 (7.5) | 1,880 (8.4) | 2,060 (9.2) | 2,375 (10.6) |
| | 2-1/2 (64) | 3 (76) | 2,910 (12.9) | 3,255 (14.5) | 3,565 (15.9) | 4,115 (18.3) | 5,820 (25.9) | 6,505 (28.9) | 7,130 (31.7) | 8,230 (36.6) |
| | 3 1/4[8] (83) | 3 3/4 (95) | 3,480 (15.5) | 3,890 (17.3) | 4,260 (19.0) | 4,920 (21.9) | 6,960 (31.0) | 7,780 (34.6) | 8,525 (37.9) | 9,845 (43.8) |
| 5/8 | 2 3/4 (70) | 3 1/4 (83) | 3,355 (14.9) | 3,755 (16.7) | 4,110 (18.3) | 4,750 (21.1) | 6,715 (29.9) | 7,505 (33.4) | 8,225 (36.6) | 9,495 (42.2) |
| | 3 1/4 (83) | 3 3/4 (95) | 4,315 (19.2) | 4,820 (21.5) | 5,285 (23.5) | 6,100 (27.1) | 8,625 (38.4) | 9,645 (42.9) | 10,565 (47.0) | 12,200 (54.3) |
| | 4 (102) | 4 1/2 (114) | 4,750 (21.1) | 5,310 (23.6) | 5,820 (25.9) | 6,720 (29.9) | 9,505 (42.3) | 10,625 (47.3) | 11,640 (51.8) | 13,440 (59.8) |
| 3/4 | 3 1/4 (83) | 4 (102) | 4,315 (19.2) | 4,820 (21.5) | 5,285 (23.5) | 6,100 (27.1) | 8,625 (38.4) | 9,645 (42.9) | 10,565 (47.0) | 12,200 (54.3) |
| | 3 3/4[7] (95) | 4 1/2 (114) | 5,345 (23.8) | 5,975 (26.6) | 6,545 (29.1) | 7,560 (33.6) | 10,690 (47.6) | 11,955 (53.2) | 13,095 (58.2) | 15,120 (67.3) |
| | 4 3/4 (121) | 5 1/2 (140) | 6,160 (27.4) | 6,890 (30.6) | 7,545 (33.6) | 8,715 (38.8) | 15,240 (67.8) | 17,040 (75.8) | 18,670 (83.0) | 21,555 (95.9) |
| 1 | 4 (102) | 4 5/8 (117) | 6,690 (29.8) | 7,480 (33.3) | 8,195 (36.5) | 9,465 (42.1) | 13,385 (59.5) | 14,965 (66.6) | 16,395 (72.9) | 18,930 (84.2) |
| | 5 3/4 (146) | 6 3/8 (162) | 10,150 (45.2) | 11,350 (50.5) | 12,430 (55.3) | 14,355 (63.9) | 20,300 (90.3) | 22,695 (101.0) | 24,865 (110.6) | 28,710 (127.7) |

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 22 to 33 as necessary. Compare to the steel values in Table 43. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear, except for the 3/4 bolts where $\alpha_{V,seis}$ = 0.81. See Section 3.1.8 for additional information on seismic applications.
6 For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.89 to the design tension strength.
7 For core drilled installations of 3/4“ anchors installed at 3-3/4“ effective embedment, apply a reduction factor of 0.81 to the design tension strength.
8 Fore core drilled installations of 1/2" anchors installed at 3-1/4" effective embedment, apply a reduction factor of 0.85 to the design tension strength.

## Table 47 — Hilti KB-TZ2 carbon steel factored resistance in the soffit of uncracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations[1,2,3,4,5,6]

| Nominal anchor diameter in. | Nominal embedment in. (mm) | Installation per Figure 4 | | | | Installation per Figure 5 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Min. conc. thickness [8] in. (mm) | Tension - $N_r$ | | Shear - $V_r$ | Min. conc. thickness [8] in. (mm) | Tension - $N_r$ | | Shear - $V_r$ |
| | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c \geq$ 20 MPa (2,900 psi) lb (kN) | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c \geq$ 20 MPa (2,900 psi) lb (kN) |
| 1/4 | 1-3/4 (44) | 2-1/2 (64) | 835 (3.7) | 905 (4.0) | 1,040 (4.6) | 2-1/4 (57) | 670 (3.0) | 725 (3.2) | 715 (3.2) |
| 3/8 | 1-7/8 (48) | 2-1/2 (64) | 1,195 (5.3) | 1,310 (5.8) | 865 (3.8) | 2-1/4 (57) | 640 (2.8) | 700 (3.1) | 1,510 (6.7) |
| | 2-1/2 (64) | 2-1/2 (64) | 1,690 (7.5) | 1,865 (8.3) | 1,350 (6.0) | 2-1/4 (57) | 1600 (7.1) | 1,765 (7.9) | 1,595 (7.1) |
| | 3 (76) | 2-1/2 (64) | 1,925 (8.6) | 2,215 (9.9) | 1,350 (6.0) | N/A | N/A | N/A | N/A |
| 1/2 | 2 (51) | 2-1/2 (64) | 1,185 (5.3) | 1,450 (6.4) | 1,140 (5.1) | 2-1/4 (57) | 1,160 (5.2) | 1,420 (6.3) | 1,710 (7.6) |
| | 2-1/2 (64) | 2-1/2 (64) | 1,760 (7.8) | 2,090 (9.3) | 1,440 (6.4) | 2-1/4 (57) | 1,220 (5.4) | 1,445 (6.4) | 2,025 (9.0) |
| | 3-1/4 (83) | 2-1/2 (64) | 2,410 (10.7) | 2,710 (12.1) | 2,095 (9.3) | N/A | N/A | N/A | N/A |
| | 3-3/4 (95) | 2-1/2 (64) | 3,030 (13.5) | 3,490 (15.5) | 2,700 (12.0) | 3-1/4 (83) | 1,710 (7.6) | 1,975 (8.8) | 2,210 (9.8) |
| 5/8 | 3-1/4 (83) | 2-1/2 (64) | 2,820 (12.5) | 3,455 (15.4) | 2,430 (10.8) | 3-1/4 (83) | 1,890 (8.4) | 2,315 (10.3) | 2,605 (11.6) |
| | 4-1/2 (114) | 2-1/2 (64) | 3,715 (16.5) | 4,550 (20.2) | 2,965 (13.2) | N/A | N/A | N/A | N/A |
| 3/4 | 4 (102) | 2-1/2 (64) | 2,440 (10.9) | 2,815 (12.5) | 2,605 (11.6) | N/A | N/A | N/A | N/A |
| | 4-1/2[9] (114) | 3-1/4 (83) | 3,085 (13.7) | 3,495 (15.5) | 5,015 (22.3) | N/A | N/A | N/A | N/A |

3.3.5

## Table 48 — Hilti KB-TZ2 carbon steel factored resistance in the soffit of cracked lightweight concrete over metal deck, applicable for both hammer and core drilled installations [1,2,3,4,5,6,7]

| Nominal anchor diameter in. | Nominal embedment in. (mm) | Installation per Figure 4 | | | | Installation per Figure 5 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Min. conc. thickness [8] in. (mm) | Tension - $N_r$ | | Shear - $V_r$ | Min. conc. thickness [8] in. (mm) | Tension - $N_r$ | | Shear - $V_r$ |
| | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c \geq$ 20 MPa (2,900 psi) lb (kN) | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c \geq$ 20 MPa (2,900 psi) lb (kN) |
| 1/4 | 1-3/4 (44) | 2-1/2 (64) | 250 (1.1) | 290 (1.3) | 1,040 (4.6) | 2-1/4 (57) | 195 (0.9) | 230 (1.0) | 715 (3.2) |
| 3/8 | 1-7/8 (48) | 2-1/2 (64) | 1,040 (4.6) | 1,270 (5.6) | 865 (3.8) | 2-1/4 (57) | 555 (2.5) | 680 (3.0) | 1,510 (6.7) |
| | 2-1/2 (64) | 2-1/2 (64) | 1,470 (6.5) | 1,770 (7.9) | 1,350 (6.0) | 2-1/4 (57) | 1,365 (6.1) | 1,645 (7.3) | 1,595 (7.1) |
| | 3 (76) | 2-1/2 (64) | 1,550 (6.9) | 1,735 (7.7) | 1,350 (6.0) | N/A | N/A | N/A | N/A |
| 1/2 | 2 (51) | 2-1/2 (64) | 1,055 (4.7) | 1,275 (5.7) | 1,140 (5.1) | 2-1/4 (57) | 945 (4.2) | 1,160 (5.1) | 1,710 (7.6) |
| | 2-1/2 (64) | 2-1/2 (64) | 1,365 (6.1) | 1,670 (7.4) | 1,440 (6.4) | 2-1/4 (57) | 945 (4.2) | 1,160 (5.2) | 2,025 (9.0) |
| | 3-1/4 (83) | 2-1/2 (64) | 2,095 (9.3) | 2,545 (11.3) | 2,095 (9.3) | N/A | N/A | N/A | N/A |
| | 3-3/4 (95) | 2-1/2 (64) | 2,140 (9.5) | 2,520 (11.2) | 2,700 (12.0) | 3-1/4 (83) | 1,210 (5.4) | 1,425 (6.3) | 2,210 (9.8) |
| 5/8 | 3-1/4 (83) | 2-1/2 (64) | 2,510 (11.2) | 3,075 (13.7) | 2,430 (10.8) | 3-1/4 (83) | 1,685 (7.5) | 2,060 (9.2) | 2,605 (11.6) |
| | 4-1/2 (114) | 2-1/2 (64) | 2,810 (12.5) | 3,440 (15.3) | 2,965 (13.2) | N/A | N/A | N/A | N/A |
| 3/4 | 4 (102) | 2-1/2 (64) | 2,135 (9.5) | 2,470 (11.0) | 2,605 (11.6) | N/A | N/A | N/A | N/A |
| | 4-1/2 (114) | 3-1/4 (83) | 2,400 (10.7) | 2,700 (12.0) | 5,015 (22.3) | N/A | N/A | N/A | N/A |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 $h_{ef}$ where $\alpha_{N,seis}$ = 0.73. See Section 3.1.8 for additional information on seismic applications.
8 Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 4 and 5.
9 For core drilled installations of 3/4“ anchors installed at 4-1/2“ nominal embedment, apply a reduction factor of 0.89 to the design tension strength of anchors installed in uncracked concrete.

## Table 49 — Allowable tensile loads for Hilti KB-TZ2 carbon steel and stainless steel anchors in the face of grout-filled concrete masonry unit (CMU) walls [1,3,4,5,6]

| Nominal anchor diameter | Nominal embedment | | Allowable Tensile capacity at $s_{cr}$ and $c_{cr}$ | | Spacing | | | | Edge Distance | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Critical spacing, $s_{cr}$ | | Minimum spacing[2], $s_{min}$ | | Load Multiplier at $s_{min}$ | Critical edge distance, $c_{cr}$ | | Minimum edge distance, $c_{min}$ | | Load Multiplier at $c_{min}$ |
| in. | in. | (mm) | lb | (kN) | in | (mm) | in | (mm) | | in | (mm) | in | (mm) | |
| 1/4 | 1-3/4 | (44) | 145 | (0.6) | 6 | (152) | 3 | (76) | 0.62 | 12 | (305) | 4 | (102) | 0.87 |
| 3/8 | 1-7/8 | (48) | 405 | (1.8) | 6 | (152) | | | 0.49 | | | | | 0.80 |
| | 3 | (76) | 590 | (2.6) | 10 | (254) | | | 0.58 | | | | | 0.93 |
| 1/2 | 2-1/2 | (64) | 500 | (2.2) | 8 | (203) | 4 | (102) | 0.59 | | | | | 0.94 |
| | 3-3/4 | (95) | 640 | (2.8) | 13 | (330) | | | 0.78 | | | | | 1.00 |
| 5/8 | 3-1/4 | (83) | 890 | (4.0) | 11 | (279) | 5 | (127) | 0.66 | 20 | (508) | | | 0.96 |
| | 4-1/2 | (114) | 940 | (4.2) | 16 | (406) | | | 0.61 | | | | | 0.96 |
| 3/4 | 4 | (102) | 1,245 | (5.5) | 13 | (330) | 6 | (152) | 0.49 | | | | | 0.75 |
| | 5-1/2 | (140) | 1,385 | (6.2) | 19 | (483) | | | 0.45 | | | | | 0.82 |

## Table 50 — Allowable shear loads for Hilti KB-TZ2 carbon steel and stainless steel anchors in the face of grout-filled concrete masonry unit (CMU) walls [1,3,4,5,6]

| Nominal anchor diameter | Nominal embedment | | Allowable shear capacity at $s_{cr}$ and $c_{cr}$ | | Spacing | | | | | Edge Distance | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Critical spacing, $s_{cr}$ | | Minimum spacing, $s_{min}$[2] | | Load multiplier at $s_{min}$ | Critical edge distance, $c_{cr}$ | | Minimum edge distance, $c_{min}$ | | Perpendicular load reduction factor at $c_{min}$ | Parallel load reduction factor at $c_{min}$ |
| in. | in. | (mm) | lb | (kN) | in | (mm) | in | (mm) | | in | (mm) | in | (mm) | | |
| 1/4 | 1-3/4 | (44) | 320 | (1.4) | 6 | (152) | 3 | (76) | 0.73 | 12 | (305) | 4 | (102) | 1.00 | 1.00 |
| 3/8 | 1-7/8 | (48) | 585 | (2.6) | 6 | (152) | | | | | | | | 0.76 | 0.99 |
| | 3 | (76) | 695 | (3.1) | 10 | (254) | | | | | | | | | |
| 1/2 | 2-1/2 | (64) | 1,045 | (4.7) | 8 | (203) | 4 | (102) | | | | | | 0.50 | 0.83 |
| | 3-3/4 | (95) | | | 13 | (330) | | | | | | | | | |
| 5/8 | 3-1/4 | (83) | 1,735 | (7.7) | 11 | (279) | 5 | (127) | | 20 | (508) | | | 0.36 | 0.75 |
| | 4-1/2 | (114) | 2,050 | (9.1) | 16 | (406) | | | | | | | | 0.35 | 0.85 |
| 3/4 | 4 | (102) | 1,735 | (7.7) | 13 | (330) | 6 | (152) | | | | | | 0.36 | 0.75 |
| | 5-1/2 | (140) | 2,050 | (9.1) | 19 | (483) | | | | | | | | 0.35 | 0.85 |

1 Values valid for anchors installed in face shells of Type 1, Grade N, lightweight, medium-weight, or normal-weight concrete masonry units conforming to ASTM C90. The masonry units must be fully grouted with coarse grout conforming to 2018 and 2015 IBC Section 2103.3, 2012 IBC Section 2103.13, or 2009 IBC Section 2103.12. Mortar must comply with 2018 and 2015 IBC Section 2103.2.1, 2012 IBC Section 2103.9, or 2009 IBC Section 2103.8. Masonry compressive strength must be at least 1,500 psi at the time of anchor installation.
2 Loads tabulated are applicable to anchors spaced a critical distance of 4 times the effective embedment. The anchors may be placed at a minimum spacing, $s_{min}$, provided that reductions are applied to the tabulated values.
3 Anchors must be installed a minimum of 1-3/8-inches from any vertical mortar joint in accordance with Figure 6.
4 Embedment depth must be measured from the outside face of the concrete masonry unit.
5 For intermediate edge and spacing distances, allowable loads may be determined by linearly interpolating between the allowable loads at the two tabulated edge or spacing distances.
6 The tabulated allowable loads have been calculated based on a safety factor of 5.0.

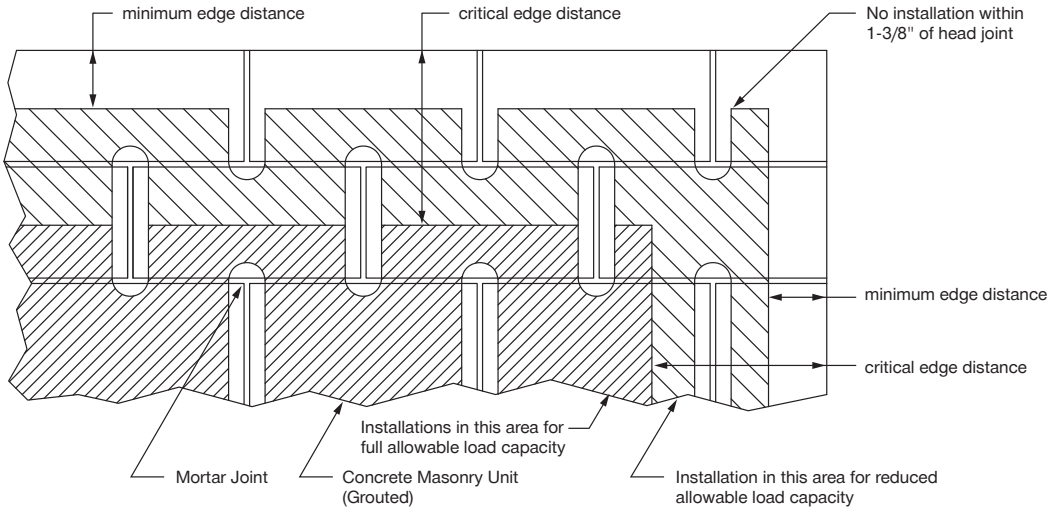
## Table 51 — Allowable tensile and shear loads for Hilti KB-TZ2 carbon and stainless steel anchors in the top of grout-filled concrete masonry walls [1,3,4,5,6]

| Nominal anchor diameter | Nominal embedment | | Minimum edge distance from edge of wall, $C_{min}$ | | Minimum spacing,[2] $s_{min}$ | | Minimum end distance $C_{end}$ | | Allowable tensile capacity | | Allowable shear capacity | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Parallel to edge of masonry wall | | Perpendicular to edge of masonry wall | |
| in. | in. | (mm) | in | (mm) | in | (mm) | in | (mm) | lb | (kN) | lb | (kN) | lb | (kN) |
| 3/8 | 1-7/8 | (48) | 1-3/4 | (44) | 6 | (152) | 12 | (305) | 300 | (1.3) | 325 | (1.4) | 175 | (0.8) |
| | 3 | (76) | | | 10 | (254) | 12 | (305) | 395 | (1.8) | 475 | (2.1) | 220 | (1.0) |
| 1/2 | 2-1/2 | (64) | | | 8 | (203) | 12 | (305) | 385 | (1.7) | 500 | (2.2) | 195 | (0.9) |
| | 3-3/4 | (95) | | | 13 | (330) | 12 | (305) | 485 | (2.2) | 610 | (2.7) | 240 | (1.1) |
| 5/8 | 3-1/4 | (83) | 2-3/4 | (70) | 11 | (279) | 12 | (305) | 620 | (2.8) | 930 | (4.1) | 410 | (1.8) |
| | 4-1/2 | (114) | | | 16 | (406) | 12 | (305) | 865 | (3.8) | 1240 | (5.5) | 465 | (2.1) |

1 Values valid for anchors installed in face shells of Type 1, Grade N, lightweight, medium-weight, or normal-weight concrete masonry units conforming to ASTM C90. The masonry units must be fully grouted with coarse grout conforming to 2018 and 2015 IBC Section 2103.3, 2012 IBC Section 2103.13, or 2009 IBC Section 2103.12. Mortar must comply with 2018 and 2015 IBC Section 2103.2.1, 2012 IBC Section 2103.9, or 2009 IBC Section 2103.8. Masonry compressive strength must be at least 1,500 psi at the time of anchor installation.
2 Loads tabulated are applicable to anchors spaced a critical distance of 4 times the effective embedment. The anchors may be placed at a minimum spacing, $s_{min}$, provided that reductions are applied to the tabulated values.
3 Anchors must be installed a minimum of 1-3/8 inches from any head joint in accordance with Figure 6.
4 Embedment depth must be measured from the outside face of the concrete masonry unit.
5 For intermediate edge and spacing distances, allowable loads may be determined by linearly interpolating between the allowable loads at the two tabulated edge or spacing distances.
6 The tabulated allowable loads have been calculated based on a safety factor of 5.0.

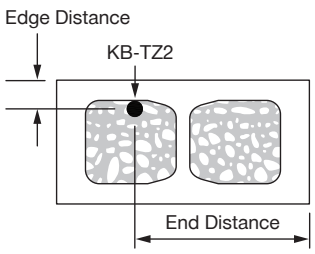
## Figure 7 — Acceptable locations (shaded areas) for Hilti KB-TZ2 anchors in the face of grout-filled CMU walls






Anchor installation is restricted to shaded areas

## Figure 8 — Edge and end distances for the Hilti KB-TZ2 anchors installed in the top of grout-filled CMU walls



## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## ORDERING INSTRUCTIONS

**Table 52 — Hilti KB-TZ2 carbon steel product portfolio**

| Description | Length (in) | Length ident. letter | Thread length (in) | Nominal embed. 1 (in) | Min. fixture thickness 1 (in) | Max. fixture thickness 1 (in) | Nominal embed. 2 (in) | Min. fixture thickness 2 (in) | Max. fixture thickness 2 (in) | Nominal embed. 3 (in) | Min. fixture thickness 3 (in) | Max. fixture thickness 3 (in) | Nominal embed. 4 (in) | Min. fixture thickness 4 (in) | Max. fixture thickness 4 (in) | Package quantity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KB-TZ2 1/4 x 2-1/8 | 2-1/8 | B | 7/8 | 1-3/4 | 0 | 1/8 | - | - | - | - | - | - | - | - | - | 100 |
| KB-TZ2 1/4 x 2-1/2 | 2-1/2 | C | 1-1/4 | 1-3/4 | 0 | 1/2 | - | - | - | - | - | - | - | - | - | 100 |
| KB-TZ2 1/4 x 3-1/4 | 3-1/4 | D | 2 | 1-3/4 | 0 | 1-1/4 | - | - | - | - | - | - | - | - | - | 100 |
| KB-TZ2 1/4 x 4-1/2 | 4-1/2 | G | 3 | 1-3/4 | 1/8 | 2-1/2 | - | - | - | - | - | - | - | - | - | 100 |
| KB-TZ2 3/8 x 2-1/2 | 2-1/2 | C | 1 | 1-7/8 | 0 | 1/4 | - | - | - | - | - | - | - | - | - | 50 |
| KB-TZ2 3/8 x 3 | 3 | D | 1 1/2 | 1-7/8 | 0 | 3/4 | 2-1/2 | 0 | 1/4 | - | - | - | - | - | - | 50 |
| KB-TZ2 3/8 x 3-1/2 | 3-1/2 | Ω | 2 | 1-7/8 | 0 | 1-1/4 | 2-1/2 | 0 | 3/4 | 3 | 0 | 1/4 | - | - | - | 50 |
| KB-TZ2 3/8 x 3-3/4 | 3-3/4 | E | 2-1/4 | 1-7/8 | 0 | 1-1/2 | 2-1/2 | 0 | 1 | 3 | 0 | 1/2 | - | - | - | 50 |
| KB-TZ2 3/8 x 5 | 5 | H | 3-1/2 | 1-7/8 | 0 | 2-3/4 | 2-1/2 | 0 | 2-1/4 | 3 | 0 | 1-3/4 | - | - | - | 50 |
| KB-TZ2 3/8 x 7 | 7 | L | 4-7/8 | 1-7/8 | 1/2 | 4-3/4 | 2-1/2 | 0 | 4-1/4 | 3 | 0 | 3-3/4 | - | - | - | 50 |
| KB-TZ2 1/2 x 3 | 3 | D | 1-1/8 | 2 | 1/4 | 1/2 | 2-1/2 | 0 | 0 | - | - | - | - | - | - | 20 |
| KB-TZ2 1/2 x 3-3/4 | 3-3/4 | E | 1-5/8 | 2 | 1/2 | 1-1/4 | 2-1/2 | 0 | 3/4 | 3 | 0 | 1/4 | - | - | - | 20 |
| KB-TZ2 1/2 x 4-1/2 | 4-1/2 | G | 2-3/8 | 2 | 1/2 | 2 | 2-1/2 | 0 | 1-1/2 | 3 | 0 | 1 | 3-3/4 | 0 | 1/4 | 20 |
| KB-TZ2 1/2 x 5-1/2 | 5-1/2 | I | 3-3/8 | 2 | 1/2 | 3 | 2-1/2 | 0 | 2-1/2 | 3 | 0 | 2 | 3-3/4 | 0 | 1-1/4 | 20 |
| KB-TZ2 1/2 x 7 | 7 | L | 4-3/4 | 2 | 5/8 | 4-1/2 | 2-1/2 | 1/8 | 4 | 3 | 0 | 3-1/2 | 3-3/4 | 0 | 2-3/4 | 20 |
| KB-TZ2 1/2 x 8-1/2 | 8-1/2 | O | 4-7/8 | 2 | 2 | 6 | 2-1/2 | 1-1/2 | 5-1/2 | 3 | 1 | 5 | 3-3/4 | 1/4 | 4-1/4 | 20 |
| KB-TZ2 1/2 x 10 | 10 | R | 4-7/8 | 2 | 3-1/2 | 7-1/2 | 2-1/2 | 3 | 7 | 3 | 2-1/2 | 6-1/2 | 3-3/4 | 1-3/4 | 5-3/4 | 20 |
| KB-TZ2 5/8 x 4-1/4 | 4-1/4 | F | 2-1/4 | 3-1/4 | 0 | 3/8 | - | - | - | - | - | - | - | - | - | 15 |
| KB-TZ2 5/8 x 4-3/4 | 4-3/4 | G | 2-3/4 | 3-1/4 | 0 | 7/8 | 3-3/4 | 0 | 3/8 | - | - | - | - | - | - | 15 |
| KB-TZ2 5/8 x 5-1/2 | 5-1/2 | I | 3-1/2 | 3-1/4 | 0 | 1-5/8 | 3-3/4 | 0 | 1-1/8 | 4-1/2 | 0 | 3/8 | - | - | - | 15 |
| KB-TZ2 5/8 x 6 | 6 | J | 4 | 3-1/4 | 0 | 2-1/8 | 3-3/4 | 0 | 1-5/8 | 4-1/2 | 0 | 7/8 | - | - | - | 15 |
| KB-TZ2 5/8 x 7 | 7 | L | 4-7/8 | 3-1/4 | 0 | 3-1/8 | 3-3/4 | 0 | 2-5/8 | 4-1/2 | 0 | 1-7/8 | - | - | - | 15 |
| KB-TZ2 5/8 x 8-1/2 | 8-1/2 | O | 6-1/2 | 3-1/4 | 0 | 4-5/8 | 3-3/4 | 0 | 4-1/8 | 4-1/2 | 0 | 3-3/8 | - | - | - | 15 |
| KB-TZ2 5/8 x 10 | 10 | R | 7-1/8 | 3-1/4 | 1/8 | 6-1/8 | 3-3/4 | 0 | 5-5/8 | 4-1/2 | 0 | 4-7/8 | - | - | - | 15 |
| KB-TZ2 3/4 x 4-3/4 | 4-3/4 | G | 2-1/2 | 4 | 0 | 1/8 | - | - | - | - | - | - | - | - | - | 10 |
| KB-TZ2 3/4 x 5-1/2 | 5-1/2 | I | 3-1/4 | 4 | 0 | 7/8 | 4-1/2 | 0 | 3/8 | - | - | - | - | - | - | 10 |
| KB-TZ2 3/4 x 6-1/4 | 6-1/4 | J | 3-1/4 | 4 | 0 | 1-5/8 | 4-1/2 | 0 | 1-1/8 | 5-1/2 | 0 | 1/8 | - | - | - | 10 |
| KB-TZ2 3/4 x 7 | 7 | L | 4 | 4 | 0 | 2-3/8 | 4-1/2 | 0 | 1-7/8 | 5-1/2 | 0 | 7/8 | - | - | - | 10 |
| KB-TZ2 3/4 x 8 | 8 | N | 5 | 4 | 0 | 3-3/8 | 4-1/2 | 0 | 2-7/8 | 5-1/2 | 0 | 1-7/8 | - | - | - | 10 |
| KB-TZ2 3/4 x 9 | 9 | P | 6 | 4 | 0 | 4-3/8 | 4-1/2 | 0 | 3-7/8 | 5-1/2 | 0 | 2-7/8 | - | - | - | 10 |
| KB-TZ2 3/4 x 10 | 10 | R | 7 | 4 | 0 | 5-3/8 | 4-1/2 | 0 | 4-7/8 | 5-1/2 | 0 | 3-7/8 | - | - | - | 10 |
| KB-TZ2 1x6-1/2 | 6-1/2 | K | 2 1/2 | 4 5/8 | 0 | 1-1/8 | 6-3/8 | - | - | - | - | - | - | - | - | 10 |
| KB-TZ2 1x8 | 8 | N | 3 7/8 | 4 5/8 | 0 | 2-5/8 | 6-3/8 | 0 | 7/8 | - | - | - | - | - | - | 10 |
| KB-TZ2 1x9 | 9 | P | 3 7/8 | 4 5/8 | 7/8 | 3-5/8 | 6-3/8 | 0 | 1-7/8 | - | - | - | - | - | - | 10 |
| KB-TZ2 1x10-1/2 | 10-1/2 | R | 6 | 4 5/8 | 3/8 | 5-1/8 | 6-3/8 | 0 | 3-3/8 | - | - | - | - | - | - | 10 |
| KB-TZ2 1x12 | 12 | T | 6 | 4 5/8 | 1-7/8 | 6-5/8 | 6-3/8 | 1/8 | 4-7/8 | - | - | - | - | - | - | 10 |

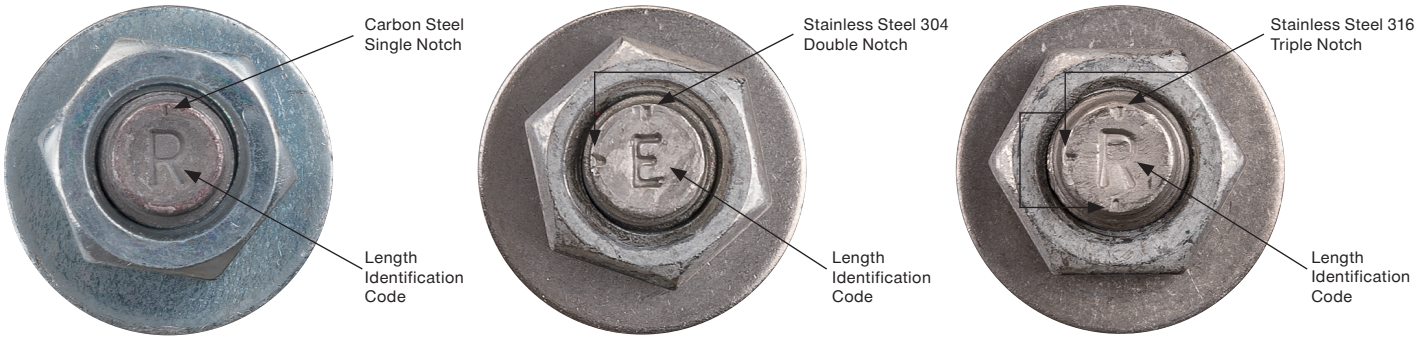
## Table 53 — Hilti KB-TZ2 SS304 product portfolio

| Description | Length (in) | Length ident. letter | Thread length (in) | Nominal embed. 1 (in) | Min. fixture thickness 1 (in) | Max. fixture thickness 1 (in) | Nominal embed. 2 (in) | Min. fixture thickness 2 (in) | Max. fixture thickness 2 (in) | Nominal embed. 3 (in) | Min. fixture thickness 3 (in) | Max. fixture thickness 3 (in) | Package quantity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KB-TZ2 1/4x2-1/8 SS304 | 2-1/8 | B | 7/8 | 1-3/4 | 0 | 1/8 | - | - | - | - | - | - | 100 |
| KB-TZ2 1/4x2-1/2 SS304 | 2-1/2 | C | 1 1/4 | 1-3/4 | 0 | 1/2 | - | - | - | - | - | - | 100 |
| KB-TZ2 1/4x3-1/4 SS304 | 3-1/4 | D | 2 | 1-3/4 | 0 | 1-1/4 | - | - | - | - | - | - | 100 |
| KB-TZ2 1/4x4-1/2 SS304 | 4-1/2 | G | 3 | 1-3/4 | 1/8 | 2-1/2 | - | - | - | - | - | - | 100 |
| KB-TZ2 3/8x2-1/2 SS304 | 2-1/2 | C | 1 | 1-7/8 | 0 | 1/4 | - | - | - | - | - | - | 50 |
| KB-TZ2 3/8x3 SS304 | 3 | D | 1 1/2 | 1-7/8 | 0 | 3/4 | 2-1/2 | 0 | 1/4 | - | - | - | 50 |
| KB-TZ2 3/8x3-1/2 SS304 | 3-1/2 | Ω | 2 | 1-7/8 | 0 | 1-1/4 | 2-1/2 | 0 | 3/4 | 3 | 0 | 1/4 | 50 |
| KB-TZ2 3/8x3-3/4 SS304 | 3-3/4 | E | 2 1/4 | 1-7/8 | 0 | 1-1/2 | 2-1/2 | 0 | 1 | 3 | 0 | 1/2 | 50 |
| KB-TZ2 3/8x5 SS304 | 5 | H | 3 1/2 | 1-7/8 | 0 | 2-3/4 | 2-1/2 | 0 | 2-1/4 | 3 | 0 | 1-3/4 | 50 |
| KB-TZ2 3/8x7 SS304 | 7 | L | 4 7/8 | 1-7/8 | 1/2 | 4-3/4 | 2-1/2 | 0 | 4-1/4 | 3 | 0 | 3-3/4 | 50 |
| KB-TZ2 1/2x3-3/4 SS304 | 3-3/4 | E | 1 5/8 | 2-1/2 | 0 | 3/4 | 3 | 0 | 1/4 | - | - | - | 20 |
| KB-TZ2 1/2x4-1/2 SS304 | 4-1/2 | G | 2 3/8 | 2-1/2 | 0 | 1-1/2 | 3 | 0 | 1 | 3-3/4 | 0 | 1/4 | 20 |
| KB-TZ2 1/2x5-1/2 SS304 | 5-1/2 | I | 3 3/8 | 2-1/2 | 0 | 2-1/2 | 3 | 0 | 2 | 3-3/4 | 0 | 1-1/4 | 20 |
| KB-TZ2 1/2x7 SS304 | 7 | L | 4 3/4 | 2-1/2 | 1/8 | 4 | 3 | 0 | 3-1/2 | 3-3/4 | 0 | 2-3/4 | 20 |
| KB-TZ2 5/8x4-1/4 SS304 | 4-1/4 | F | 2 1/4 | 3-1/4 | 0 | 3/8 | - | - | - | - | - | - | 15 |
| KB-TZ2 5/8x4-3/4 SS304 | 4-3/4 | G | 2 3/4 | 3-1/4 | 0 | 7/8 | 3-3/4 | 0 | 3/8 | - | - | - | 15 |
| KB-TZ2 5/8x6 SS304 | 6 | J | 4 | 3-1/4 | 0 | 2-1/8 | 3-3/4 | 0 | 1-5/8 | 4-1/2 | 0 | 7/8 | 15 |
| KB-TZ2 5/8x7 SS304 | 7 | L | 4 7/8 | 3-1/4 | 0 | 3-1/8 | 3-3/4 | 0 | 2-5/8 | 4-1/2 | 0 | 1-7/8 | 15 |
| KB-TZ2 5/8x8-1/2 SS304 | 8-1/2 | O | 6 1/2 | 3-1/4 | 0 | 4-5/8 | 3-3/4 | 0 | 4-1/8 | 4-1/2 | 0 | 3-3/8 | 15 |
| KB-TZ2 5/8x10 SS304 | 10 | R | 7 1/8 | 3-1/4 | 1/8 | 6-1/8 | 3-3/4 | 0 | 5-5/8 | 4-1/2 | 0 | 4-7/8 | 15 |
| KB-TZ2 3/4x4-3/4 SS304 | 4-3/4 | G | 1 3/4 | 4 | 0 | 1/8 | - | - | - | - | - | - | 10 |
| KB-TZ2 3/4x5-1/2 SS304 | 5-1/2 | I | 2 1/2 | 4 | 0 | 7/8 | 4-1/2 | 0 | 3/8 | - | - | - | 10 |
| KB-TZ2 3/4x6-1/4 SS304 | 6-1/4 | J | 3 1/4 | 4 | 0 | 1-5/8 | 4-1/2 | 0 | 1-1/8 | 5-1/2 | 0 | 1/8 | 10 |
| KB-TZ2 3/4x7 SS304 | 7 | L | 4 | 4 | 0 | 2-3/8 | 4-1/2 | 0 | 1-7/8 | 5-1/2 | 0 | 7/8 | 10 |
| KB-TZ2 3/4x8 SS304 | 8 | N | 5 | 4 | 0 | 3-3/8 | 4-1/2 | 0 | 2-7/8 | 5-1/2 | 0 | 1-7/8 | 10 |
| KB-TZ2 3/4x9 SS304 | 9 | P | 6 | 4 | 0 | 4-3/8 | 4-1/2 | 0 | 3-7/8 | 5-1/2 | 0 | 2-7/8 | 10 |
| KB-TZ2 3/4x10 SS304 | 10 | R | 7 | 4 | 0 | 5-3/8 | 4-1/2 | 0 | 4-7/8 | 5-1/2 | 0 | 3-7/8 | 10 |
| KB-TZ2 3/4x12 SS304 | 12 | T | 7 | 4 | 1-5/8 | 7-3/8 | 4-1/2 | 1-1/8 | 6-7/8 | 5-1/2 | 1/8 | 5-7/8 | 10 |
| KB-TZ2 1x6-1/2 SS304 | 6-1/2 | K | 2 1/2 | 4-5/8 | 0 | 7/8 | 6-3/8 | - | - | - | - | - | 10 |
| KB-TZ2 1x8 SS304 | 8 | N | 3 7/8 | 4-5/8 | 0 | 2-3/8 | 6-3/8 | 0 | 7/8 | - | - | - | 10 |
| KB-TZ2 1x9 SS304 | 9 | P | 3 7/8 | 4-5/8 | 1 | 3-3/8 | 6-3/8 | 0 | 1-7/8 | - | - | - | 10 |
| KB-TZ2 1x10-1/2 SS304 | 10-1/2 | R | 6 | 4 5/8 | 1/2 | 4-7/8 | 6-3/8 | 0 | 3-3/8 | - | - | - | 10 |
| KB-TZ2 1x12 SS304 | 12 | T | 6 | 4 5/8 | 2 | 6-3/8 | 6-3/8 | 1/4 | 4-7/8 | - | - | - | 10 |

## Table 54 — Hilti KB-TZ2 SS316 product portfolio

| Description | Length (in) | Length ident. letter | Thread length (in) | Nominal embed. 1 (in) | Min. fixture thickness 1 (in) | Max. fixture thickness 1 (in) | Nominal embed. 2 (in) | Min. fixture thickness 2 (in) | Max. fixture thickness 2 (in) | Nominal embed. 3 (in) | Min. fixture thickness 3 (in) | Max. fixture thickness 3 (in) | Package quantity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KB-TZ2 1/4x2-1/2 SS316 | 2-1/2 | C | 1-1/4 | 1-3/4 | 0 | 1/2 | - | - | - | - | - | - | 100 |
| KB-TZ2 1/4x3-1/4 SS316 | 3-1/4 | D | 2 | 1-3/4 | 0 | 1-1/4 | - | - | - | - | - | - | 100 |
| KB-TZ2 1/4x4-1/2 SS316 | 4-1/2 | G | 3 | 1-3/4 | 1/8 | 2-1/2 | - | - | - | - | - | - | 100 |
| KB-TZ2 3/8x2-1/2 SS316 | 2-1/2 | C | 1 | 1-7/8 | 0 | 1/4 | - | - | - | - | - | - | 50 |
| KB-TZ2 3/8x3 SS316 | 3 | D | 1-1/2 | 1-7/8 | 0 | 3/4 | 2-1/2 | 0 | 1/4 | - | - | - | 50 |
| KB-TZ2 3/8x3-1/2 SS316 | 3-1/2 | Ω | 2 | 1-7/8 | 0 | 1-1/4 | 2-1/2 | 0 | 3/4 | 3 | 0 | 1/4 | 50 |
| KB-TZ2 3/8x3-3/4 SS316 | 3-3/4 | E | 2-1/4 | 1-7/8 | 0 | 1-1/2 | 2-1/2 | 0 | 1 | 3 | 0 | 1/2 | 50 |
| KB-TZ2 3/8x5 SS316 | 5 | H | 3-1/2 | 1-7/8 | 0 | 2-3/4 | 2-1/2 | 0 | 2-1/4 | 3 | 0 | 1-3/4 | 50 |
| KB-TZ2 3/8x7 SS316 | 7 | L | 4-7/8 | 1-7/8 | 1/2 | 4-3/4 | 2-1/2 | 0 | 4-1/4 | 3 | 0 | 3-3/4 | 50 |
| KB-TZ2 1/2x3-3/4 SS316 | 3-3/4 | E | 1-5/8 | 2-1/2 | 0 | 3/4 | 3 | 0 | 1/4 | - | - | - | 20 |
| KB-TZ2 1/2x4-1/2 SS316 | 4-1/2 | G | 2-3/8 | 2-1/2 | 0 | 1-1/2 | 3 | 0 | 1 | 3-3/4 | 0 | 1/4 | 20 |
| KB-TZ2 1/2x5-1/2 SS316 | 5-1/2 | I | 3-3/8 | 2-1/2 | 0 | 2-1/2 | 3 | 0 | 2 | 3-3/4 | 0 | 1-1/4 | 20 |
| KB-TZ2 1/2x7 SS316 | 7 | L | 4-3/4 | 2-1/2 | 1/8 | 4 | 3 | 0 | 3-1/2 | 3-3/4 | 0 | 2-3/4 | 20 |
| KB-TZ2 1/2x8-1/2 SS316 | 8-1/2 | O | 4-7/8 | 2-1/2 | 1-1/2 | 5-1/2 | 3 | 1 | 5 | 3-3/4 | 1/4 | 4-1/4 | 20 |
| KB-TZ2 1/2x10 SS316 | 10 | R | 4-7/8 | 2-1/2 | 3 | 7 | 3 | 2-1/2 | 6-1/2 | 3-3/4 | 1-3/4 | 5-3/4 | 20 |
| KB-TZ2 5/8x4-1/4 SS316 | 4-1/4 | F | 2-1/4 | 3-1/4 | 0 | 3/8 | - | - | - | - | - | - | 15 |
| KB-TZ2 5/8x4-3/4 SS316 | 4-3/4 | G | 2-3/4 | 3-1/4 | 0 | 7/8 | 3-3/4 | 0 | 3/8 | - | - | - | 15 |
| KB-TZ2 5/8x6 SS316 | 6 | J | 4 | 3-1/4 | 0 | 2-1/8 | 3-3/4 | 0 | 1-5/8 | 4-1/2 | 0 | 7/8 | 15 |
| KB-TZ2 5/8x7 SS316 | 7 | L | 4-7/8 | 3-1/4 | 0 | 3-1/8 | 3-3/4 | 0 | 2-5/8 | 4-1/2 | 0 | 1-7/8 | 15 |
| KB-TZ2 5/8x8-1/2 SS316 | 8-1/2 | O | 6-1/2 | 3-1/4 | 0 | 4-5/8 | 3-3/4 | 0 | 4-1/8 | 4-1/2 | 0 | 3-3/8 | 15 |
| KB-TZ2 5/8x10 SS316 | 10 | R | 7-1/8 | 3-1/4 | 1/8 | 6-1/8 | 3-3/4 | 0 | 5-5/8 | 4-1/2 | 0 | 4-7/8 | 15 |
| KB-TZ2 3/4x4-3/4 SS316 | 4-3/4 | G | 1-3/4 | 4 | 0 | 1/8 | - | - | - | - | - | - | 10 |
| KB-TZ2 3/4x5-1/2 SS316 | 5-1/2 | I | 2-1/2 | 4 | 0 | 7/8 | 4-1/2 | 0 | 3/8 | - | - | - | 10 |
| KB-TZ2 3/4x6-1/4 SS316 | 6-1/4 | J | 3-1/4 | 4 | 0 | 1-5/8 | 4-1/2 | 0 | 1-1/8 | 5-1/2 | 0 | 1/8 | 10 |
| KB-TZ2 3/4x7 SS316 | 7 | L | 4 | 4 | 0 | 2-3/8 | 4-1/2 | 0 | 1-7/8 | 5-1/2 | 0 | 7/8 | 10 |
| KB-TZ2 3/4x8 SS316 | 8 | N | 5 | 4 | 0 | 3-3/8 | 4-1/2 | 0 | 2-7/8 | 5-1/2 | 0 | 1-7/8 | 10 |
| KB-TZ2 3/4x9 SS316 | 9 | P | 6 | 4 | 0 | 4-3/8 | 4-1/2 | 0 | 3-7/8 | 5-1/2 | 0 | 2-7/8 | 10 |
| KB-TZ2 3/4x10 SS316 | 10 | R | 7 | 4 | 0 | 5-3/8 | 4-1/2 | 0 | 4-7/8 | 5-1/2 | 0 | 3-7/8 | 10 |
| KB-TZ2 3/4x12 SS316 | 12 | T | 7 | 4 | 1-5/8 | 7-3/8 | 4-1/2 | 1-1/8 | 6-7/8 | 5-1/2 | 1/8 | 5-7/8 | 10 |

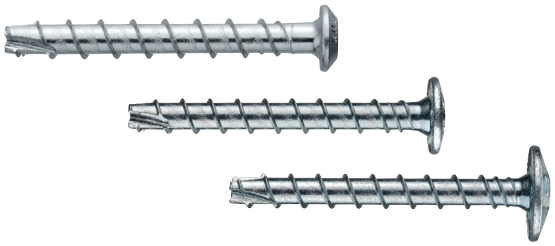
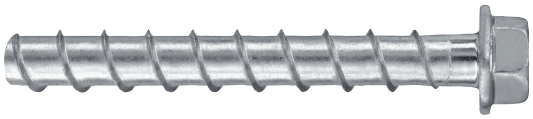
## Figure 9 — Anchor head with length identification code and KB-TZ2 head notch embossment



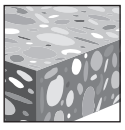
# 3.3.6 KWIK HUS-EZ SCREW ANCHOR

## PRODUCT DESCRIPTION

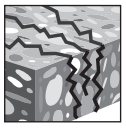
**KWIK HUS EZ carbon steel anchors**

| Anchor System | | Features and Benefits |
|---|---|---|
|  | Carbon Steel KH-EZ C 1/4" and 3/8" | • OSHA Table 1926.1153 Table 1 complaint installation when installed with Hilti vacuum and DRS system or Hilti SafeSet™ hollow drill bit technology<br>• Easy installation using impact tool or torque wrench<br>• Product and length identification marks helps facilitate quality control after installation<br>• Through fixture installation improves productivity and more accurate installation.<br>• Thread design helps enable quality setting and exceptional load values in wide variety of base material strengths.<br>• 1/4" diameter available in hex head countersunk head and pan head styles.<br>• Anchor is fully removable.<br>• Anchor diameter is same as drill bit diameter. No special diameter bit required.<br>• Suitable for reduced edge distances and spacing.<br>• Corrosion resistant coating allows for use in outdoor moderate corrosive environments (KH-EZ CRC only).<br>• Installation process allows for adjustability. |
|  | Carbon Steel 1/4" KH-EZ P, PM, PL | |
|  | Carbon Steel KH EZ 1/4"-3/4" | |
|  | Carbon Steel KH-EZ CRC 3/8"-3/4" | |

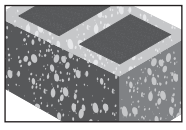




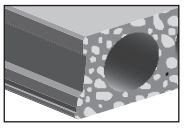
Uncracked concrete



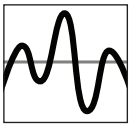
Cracked concrete



Grout-filled concrete masonry



Hollowcore concrete



Seismic Design Categories A-F




SafeSet™ System with Hollow Drill Bit




Profis Anchor design software

| Approvals/Listings | |
|---|---|
| **ICC-ES (International Code Council)** | ESR-3027 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193<br>ESR-3056 in grout-filled CMU per ICC-ES AC106 |
| **City of Los Angeles** | City of Los Angeles 2020 LABC Supplement (within ESR-3027 and ESR-3056) |
| **Florida Building Code** | 2020 FBC w/ HVHZ (within ESR-3027 and ESR-3056) |
| **FM (Factory Mutual)** | Pipe hanger components for automatic sprinkler systems for KH-EZ I and KH-EZ E |
| **ANSI/MSS SP-58-2018** | Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information. |

## MATERIAL SPECIFICATIONS

Heat treated carbon steel with a minimum zinc coating of 0.0003 inch (8 µm) thick in accordance with DIN EN ISO 4042.

KH-EZ CRC has mechanically deposited zinc coating with a minimum thickness of 0.0021 inch (53 µm) in accordance with ASTM B695, Class 55.

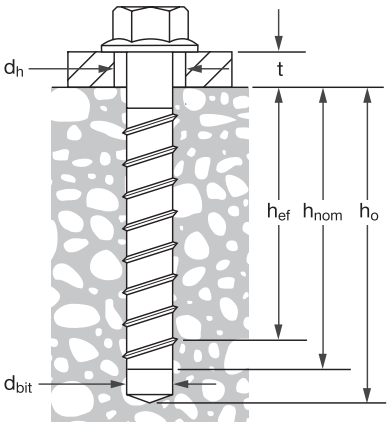
## INSTALLATION PARAMETERS

**Table 1 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC specifications**

| Setting information | Symbol | Units | Nominal anchor diameter | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | | 3/8 | | | | 1/2 | | | 5/8 | | | 3/4 | | |
| Head style and coating | | | Hex, P, PM, PL, C head | | Hex, C head | | Hex, C head (Including CRC) | | Hex head (Including CRC) | | | Hex head (Including CRC) | | | Hex head (Including CRC) | | |
| Nominal bit diameter | $d_{bit}$ | in. | 1/4 | | 3/8 | | | | 1/2 | | | 5/8 | | | 3/4 | | |
| Minimum nominal embedment | $h_{nom}$ | in. | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 2-1/4 | 3 | 4-1/4 | 3-1/4 | 4 | 5 | 4 | 6-1/4 | |
| Minimum effective embedment | $h_{ef}$ | in. | 1.18 | 1.92 | 1.11 | 1.54 | 1.86 | 2.50 | 1.50 | 2.16 | 3.22 | 2.39 | 3.03 | 3.88 | 2.92 | 4.84 | |
| Minimum hole depth | $h_o$ | in. | 2 | 2-7/8 | 1-7/8 | 2-3/8 | 2-3/4 | 3-1/2 | 2-5/8 | 3-3/8 | 4-5/8 | 3-5/8 | 4-3/8 | 5-3/8 | 4-3/8 | 6-5/8 | |
| Minimum fixture hole diameter | $d_h$ | in. | 3/8 | | 1/2 | | | | 5/8 | | | 3/4 | | | 7/8 | | |
| Anchor Length = $h_{nom}$ + t | $\ell$ | | See ordering information | | | | | | | | | | | | | | |
| Installation torque concrete[1] | $T_{inst}$ | ft-lb (Nm) | 18 (24) | | 19 (26) | | 40 (54) | | 45 (61) | | | 85 (115) | | | 95[4] (129) | | |
| Maximum impact wrench torque rating concrete[2] | $T_{impact,max}$ | ft-lb (Nm) | 157 (213) | | 157 (213) | | 450 (610) | | 137 (186) | 450 (610) | | 590 (800) | | | 590 (800) | | |
| Installation torque masonry KH-EZ (P, PM, PL, C)[1] | $T_{inst}$ | ft-lb (Nm) | 21 (28) | | 22 (30) | | | | 34 (46) | | | 38 (52) | | | 70 (95) | | |
| Installation torque masonry for KH-EZ CRC[1] | $T_{inst}$ | ft-lb (Nm) | | | | | 20 (27) | | 25 (34) | | | 35 (48) | | | 45 (61) | | |
| Maximum impact wrench torque rating masonry for KH-EZ (P, PM, PL, C)[2,3] | $T_{impact,max}$ | ft-lb (Nm) | 114 (155) | | 114 (155) | | | 332 (450) | 332 (450) | | | 332 (450) | | | 332 (450) | | |
| Maximum impact wrench torque rating masonry for KH-EZ CRC[2,3] | $T_{impact,max}$ | ft-lb (Nm) | | | | | 100 (136) | | 100 (136) | | | 332 (450) | | | 332 (450) | | |
| Wrench size | | in. | 7/16 | | 9/16 | | | | 3/4 | | | 15/16 | | | 1-1/8 | | |

1 $T_{inst}$ is the maximum installation torque that may be applied with a torque wrench.
2 Because of variability in measurement procedures, the published torque of an impact tool may not correlate properly with the above setting torques. Over torquing can damage the base material, anchor and/or reduce its holding capacity.
3 For more information on KH-EZ installed in masonry, see ESR-3056 and Design Information for Masonry in this section.
4 Maximum installation torque in concrete for 3/4-in diameter KH-EZ CRC is 95 ft-lbs. (115 Nm).

**Figure 1 — Hilti KH-EZ specifications**




## DESIGN INFORMATION IN CONCRETE PER ACI 318

### ACI 318 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-3027 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8 of the North American Product Technical Guide, Volume 2: Anchor Fastening Technical Guide, Edition 22 (PTG Ed. 21). Data tables from ESR-3027 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

**Table 2 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC design Strength with concrete / pullout failure in uncracked concrete[1,2,3,4]**

| Nominal anchor diameter in. (mm) | Nominal Embed. Depth in. (mm) | Tension - $\phi N_n$ | | | | Shear - $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 1/4 (6.4) | 1-5/8 (41) | 585 (2.6) | 620 (2.8) | 675 (3.0) | 765 (3.4) | 1,075 (4.8) | 1,180 (5.2) | 1,360 (6.0) | 1,670 (7.4) |
| | 2-1/2 (64) | 1,525 (6.8) | 1,670 (7.4) | 1,930 (8.6) | 2,365 (10.5) | 2,235 (9.9) | 2,450 (10.9) | 2,825 (12.6) | 3,460 (15.4) |
| 3/8 (9.5) | 1-5/8 (41) | 910 (4.0) | 1,000 (4.4) | 1,155 (5.1) | 1,415 (6.3) | 980 (4.4) | 1,075 (4.8) | 1,245 (5.5) | 1,520 (6.8) |
| | 2-1/8 (54) | 1,490 (6.6) | 1,635 (7.3) | 1,885 (8.4) | 2,310 (10.3) | 1,605 (7.1) | 1,760 (7.8) | 2,030 (9.0) | 2,485 (11.1) |
| | 2-1/2 (64) | 1,980 (8.8) | 2,165 (9.6) | 2,505 (11.1) | 3,065 (13.6) | 2,130 (9.5) | 2,335 (10.4) | 2,695 (12.0) | 3,300 (14.7) |
| | 3-1/4 (83) | 3,085 (13.7) | 3,375 (15.0) | 3,900 (17.3) | 4,775 (21.2) | 6,640 (29.5) | 7,275 (32.4) | 8,400 (37.4) | 10,290 (45.8) |
| 1/2 (12.7) | 2-1/4 (57) | 1,645 (7.3) | 1,800 (8.0) | 2,080 (9.3) | 2,550 (11.3) | 1,770 (7.9) | 1,940 (8.6) | 2,240 (10.0) | 2,745 (12.2) |
| | 3 (76) | 2,785 (12.4) | 3,050 (13.6) | 3,525 (15.7) | 4,315 (19.2) | 3,000 (13.3) | 3,285 (14.6) | 3,795 (16.9) | 4,645 (20.7) |
| | 4-1/4 (108) | 5,070 (22.6) | 5,555 (24.7) | 6,415 (28.5) | 7,855 (34.9) | 10,920 (48.6) | 11,965 (53.2) | 13,815 (61.5) | 16,920 (75.3) |
| 5/8 (15.9) | 3-1/4 (83) | 3,240 (14.4) | 3,550 (15.8) | 4,100 (18.2) | 5,025 (22.4) | 3,490 (15.5) | 3,825 (17.0) | 4,415 (19.6) | 5,410 (24.1) |
| | 4 (102) | 4,630 (20.6) | 5,070 (22.6) | 5,855 (26.0) | 7,170 (31.9) | 9,970 (44.3) | 10,920 (48.6) | 12,610 (56.1) | 15,445 (68.7) |
| | 5 (127) | 6,705 (29.8) | 7,345 (32.7) | 8,485 (37.7) | 10,390 (46.2) | 14,445 (64.3) | 15,825 (70.4) | 18,270 (81.3) | 22,380 (99.6) |
| 3/4 (19.1) | 4 (102) | 4,380 (19.5) | 4,795 (21.3) | 5,540 (24.6) | 6,785 (30.2) | 9,430 (41.9) | 10,330 (45.9) | 11,930 (53.1) | 14,610 (65.0) |
| | 6-1/4 (159) | 9,345 (41.6) | 10,235 (45.5) | 11,820 (52.6) | 14,475 (64.4) | 20,125 (89.5) | 22,045 (98.1) | 25,455 (113.2) | 31,175 (138.7) |

3.3.6

**Table 3 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC design Strength with concrete / pullout failure in cracked concrete[1,2,3,4,5]**

| Nominal anchor diameter in. (mm) | Nominal embed. in. (mm) | Tension - $\phi N_n$ | | | | Shear - $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 1/4 (6.4) | 1-5/8 (41) | 300 (1.3) | 315 (1.4) | 345 (1.5) | 390 (1.7) | 765 (3.4) | 835 (3.7) | 965 (4.3) | 1,180 (5.2) |
| | 2-1/2 (64) | 760 (3.4) | 830 (3.7) | 960 (4.3) | 1,175 (5.2) | 1,585 (7.1) | 1,735 (7.7) | 2,000 (8.9) | 2,450 (10.9) |
| 3/8 (9.5) | 1-5/8 (41) | 475 (2.1) | 520 (2.3) | 600 (2.7) | 730 (3.2) | 695 (3.1) | 760 (3.4) | 880 (3.9) | 1,080 (4.8) |
| | 2-1/8 (54) | 1,055 (4.7) | 1,155 (5.1) | 1,335 (5.9) | 1,635 (7.3) | 1,135 (5.0) | 1,245 (5.5) | 1,440 (6.4) | 1,760 (7.8) |
| | 2-1/2 (64) | 1,400 (6.2) | 1,535 (6.8) | 1,775 (7.9) | 2,170 (9.7) | 1,510 (6.7) | 1,655 (7.4) | 1,910 (8.5) | 2,340 (10.4) |
| | 3-1/4 (83) | 2,185 (9.7) | 2,390 (10.6) | 2,765 (12.3) | 3,385 (15.1) | 4,705 (20.9) | 5,155 (22.9) | 5,950 (26.5) | 7,285 (32.4) |
| 1/2 (12.7) | 2-1/4 (57) | 1,035 (4.6) | 1,135 (5.0) | 1,310 (5.8) | 1,605 (7.1) | 1,115 (5.0) | 1,220 (5.4) | 1,410 (6.3) | 1,725 (7.7) |
| | 3 (76) | 1,755 (7.8) | 1,920 (8.5) | 2,220 (9.9) | 2,715 (12.1) | 1,890 (8.4) | 2,070 (9.2) | 2,390 (10.6) | 2,925 (13.0) |
| | 4-1/4 (108) | 3,190 (14.2) | 3,495 (15.5) | 4,040 (18.0) | 4,945 (22.0) | 6,875 (30.6) | 7,530 (33.5) | 8,695 (38.7) | 10,650 (47.4) |
| 5/8 (15.9) | 3-1/4 (83) | 2,040 (9.1) | 2,235 (9.9) | 2,580 (11.5) | 3,165 (14.1) | 2,200 (9.8) | 2,410 (10.7) | 2,780 (12.4) | 3,405 (15.1) |
| | 4 (102) | 3,140 (14.0) | 3,510 (15.6) | 3,845 (17.1) | 4,515 (20.1) | 6,760 (30.1) | 7,560 (33.6) | 8,280 (36.8) | 9,725 (43.3) |
| | 5 (127) | 4,225 (18.8) | 4,625 (20.6) | 5,340 (23.8) | 6,540 (29.1) | 9,095 (40.5) | 9,965 (44.3) | 11,505 (51.2) | 14,090 (62.7) |
| 3/4 (19.1) | 4 (102) | 2,755 (12.3) | 3,020 (13.4) | 3,485 (15.5) | 4,270 (19.0) | 5,940 (26.4) | 6,505 (28.9) | 7,510 (33.4) | 9,200 (40.9) |
| | 6-1/4 (159) | 5,885 (26.2) | 6,445 (28.7) | 7,440 (33.1) | 9,115 (40.5) | 12,670 (56.4) | 13,880 (61.7) | 16,030 (71.3) | 19,630 (87.3) |

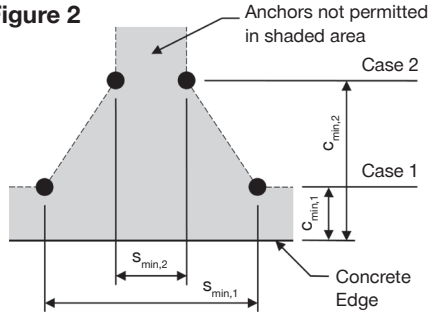
1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in Tables 6 through 15 as necessary. Compare to the steel values in Table 4. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λa as follows: For sand-lightweight, λa = 0.68. For all-lightweight, λa = 0.60.
5 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors: 1/4-in diameter by 1-5/8-in nominal embedment depth - $a_{N,seis}$ = 0.60
All other sizes - $a_{N,seis}$ = 0.75
No reduction needed for seismic shear. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

## Table 4 — Steel design strength for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC anchors[1,2]

| Anchor diameter in. (mm) | Nominal embedment depth in. (mm) | | | Tensile [3] $\phi N_{sa}$ lb (kN) | Shear [4] $\phi V_{sa}$ lb (kN) | Seismic shear [5] $\phi V_{sa,eq}$ lb (kN) |
|---|---|---|---|---|---|---|
| 1/4 (6.4) | 1-5/8 (41) | 2-1/2 (64) | | 3,945 (17.5) | 930 (4.1) | 835 (3.7) |
| 3/8 (9.5) | 1-5/8 (41) | 2-1/8 (54) | | 5,980 (26.6) | 2,200 (9.8) | 2,200 (9.8) |
| | 2-1/2 (64) | 3-1/4 (83) | | 6,720 (29.9) | 3,110 (13.8) | 1,865 (8.3) |
| 1/2 (12.7) | 2-1/4 (57) | 3 (76) | 4-1/4 (108) | 11,780 (52.4) | 5,545 (24.7) | 3,330 (14.8) |
| 5/8 (15.9) | 3-1/4 (83) | 4 (102) | 5 (127) | 15,735 (70.0) | 6,735 (30.0) | 4,040 (18.0) |
| 3/4 (19.1) | 4 (102) | 6-1/4 (159) | | 20,810 (92.6) | 9,995 (44.5) | 6,935 (30.8) |

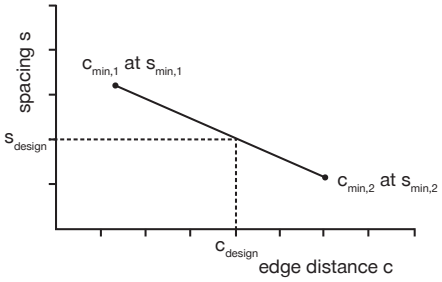
1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KH-EZ anchors are to be considered brittle steel elements.
3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
4 Shear values determined by static shear tests with $\phi Vsa < \phi$ 0.60 Ase,V futa as noted in ACI 318 Chapter 17.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi$ 0.60 $A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

**Figure 2**




For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$




## Table 5 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC specifications[1]

| Setting information | Symbol | Units | Nominal anchor diameter | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | | 3/8 | | | | 1/2 | | | 5/8 | | | 3/4 | |
| Effective minimum embedment | $h_{ef}$ | in. | 1.18 | 1.92 | 1.11 | 1.54 | 1.86 | 2.50 | 1.50 | 2.16 | 3.22 | 2.39 | 3.03 | 3.88 | 2.92 | 4.84 |
| Minimum member thickness | $h_{min}$ | in. | 3-1/4 | 4-1/8 | 3-1/4 | 3-2/3 | 4 | 4-7/8 | 4-1/2 | 4-3/4 | 6-3/4 | 5 | 6 | 7 | 6 | 8-1/8 |
| Case 1 | $c_{min,1}$ | in. | 1.50 | | | | | | 1.75 | | | | | | | |
| | for $s_{min,1} \geq$ | in. | 3 | | | | | | | | | 4 | | | | |
| Case 2 | $c_{min,2}$ | in. | 2 | 2.78 | 2.63 | 2.75 | 2.92 | 3.75 | 1.75 | | | 3.63 | 4.57 | 5.81 | 4.41 | 7.28 |
| | for $s_{min,2} \geq$ | in. | 1.50 | | 2.25 | | | | 3 | | | | | | | |

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacings.

## Table 6 — Load adjustment factors for 1/4-in. diameter Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL and KH-EZ C in uncracked concrete[1,2]

| 1/4-in. KH-EZ uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 |
| | | (mm) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-1/2 | (38) | 0.71 | 0.63 | 0.78 | 0.65 | 0.59 | 0.56 | 0.40 | 0.21 | 0.78 | 0.42 | n/a | n/a |
| | 2 | (51) | 0.78 | 0.67 | 1.00 | 0.77 | 0.62 | 0.58 | 0.61 | 0.33 | 1.00 | 0.65 | n/a | n/a |
| | 2-1/2 | (64) | 0.85 | 0.72 | | 0.90 | 0.65 | 0.60 | 0.86 | 0.46 | | 0.90 | n/a | n/a |
| | 3 | (76) | 0.92 | 0.76 | | 1.00 | 0.68 | 0.62 | 1.00 | 0.60 | | 1.00 | n/a | n/a |
| | 3-1/4 | (83) | 0.96 | 0.78 | | | 0.70 | 0.63 | | 0.68 | | | 0.88 | n/a |
| | 3-1/2 | (89) | 0.99 | 0.80 | | | 0.71 | 0.64 | | 0.76 | | | 0.92 | n/a |
| | 4 | (102) | 1.00 | 0.85 | | | 0.74 | 0.66 | | 0.92 | | | 0.98 | n/a |
| | 4-1/8 | (105) | | 0.86 | | | 0.75 | 0.66 | | 0.97 | | | 1.00 | 0.81 |
| | 4-1/2 | (114) | | 0.89 | | | 0.77 | 0.68 | | 1.00 | | | | 0.84 |
| | 5 | (127) | | 0.93 | | | 0.80 | 0.70 | | | | | | 0.89 |
| | 5-1/2 | (140) | | 0.98 | | | 0.83 | 0.72 | | | | | | 0.93 |
| | 6 | (152) | | 1.00 | | | 0.86 | 0.74 | | | | | | 0.97 |
| | 7 | (178) | | | | | 0.92 | 0.78 | | | | | | 1.00 |
| | 8 | (203) | | | | | 0.98 | 0.82 | | | | | | |
| | 9 | (229) | | | | | 1.00 | 0.86 | | | | | | |
| | 10 | (254) | | | | | | 0.89 | | | | | | |
| | 11 | (279) | | | | | | 0.93 | | | | | | |
| | 12 | (305) | | | | | | 0.97 | | | | | | |
| | 14 | (356) | | | | | | 1.00 | | | | | | |

3.3.6

## Table 7 — Load adjustment factors for 1/4-in. diameter Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL and KH-EZ C in cracked concrete[1,2]

| 1/4-in. KH-EZ cracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 |
| | | (mm) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-1/2 | (38) | 0.71 | 0.63 | 0.88 | 0.65 | 0.59 | 0.56 | 0.40 | 0.21 | 0.80 | 0.43 | n/a | n/a |
| | 2 | (51) | 0.78 | 0.67 | 1.00 | 0.77 | 0.62 | 0.58 | 0.62 | 0.33 | 1.00 | 0.66 | n/a | n/a |
| | 2-1/2 | (64) | 0.85 | 0.72 | | 0.90 | 0.65 | 0.60 | 0.87 | 0.46 | | 0.90 | n/a | n/a |
| | 3 | (76) | 0.92 | 0.76 | | 1.00 | 0.68 | 0.62 | 1.00 | 0.60 | | 1.00 | n/a | n/a |
| | 3-1/4 | (83) | 0.96 | 0.78 | | | 0.70 | 0.63 | | 0.68 | | | 0.89 | n/a |
| | 3-1/2 | (89) | 0.99 | 0.80 | | | 0.71 | 0.64 | | 0.76 | | | 0.92 | n/a |
| | 4 | (102) | 1.00 | 0.85 | | | 0.74 | 0.66 | | 0.93 | | | 0.98 | n/a |
| | 4-1/8 | (105) | | 0.86 | | | 0.75 | 0.66 | | 0.97 | | | 1.00 | 0.81 |
| | 4-1/2 | (114) | | 0.89 | | | 0.77 | 0.68 | | 1.00 | | | | 0.85 |
| | 5 | (127) | | 0.93 | | | 0.80 | 0.70 | | | | | | 0.89 |
| | 5-1/2 | (140) | | 0.98 | | | 0.83 | 0.72 | | | | | | 0.93 |
| | 6 | (152) | | 1.00 | | | 0.86 | 0.74 | | | | | | 0.98 |
| | 7 | (178) | | | | | 0.92 | 0.78 | | | | | | 1.00 |
| | 8 | (203) | | | | | 0.98 | 0.82 | | | | | | |
| | 9 | (229) | | | | | 1.00 | 0.86 | | | | | | |
| | 10 | (254) | | | | | | 0.90 | | | | | | |
| | 11 | (279) | | | | | | 0.94 | | | | | | |
| | 12 | (305) | | | | | | 0.98 | | | | | | |
| | 14 | (356) | | | | | | 1.00 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

## Table 8 — Load Adjustment Factors for 3/8-in. diameter Hilti KH-EZ, KH-EZ C and KH-EZ CRC in uncracked [1,2]

| 3/8-in. KH-EZ uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear [3] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Conc. thickness factor in shear [4] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ toward edge $f_{RV}$ | | | | II to and away from edge $f_{RV}$ | | | | | | | |
| Embedment in. | | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 |
| $h_{nom}$ (mm) | | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-1/2 (38) | n/a | n/a | n/a | n/a | 0.58 | 0.62 | 0.63 | 0.57 | n/a | n/a | n/a | n/a | 0.49 | 0.32 | 0.25 | 0.08 | 0.58 | 0.62 | 0.50 | 0.17 | n/a | n/a | n/a | n/a |
| | 2 (51) | n/a | n/a | n/a | n/a | 0.76 | 0.75 | 0.75 | 0.66 | n/a | n/a | n/a | n/a | 0.75 | 0.49 | 0.38 | 0.13 | 0.76 | 0.75 | 0.75 | 0.26 | n/a | n/a | n/a | n/a |
| | 2-1/4 (57) | 0.84 | 0.74 | 0.70 | 0.65 | 0.86 | 0.82 | 0.81 | 0.70 | 0.65 | 0.62 | 0.60 | 0.55 | 0.90 | 0.59 | 0.46 | 0.16 | 0.90 | 0.82 | 0.81 | 0.31 | n/a | n/a | n/a | n/a |
| | 2-1/2 (64) | 0.88 | 0.77 | 0.72 | 0.67 | 0.95 | 0.91 | 0.88 | 0.75 | 0.67 | 0.63 | 0.61 | 0.55 | 1.00 | 0.69 | 0.54 | 0.18 | 1.00 | 0.91 | 0.88 | 0.37 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.95 | 0.82 | 0.77 | 0.70 | 1.00 | 1.00 | 1.00 | 0.85 | 0.71 | 0.66 | 0.63 | 0.56 | | 0.90 | 0.71 | 0.24 | | 1.00 | 1.00 | 0.48 | n/a | n/a | n/a | n/a |
| | 3-1/4 (83) | 0.99 | 0.85 | 0.79 | 0.72 | | | | 0.90 | 0.72 | 0.67 | 0.64 | 0.57 | | 1.00 | 0.80 | 0.27 | | | | 0.54 | 0.95 | n/a | n/a | n/a |
| | 3-1/2 (89) | 1.00 | 0.88 | 0.81 | 0.73 | | | | 0.95 | 0.74 | 0.68 | 0.65 | 0.58 | | | 0.89 | 0.30 | | | | 0.61 | 0.98 | n/a | n/a | n/a |
| | 4 (102) | | 0.93 | 0.86 | 0.77 | | | | 1.00 | 0.78 | 0.71 | 0.68 | 0.59 | | | 1.00 | 0.37 | | | | 0.74 | 1.00 | 0.91 | 0.84 | n/a |
| | 4-1/2 (114) | | 0.99 | 0.90 | 0.80 | | | | | 0.81 | 0.73 | 0.70 | 0.60 | | | | 0.44 | | | | 0.88 | | | 0.89 | n/a |
| | 4-3/4 (121) | | 1.00 | 0.93 | 0.82 | | | | | 0.83 | 0.75 | 0.71 | 0.60 | | | | 0.48 | | | | 0.96 | | | 0.91 | 0.639 |
| | 5 (127) | | | 0.95 | 0.83 | | | | | 0.84 | 0.76 | 0.72 | 0.61 | | | | 0.52 | | | | 1.00 | | | 0.94 | 0.655 |
| | 6 (152) | | | 1.00 | 0.90 | | | | | 0.91 | 0.81 | 0.76 | 0.63 | | | | 0.68 | | | | | | | 1.00 | 0.718 |
| | 7 (178) | | | | 0.97 | | | | | 0.98 | 0.86 | 0.81 | 0.65 | | | | 0.86 | | | | | | | | 0.775 |
| | 8 (203) | | | | 1.00 | | | | | 1.00 | 0.91 | 0.85 | 0.67 | | | | 1.00 | | | | | | | | 0.829 |
| | 9 (229) | | | | | | | | | | 0.97 | 0.90 | 0.69 | | | | | | | | | | | | 0.879 |
| | 10 (254) | | | | | | | | | | 1.00 | 0.94 | 0.71 | | | | | | | | | | | | 0.927 |
| | 11 (279) | | | | | | | | | | | 0.98 | 0.74 | | | | | | | | | | | | 0.972 |
| | 12 (305) | | | | | | | | | | | 1.00 | 0.76 | | | | | | | | | | | | 1.000 |
| | 14 (356) | | | | | | | | | | | | 0.80 | | | | | | | | | | | | |
| | 16 (406) | | | | | | | | | | | | 0.84 | | | | | | | | | | | | |
| | 18 (457) | | | | | | | | | | | | 0.89 | | | | | | | | | | | | |
| | 20 (508) | | | | | | | | | | | | 0.93 | | | | | | | | | | | | |
| | 24 (610) | | | | | | | | | | | | 1.000 | | | | | | | | | | | | |

## Table 9 — Load Adjustment Factors for 3/8-in. diameter Hilti KH-EZ, KH-EZ C and KH-EZ CRC in cracked [1,2]

| 3/8-in. KH-EZ cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear [3] $f_{AV}$ | | | | Edge distance in shear | | | | | | | | Conc. thickness factor in shear [4] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ⊥ toward edge $f_{RV}$ | | | | II to and away from edge $f_{RV}$ | | | | | | | |
| Embedment in. | | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 |
| $h_{nom}$ (mm) | | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-1/2 (38) | n/a | n/a | n/a | n/a | 0.92 | 0.74 | 0.66 | 0.57 | n/a | n/a | n/a | n/a | 0.49 | 0.32 | 0.25 | 0.09 | 0.92 | 0.64 | 0.50 | 0.17 | n/a | n/a | n/a | n/a |
| | 2 (51) | n/a | n/a | n/a | n/a | 1.00 | 0.90 | 0.79 | 0.66 | n/a | n/a | n/a | n/a | 0.76 | 0.50 | 0.39 | 0.13 | 1.00 | 0.90 | 0.77 | 0.26 | n/a | n/a | n/a | n/a |
| | 2-1/4 (57) | 0.84 | 0.74 | 0.70 | 0.65 | 1.00 | 0.98 | 0.85 | 0.70 | 0.66 | 0.62 | 0.60 | 0.55 | 0.90 | 0.59 | 0.46 | 0.16 | 1.00 | 0.98 | 0.85 | 0.31 | n/a | n/a | n/a | n/a |
| | 2-1/2 (64) | 0.88 | 0.77 | 0.72 | 0.67 | 1.00 | 1.00 | 0.92 | 0.75 | 0.67 | 0.63 | 0.61 | 0.55 | 1.00 | 0.69 | 0.54 | 0.18 | 1.00 | 1.00 | 0.92 | 0.37 | n/a | n/a | n/a | n/a |
| | 3 (76) | 0.95 | 0.82 | 0.77 | 0.70 | 1.00 | | 1.00 | 0.85 | 0.71 | 0.66 | 0.63 | 0.56 | 1.00 | 0.91 | 0.71 | 0.24 | 1.00 | 1.00 | 1.00 | 0.48 | n/a | n/a | n/a | n/a |
| | 3-1/4 (83) | 0.99 | 0.85 | 0.79 | 0.72 | | | | 0.90 | 0.73 | 0.67 | 0.64 | 0.57 | | 1.00 | 0.80 | 0.27 | | | | 0.55 | 0.95 | n/a | n/a | n/a |
| | 3-1/2 (89) | 1.00 | 0.88 | 0.81 | 0.73 | | | | 0.95 | 0.74 | 0.68 | 0.65 | 0.58 | | | 0.90 | 0.31 | | | | 0.61 | 0.98 | n/a | n/a | n/a |
| | 4 (102) | | 0.93 | 0.86 | 0.77 | | | | 1.00 | 0.78 | 0.71 | 0.68 | 0.59 | | | 1.00 | 0.37 | | | | 0.75 | 1.00 | 0.91 | 0.84 | n/a |
| | 4-1/2 (114) | | 0.99 | 0.90 | 0.80 | | | | | 0.81 | 0.73 | 0.70 | 0.60 | | | | 0.44 | | | | 0.89 | | 0.97 | 0.89 | n/a |
| | 4-3/4 (121) | | 1.00 | 0.93 | 0.82 | | | | | 0.83 | 0.75 | 0.71 | 0.60 | | | | 0.48 | | | | 0.97 | | 1.00 | 0.92 | 0.64 |
| | 5 (127) | | | 0.95 | 0.83 | | | | | 0.85 | 0.76 | 0.72 | 0.61 | | | | 0.52 | | | | 1.00 | | | 0.94 | 0.66 |
| | 6 (152) | | | 1.00 | 0.90 | | | | | 0.92 | 0.81 | 0.77 | 0.63 | | | | 0.69 | | | | | | | 1.00 | 0.72 |
| | 7 (178) | | | | 0.97 | | | | | 0.98 | 0.87 | 0.81 | 0.65 | | | | 0.86 | | | | | | | | 0.78 |
| | 8 (203) | | | | 1.00 | | | | | 1.00 | 0.92 | 0.85 | 0.67 | | | | 1.00 | | | | | | | | 0.83 |
| | 9 (229) | | | | | | | | | | 0.97 | 0.90 | 0.69 | | | | | | | | | | | | 0.88 |
| | 10 (254) | | | | | | | | | | 1.00 | 0.94 | 0.72 | | | | | | | | | | | | 0.93 |
| | 11 (279) | | | | | | | | | | | 0.99 | 0.74 | | | | | | | | | | | | 0.97 |
| | 12 (305) | | | | | | | | | | | 1.00 | 0.76 | | | | | | | | | | | | 1.00 |
| | 14 (356) | | | | | | | | | | | | 0.80 | | | | | | | | | | | | |
| | 16 (406) | | | | | | | | | | | | 0.85 | | | | | | | | | | | | |
| | 18 (457) | | | | | | | | | | | | 0.89 | | | | | | | | | | | | |
| | 20 (508) | | | | | | | | | | | | 0.93 | | | | | | | | | | | | |
| | 24 (610) | | | | | | | | | | | | 1.00 | | | | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318-14 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

**Table 10 — Load adjustment factors for 1/2-in. diameter Hilti KH-EZ and KH-EZ CRC in uncracked concrete[1,2]**

| 1/2-in. KH-EZ uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear | | | | | | Conc. thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ toward edge $f_{RV}$ | | | II to and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{nom}$ | | in. | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 |
| | | (mm) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.68 | 0.57 | 0.51 | n/a | n/a | n/a | 0.40 | 0.25 | 0.07 | 0.68 | 0.50 | 0.15 | n/a | n/a | n/a |
| | 2 | (51) | n/a | n/a | n/a | 0.75 | 0.62 | 0.54 | n/a | n/a | n/a | 0.48 | 0.31 | 0.09 | 0.75 | 0.61 | 0.18 | n/a | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | n/a | 0.91 | 0.71 | 0.60 | n/a | n/a | n/a | 0.68 | 0.43 | 0.13 | 0.91 | 0.71 | 0.25 | n/a | n/a | n/a |
| | 3 | (76) | 0.83 | 0.73 | 0.66 | 1.00 | 0.81 | 0.66 | 0.65 | 0.61 | 0.55 | 0.89 | 0.56 | 0.17 | 1.00 | 0.81 | 0.33 | n/a | n/a | n/a |
| | 3-1/2 | (89) | 0.88 | 0.77 | 0.68 | | 0.93 | 0.73 | 0.68 | 0.63 | 0.56 | 1.00 | 0.71 | 0.21 | | 0.93 | 0.42 | n/a | n/a | n/a |
| | 4 | (102) | 0.94 | 0.81 | 0.71 | | 1.00 | 0.80 | 0.71 | 0.65 | 0.57 | | 0.87 | 0.26 | | 1.00 | 0.52 | n/a | n/a | n/a |
| | 4-1/2 | (114) | 0.99 | 0.85 | 0.73 | | | 0.87 | 0.73 | 0.67 | 0.58 | | 1.00 | 0.31 | | | 0.62 | 0.96 | n/a | n/a |
| | 4-3/4 | (121) | 1.00 | 0.87 | 0.75 | | | 0.91 | 0.74 | 0.68 | 0.58 | | | 0.33 | | | 0.67 | 0.99 | 0.85 | n/a |
| | 5 | (127) | | 0.89 | 0.76 | | | 0.95 | 0.76 | 0.69 | 0.58 | | | 0.36 | | | 0.72 | 1.00 | 0.87 | n/a |
| | 6 | (152) | | 0.96 | 0.81 | | | 1.00 | 0.81 | 0.73 | 0.60 | | | 0.47 | | | 0.95 | | 0.95 | n/a |
| | 6-3/4 | (171) | | 1.00 | 0.85 | | | | 0.85 | 0.76 | 0.61 | | | 0.57 | | | 1.00 | | 1.00 | 0.68 |
| | 7 | (178) | | | 0.86 | | | | 0.86 | 0.77 | 0.62 | | | 0.60 | | | | | | 0.69 |
| | 8 | (203) | | | 0.91 | | | | 0.91 | 0.80 | 0.64 | | | 0.73 | | | | | | 0.73 |
| | 9 | (229) | | | 0.97 | | | | 0.96 | 0.84 | 0.65 | | | 0.87 | | | | | | 0.78 |
| | 10 | (254) | | | 1.00 | | | | 1.00 | 0.88 | 0.67 | | | 1.00 | | | | | | 0.82 |
| | 11 | (279) | | | | | | | | 0.92 | 0.69 | | | | | | | | | 0.86 |
| | 12 | (305) | | | | | | | | 0.95 | 0.70 | | | | | | | | | 0.90 |
| | 14 | (356) | | | | | | | | 1.00 | 0.74 | | | | | | | | | 0.97 |
| | 16 | (406) | | | | | | | | | 0.77 | | | | | | | | | 1.00 |
| | 18 | (457) | | | | | | | | | 0.80 | | | | | | | | | |
| | 20 | (508) | | | | | | | | | 0.84 | | | | | | | | | |
| | > 24 | (610) | | | | | | | | | 0.91 | | | | | | | | | |

**Table 11 — Load adjustment factors for 1/2-in. diameter Hilti KH-EZ and KH-EZ CRC in cracked concrete[1,2]**

| 1/2-in. KH-EZ cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear | | | | | | Conc. thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | ⊥ toward edge $f_{RV}$ | | | II to and away from edge $f_{RV}$ | | | | | |
| Embedment $h_{nom}$ | | in. | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 |
| | | (mm) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.82 | 0.66 | 0.55 | n/a | n/a | n/a | 0.45 | 0.28 | 0.08 | 0.82 | 0.57 | 0.17 | n/a | n/a | n/a |
| | 2 | (51) | n/a | n/a | n/a | 0.90 | 0.72 | 0.58 | n/a | n/a | n/a | 0.55 | 0.35 | 0.10 | 0.90 | 0.70 | 0.21 | n/a | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | n/a | 1.00 | 0.83 | 0.65 | n/a | n/a | n/a | 0.77 | 0.49 | 0.14 | 1.00 | 0.83 | 0.29 | n/a | n/a | n/a |
| | 3 | (76) | 0.83 | 0.73 | 0.66 | 1.00 | 0.94 | 0.72 | 0.67 | 0.62 | 0.56 | 1.00 | 0.64 | 0.19 | 1.00 | 0.94 | 0.38 | n/a | n/a | n/a |
| | 3-1/2 | (89) | 0.88 | 0.77 | 0.68 | | 1.00 | 0.79 | 0.70 | 0.64 | 0.56 | | 0.80 | 0.24 | | 1.00 | 0.48 | n/a | n/a | n/a |
| | 4 | (102) | 0.94 | 0.81 | 0.71 | | 1.00 | 0.87 | 0.72 | 0.66 | 0.57 | | 0.98 | 0.29 | | 1.00 | 0.59 | n/a | n/a | n/a |
| | 4-1/2 | (114) | 0.99 | 0.85 | 0.73 | | | 0.95 | 0.75 | 0.69 | 0.58 | | 1.00 | 0.35 | | | 0.70 | 1.00 | n/a | n/a |
| | 4-3/4 | (121) | 1.00 | 0.87 | 0.75 | | | 0.99 | 0.77 | 0.70 | 0.59 | | | 0.38 | | | 0.76 | | 0.88 | n/a |
| | 5 | (127) | | 0.89 | 0.76 | | | 1.00 | 0.78 | 0.71 | 0.59 | | | 0.41 | | | 0.82 | | 0.91 | n/a |
| | 6 | (152) | | 0.96 | 0.81 | | | 1.00 | 0.84 | 0.75 | 0.61 | | | 0.54 | | | 1.00 | | 0.99 | n/a |
| | 6-3/4 | (171) | | 1.00 | 0.85 | | | | 0.88 | 0.78 | 0.62 | | | 0.64 | | | | | 1.00 | 0.70 |
| | 7 | (178) | | | 0.86 | | | | 0.89 | 0.79 | 0.63 | | | 0.68 | | | | | | 0.72 |
| | 8 | (203) | | | 0.91 | | | | 0.95 | 0.83 | 0.65 | | | 0.83 | | | | | | 0.77 |
| | 9 | (229) | | | 0.97 | | | | 1.00 | 0.87 | 0.67 | | | 0.99 | | | | | | 0.81 |
| | 10 | (254) | | | 1.00 | | | | | 0.91 | 0.68 | | | 1.00 | | | | | | 0.86 |
| | 11 | (279) | | | | | | | | 0.95 | 0.70 | | | | | | | | | 0.90 |
| | 12 | (305) | | | | | | | | 0.99 | 0.72 | | | | | | | | | 0.94 |
| | 14 | (356) | | | | | | | | 1.00 | 0.76 | | | | | | | | | 1.00 |
| | 16 | (406) | | | | | | | | | 0.79 | | | | | | | | | |
| | 18 | (457) | | | | | | | | | 0.83 | | | | | | | | | |
| | 20 | (508) | | | | | | | | | 0.87 | | | | | | | | | |
| | > 24 | (610) | | | | | | | | | 0.94 | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

## Table 12 — Load adjustment factors for 5/8-in. diameter Hilti KH-EZ and KH-EZ CRC in uncracked concrete[1,2]

| 5/8-in. KH-EZ uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | | Edge distance in shear: II to and away from edge $f_{RV}$ | | | Conc. thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | | in. | 3-1/4 | 4 | 5 | 3-1/4 | 4 | 5 | 3-1/4 | 4 | 5 | 3-1/4 | 4 | 5 | 3-1/4 | 4 | 5 | 3-1/4 | 4 | 5 |
| | | (mm) | (83) | (102) | (127) | (83) | (102) | (127) | (83) | (102) | (127) | (83) | (102) | (127) | (83) | (102) | (127) | (83) | (102) | (127) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.622 | 0.562 | 0.514 | n/a | n/a | n/a | 0.235 | 0.086 | 0.063 | 0.470 | 0.173 | 0.125 | n/a | n/a | n/a |
| | 2 | (51) | n/a | n/a | n/a | 0.667 | 0.596 | 0.540 | n/a | n/a | n/a | 0.287 | 0.106 | 0.076 | 0.574 | 0.211 | 0.153 | n/a | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | n/a | 0.762 | 0.667 | 0.592 | n/a | n/a | n/a | 0.401 | 0.147 | 0.107 | 0.762 | 0.295 | 0.214 | n/a | n/a | n/a |
| | 3 | (76) | 0.709 | 0.665 | 0.629 | 0.863 | 0.741 | 0.648 | 0.609 | 0.556 | 0.545 | 0.528 | 0.194 | 0.141 | 0.863 | 0.388 | 0.281 | n/a | n/a | n/a |
| | 3-1/2 | (89) | 0.744 | 0.693 | 0.650 | 0.969 | 0.819 | 0.705 | 0.627 | 0.565 | 0.553 | 0.665 | 0.244 | 0.177 | 0.969 | 0.488 | 0.354 | n/a | n/a | n/a |
| | 4 | (102) | 0.779 | 0.720 | 0.672 | 1.000 | 0.901 | 0.764 | 0.645 | 0.574 | 0.560 | 0.812 | 0.298 | 0.216 | 1.000 | 0.597 | 0.433 | n/a | n/a | n/a |
| | 4-1/2 | (114) | 0.814 | 0.748 | 0.693 | | 0.987 | 0.826 | 0.663 | 0.584 | 0.568 | 0.969 | 0.356 | 0.258 | | 0.712 | 0.516 | n/a | n/a | n/a |
| | 5 | (127) | 0.849 | 0.775 | 0.715 | | 1.000 | 0.890 | 0.681 | 0.593 | 0.575 | 1.000 | 0.417 | 0.302 | | 0.834 | 0.605 | 0.852 | n/a | n/a |
| | 5-1/2 | (140) | 0.884 | 0.803 | 0.736 | | | 0.956 | 0.700 | 0.602 | 0.583 | | 0.481 | 0.349 | | 0.962 | 0.698 | 0.893 | n/a | n/a |
| | 6 | (152) | 0.918 | 0.830 | 0.758 | | | 1.000 | 0.718 | 0.612 | 0.590 | | 0.548 | 0.398 | | 1.000 | 0.795 | 0.933 | 0.668 | n/a |
| | 7 | (178) | 0.988 | 0.885 | 0.801 | | | | 0.754 | 0.630 | 0.605 | | 0.691 | 0.501 | | | 1.000 | 1.000 | 0.722 | 0.648 |
| | 8 | (203) | 1.000 | 0.940 | 0.844 | | | | 0.790 | 0.649 | 0.620 | | 0.844 | 0.612 | | | | | 0.772 | 0.693 |
| | 9 | (229) | | 0.995 | 0.887 | | | | 0.827 | 0.667 | 0.635 | | 1.000 | 0.730 | | | | | 0.818 | 0.735 |
| | 10 | (254) | | 1.000 | 0.930 | | | | 0.863 | 0.686 | 0.650 | | | 0.855 | | | | | 0.863 | 0.775 |
| | 11 | (279) | | | 0.973 | | | | 0.899 | 0.705 | 0.665 | | | 0.987 | | | | | 0.905 | 0.813 |
| | 12 | (305) | | | 1.000 | | | | 0.935 | 0.723 | 0.680 | | | 1.000 | | | | | 0.945 | 0.849 |
| | 14 | (356) | | | | | | | 1.000 | 0.760 | 0.710 | | | | | | | | 1.000 | 0.917 |
| | 16 | (406) | | | | | | | | 0.798 | 0.740 | | | | | | | | | 0.980 |
| | 18 | (457) | | | | | | | | 0.835 | 0.770 | | | | | | | | | 1.000 |
| | 20 | (508) | | | | | | | | 0.872 | 0.800 | | | | | | | | | |
| | 24 | (610) | | | | | | | | 0.947 | 0.860 | | | | | | | | | |
| | > 30 | (762) | | | | | | | | 1.000 | 0.951 | | | | | | | | | |

## Table 13 — Load adjustment factors for 5/8-in. diameter Hilti KH-EZ and KH-EZ CRC in cracked concrete[1,2]

| 5/8-in. KH-EZ cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | | Edge distance in shear: II to and away from edge $f_{RV}$ | | | Conc. thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | | in. | 3-1/4 | 4 | 5 | 3-1/4 | 4 | 5 | 3-1/4 | 4 | 5 | 3-1/4 | 4 | 5 | 3-1/4 | 4 | 5 | 3-1/4 | 4 | 5 |
| | | (mm) | (83) | (102) | (127) | (83) | (102) | (127) | (83) | (102) | (127) | (83) | (102) | (127) | (83) | (102) | (127) | (83) | (102) | (127) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.630 | 0.565 | 0.514 | n/a | n/a | n/a | 0.267 | 0.098 | 0.071 | 0.533 | 0.196 | 0.142 | n/a | n/a | n/a |
| | 2 | (51) | n/a | n/a | n/a | 0.676 | 0.599 | 0.540 | n/a | n/a | n/a | 0.326 | 0.120 | 0.087 | 0.652 | 0.239 | 0.174 | n/a | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | n/a | 0.772 | 0.670 | 0.592 | n/a | n/a | n/a | 0.455 | 0.167 | 0.121 | 0.772 | 0.335 | 0.243 | n/a | n/a | n/a |
| | 3 | (76) | 0.709 | 0.665 | 0.629 | 0.873 | 0.745 | 0.648 | 0.618 | 0.561 | 0.549 | 0.599 | 0.220 | 0.159 | 0.873 | 0.440 | 0.319 | n/a | n/a | n/a |
| | 3-1/2 | (89) | 0.744 | 0.693 | 0.650 | 0.981 | 0.824 | 0.705 | 0.638 | 0.571 | 0.557 | 0.754 | 0.277 | 0.201 | 0.981 | 0.554 | 0.402 | n/a | n/a | n/a |
| | 4 | (102) | 0.779 | 0.720 | 0.672 | 1.000 | 0.906 | 0.764 | 0.658 | 0.581 | 0.565 | 0.922 | 0.339 | 0.245 | 1.000 | 0.677 | 0.491 | n/a | n/a | n/a |
| | 4-1/2 | (114) | 0.814 | 0.748 | 0.693 | | 0.992 | 0.826 | 0.678 | 0.591 | 0.574 | 1.000 | 0.404 | 0.293 | | 0.808 | 0.586 | n/a | n/a | n/a |
| | 5 | (127) | 0.849 | 0.775 | 0.715 | | 1.000 | 0.890 | 0.697 | 0.601 | 0.582 | 1.000 | 0.473 | 0.343 | | 0.946 | 0.686 | 0.888 | n/a | n/a |
| | 5-1/2 | (140) | 0.884 | 0.803 | 0.736 | | | 0.956 | 0.717 | 0.611 | 0.590 | | 0.546 | 0.396 | | 1.000 | 0.792 | 0.932 | n/a | n/a |
| | 6 | (152) | 0.918 | 0.830 | 0.758 | | | 1.000 | 0.737 | 0.621 | 0.598 | | 0.622 | 0.451 | | | 0.902 | 0.973 | 0.697 | n/a |
| | 7 | (178) | 0.988 | 0.885 | 0.801 | | | | 0.776 | 0.642 | 0.614 | | 0.784 | 0.568 | | | 1.000 | 1.000 | 0.753 | 0.676 |
| | 8 | (203) | 1.000 | 0.940 | 0.844 | | | | 0.816 | 0.662 | 0.631 | | 0.958 | 0.694 | | | | | 0.805 | 0.723 |
| | 9 | (229) | | 0.995 | 0.887 | | | | 0.855 | 0.682 | 0.647 | | 1.000 | 0.828 | | | | | 0.854 | 0.767 |
| | 10 | (254) | | 1.000 | 0.930 | | | | 0.895 | 0.702 | 0.663 | | | 0.970 | | | | | 0.900 | 0.808 |
| | 11 | (279) | | | 0.973 | | | | 0.934 | 0.723 | 0.680 | | | 1.000 | | | | | 0.944 | 0.848 |
| | 12 | (305) | | | 1.000 | | | | 0.974 | 0.743 | 0.696 | | | | | | | | 0.986 | 0.885 |
| | 14 | (356) | | | | | | | 1.000 | 0.783 | 0.729 | | | | | | | | 1.000 | 0.956 |
| | 16 | (406) | | | | | | | | 0.824 | 0.761 | | | | | | | | | 1.000 |
| | 18 | (457) | | | | | | | | 0.864 | 0.794 | | | | | | | | | |
| | 20 | (508) | | | | | | | | 0.905 | 0.827 | | | | | | | | | |
| | 24 | (610) | | | | | | | | 0.986 | 0.892 | | | | | | | | | |
| | > 30 | (762) | | | | | | | | 1.000 | 0.990 | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

**Table 14 — Load adjustment factors for 3/4-in. diameter Hilti KH-EZ and KH-EZ CRC in uncracked concrete[1,2]**

| 3/4-in. KH-EZ uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. (mm) | 4 (102) | 6-1/4 (159) | 4 (102) | 6-1/4 (159) | 4 (102) | 6-1/4 (159) | 4 (102) | 6-1/4 (159) | 4 (102) | 6-1/4 (159) | 4 (102) | 6-1/4 (159) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | 0.57 | 0.48 | n/a | n/a | 0.10 | 0.05 | 0.19 | 0.10 | n/a | n/a |
| | 2 | (51) | n/a | n/a | 0.61 | 0.50 | n/a | n/a | 0.12 | 0.06 | 0.23 | 0.12 | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | 0.68 | 0.54 | n/a | n/a | 0.16 | 0.08 | 0.33 | 0.17 | n/a | n/a |
| | 3 | (76) | 0.67 | 0.60 | 0.76 | 0.58 | 0.56 | 0.54 | 0.21 | 0.11 | 0.43 | 0.22 | n/a | n/a |
| | 3-1/2 | (89) | 0.70 | 0.62 | 0.84 | 0.62 | 0.57 | 0.55 | 0.27 | 0.14 | 0.54 | 0.28 | n/a | n/a |
| | 4 | (102) | 0.73 | 0.64 | 0.93 | 0.67 | 0.58 | 0.55 | 0.33 | 0.17 | 0.66 | 0.34 | n/a | n/a |
| | 4-1/2 | (114) | 0.76 | 0.65 | 1.00 | 0.72 | 0.59 | 0.56 | 0.39 | 0.20 | 0.79 | 0.41 | n/a | n/a |
| | 5 | (127) | 0.79 | 0.67 | | 0.76 | 0.60 | 0.56 | 0.46 | 0.24 | 0.92 | 0.48 | n/a | n/a |
| | 5-1/2 | (140) | 0.81 | 0.69 | | 0.81 | 0.61 | 0.57 | 0.53 | 0.28 | 1.00 | 0.55 | n/a | n/a |
| | 6 | (152) | 0.84 | 0.71 | | 0.86 | 0.62 | 0.58 | 0.61 | 0.31 | | 0.63 | 0.69 | n/a |
| | 7 | (178) | 0.90 | 0.74 | | 0.97 | 0.64 | 0.59 | 0.77 | 0.40 | | 0.79 | 0.75 | n/a |
| | 8 | (203) | 0.96 | 0.78 | | 1.00 | 0.66 | 0.60 | 0.94 | 0.48 | | 0.97 | 0.80 | n/a |
| | 8-1/8 | (206) | 0.96 | 0.78 | | | 0.66 | 0.60 | 0.96 | 0.50 | | 0.99 | 0.80 | 0.65 |
| | 9 | (229) | 1.00 | 0.81 | | | 0.68 | 0.62 | 1.00 | 0.58 | | 1.00 | 0.85 | 0.68 |
| | 10 | (254) | | 0.84 | | | 0.70 | 0.63 | | 0.68 | | | 0.89 | 0.72 |
| | 11 | (279) | | 0.88 | | | 0.72 | 0.64 | | 0.78 | | | 0.94 | 0.75 |
| | 12 | (305) | | 0.91 | | | 0.74 | 0.65 | | 0.89 | | | 0.98 | 0.79 |
| | 14 | (356) | | 0.98 | | | 0.78 | 0.68 | | 1.00 | | | 1.00 | 0.85 |
| | 16 | (406) | | 1.00 | | | 0.82 | 0.71 | | | | | | 0.91 |
| | 18 | (457) | | | | | 0.86 | 0.73 | | | | | | 0.96 |
| | 20 | (508) | | | | | 0.90 | 0.76 | | | | | | 1.00 |
| | 24 | (610) | | | | | 0.98 | 0.81 | | | | | | |
| | 30 | (762) | | | | | 1.00 | 0.89 | | | | | | |
| | > 36 | (914) | | | | | | 0.96 | | | | | | |

3.3.6

**Table 15 — Load adjustment factors for 3/4-in. diameter Hilti KH-EZ and KH-EZ CRC in cracked concrete[1,2]**

| 3/4-in. KH-EZ cracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. (mm) | 4 (102) | 6-1/4 (159) | 4 (102) | 6-1/4 (159) | 4 (102) | 6-1/4 (159) | 4 (102) | 6-1/4 (159) | 4 (102) | 6-1/4 (159) | 4 (102) | 6-1/4 (159) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | 0.57 | 0.48 | n/a | n/a | 0.11 | 0.06 | 0.22 | 0.11 | n/a | n/a |
| | 2 | (51) | n/a | n/a | 0.61 | 0.50 | n/a | n/a | 0.13 | 0.07 | 0.27 | 0.14 | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | 0.68 | 0.54 | n/a | n/a | 0.19 | 0.10 | 0.37 | 0.19 | n/a | n/a |
| | 3 | (76) | 0.67 | 0.60 | 0.76 | 0.58 | 0.57 | 0.54 | 0.24 | 0.13 | 0.49 | 0.25 | n/a | n/a |
| | 3-1/2 | (89) | 0.70 | 0.62 | 0.85 | 0.63 | 0.58 | 0.55 | 0.31 | 0.16 | 0.61 | 0.32 | n/a | n/a |
| | 4 | (102) | 0.73 | 0.64 | 0.93 | 0.67 | 0.59 | 0.56 | 0.38 | 0.19 | 0.75 | 0.39 | n/a | n/a |
| | 4-1/2 | (114) | 0.76 | 0.65 | 1.00 | 0.72 | 0.60 | 0.56 | 0.45 | 0.23 | 0.90 | 0.46 | n/a | n/a |
| | 5 | (127) | 0.79 | 0.67 | | 0.77 | 0.61 | 0.57 | 0.52 | 0.27 | 1.00 | 0.54 | n/a | n/a |
| | 5-1/2 | (140) | 0.81 | 0.69 | | 0.81 | 0.62 | 0.58 | 0.60 | 0.31 | | 0.63 | n/a | n/a |
| | 6 | (152) | 0.84 | 0.71 | | 0.87 | 0.63 | 0.58 | 0.69 | 0.36 | | 0.71 | 0.72 | n/a |
| | 7 | (178) | 0.90 | 0.74 | | 0.97 | 0.65 | 0.60 | 0.87 | 0.45 | | 0.90 | 0.78 | n/a |
| | 8 | (203) | 0.96 | 0.78 | | 1.00 | 0.67 | 0.61 | 1.00 | 0.55 | | 1.00 | 0.83 | n/a |
| | 8-1/8 | (206) | 0.96 | 0.78 | | | 0.68 | 0.61 | | 0.56 | | | 0.84 | 0.67 |
| | 9 | (229) | 1.00 | 0.81 | | | 0.70 | 0.63 | | 0.66 | | | 0.88 | 0.71 |
| | 10 | (254) | | 0.84 | | | 0.72 | 0.64 | | 0.77 | | | 0.93 | 0.75 |
| | 11 | (279) | | 0.88 | | | 0.74 | 0.65 | | 0.89 | | | 0.98 | 0.78 |
| | 12 | (305) | | 0.91 | | | 0.76 | 0.67 | | 1.00 | | | 1.00 | 0.82 |
| | 14 | (356) | | 0.98 | | | 0.80 | 0.70 | | | | | | 0.89 |
| | 16 | (406) | | 1.00 | | | 0.85 | 0.72 | | | | | | 0.95 |
| | 18 | (457) | | | | | 0.89 | 0.75 | | | | | | 1.00 |
| | 20 | (508) | | | | | 0.93 | 0.78 | | | | | | |
| | 24 | (610) | | | | | 1.00 | 0.84 | | | | | | |
| | 30 | (762) | | | | | | 0.92 | | | | | | |
| | > 36 | (914) | | | | | | 1.00 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

## Table 16 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6]

| Nominal anchor diameter in. | Nominal embedment in. (mm) | Installation in lower flute | | | | Installation in upper flute | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Tension - $\phi N_n$ | | Shear - $\phi V_n$ | | Tension - $\phi N_n$ | | Shear - $\phi V_n$ | |
| | | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) |
| 1/4 | 1-5/8 (41) | 545 (2.4) | 595 (2.6) | 725 (3.2) | 725 (3.2) | 670 (3.0) | 730 (3.2) | 725 (3.2) | 725 (3.2) |
| | 2-1/2 (64) | 1,220 (5.4) | 1,410 (6.3) | 1,325 (5.9) | 1,325 (5.9) | 1,275 (5.7) | 1,470 (6.5) | 1,960 (8.7) | 1,960 (8.7) |
| 3/8 | 1-5/8 (41) | 845 (3.8) | 975 (4.3) | 905 (4.0) | 905 (4.0) | 970 (4.3) | 1,120 (5.0) | 2,200 (9.8) | 2,200 (9.8) |
| | 2-1/2 (64) | 1,455 (6.5) | 1,680 (7.5) | 905 (4.0) | 905 (4.0) | 1,900 (8.5) | 2,195 (9.8) | 3,655 (16.3) | 3,655 (16.3) |
| | 3-1/4 (83) | 2,550 (11.3) | 2,945 (13.1) | 2,165 (9.6) | 2,165 (9.6) | n/a | n/a | n/a | n/a |
| 1/2 | 2-1/4 (57) | 850 (3.8) | 980 (4.4) | 965 (4.3) | 965 (4.3) | 905 (4.0) | 1,045 (4.6) | 4,710 (21.0) | 4,710 (21.0) |
| | 3 (76) | 1,990 (8.9) | 2,300 (10.2) | 1,750 (7.8) | 1,750 (7.8) | n/a | n/a | n/a | n/a |
| | 4-1/4 (108) | 3,485 (15.5) | 4,025 (17.9) | 2,155 (9.6) | 2,155 (9.6) | n/a | n/a | n/a | n/a |
| 5/8 | 3-1/4 (83) | 2,715 (12.1) | 3,135 (13.9) | 2,080 (9.3) | 2,080 (9.3) | n/a | n/a | n/a | n/a |
| | 5 (127) | 6,170 (27.4) | 7,125 (31.7) | 2,515 (11.2) | 2,515 (11.2) | n/a | n/a | n/a | n/a |
| 3/4 | 4 (102) | 2,715 (12.1) | 3,135 (13.9) | 2,255 (10.0) | 2,255 (10.0) | n/a | n/a | n/a | n/a |

## Table 17 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the soffit of cracked lightweight concrete over metal deck[1,2,3,4,5,6]

| Nominal anchor diameter in. | Nominal embedment in. (mm) | Installation in lower flute | | | | Installation in upper flute | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Tension - $\phi N_n$[7] | | Shear - $\phi V_n$[8] | | Tension - $\phi N_n$[7] | | Shear - $\phi V_n$[8] | |
| | | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) |
| 1/4 | 1-5/8 (41) | 280 (1.2) | 305 (1.4) | 725 (3.2) | 725 (3.2) | 340 (1.5) | 370 (1.6) | 725 (3.2) | 725 (3.2) |
| | 2-1/2 (64) | 605 (2.7) | 700 (3.1) | 1,325 (5.9) | 1,325 (5.9) | 635 (2.8) | 735 (3.3) | 1,960 (8.7) | 1,960 (8.7) |
| 3/8 | 1-5/8 (41) | 525 (2.3) | 605 (2.7) | 905 (4.0) | 905 (4.0) | 770 (3.4) | 890 (4.0) | 2,200 (9.8) | 2,200 (9.8) |
| | 2-1/2 (64) | 1,035 (4.6) | 1,195 (5.3) | 905 (4.0) | 905 (4.0) | 1,345 (6.0) | 1,555 (6.9) | 3,655 (16.3) | 3,655 (16.3) |
| | 3-1/4 (83) | 1,805 (8.0) | 2,085 (9.3) | 2,165 (9.6) | 2,165 (9.6) | n/a | n/a | n/a | n/a |
| 1/2 | 2-1/4 (57) | 535 (2.4) | 620 (2.8) | 965 (4.3) | 965 (4.3) | 640 (2.8) | 740 (3.3) | 4,710 (21.0) | 4,710 (21.0) |
| | 3 (76) | 1,255 (5.6) | 1,450 (6.4) | 1,750 (7.8) | 1,750 (7.8) | n/a | n/a | n/a | n/a |
| | 4-1/4 (108) | 2,195 (9.8) | 2,535 (11.3) | 2,155 (9.6) | 2,155 (9.6) | n/a | n/a | n/a | n/a |
| 5/8 | 3-1/4 (83) | 1,710 (7.6) | 1,975 (8.8) | 2,080 (9.3) | 2,080 (9.3) | n/a | n/a | n/a | n/a |
| | 5 (127) | 3,885 (17.3) | 4,485 (20.0) | 2,515 (11.2) | 2,515 (11.2) | n/a | n/a | n/a | n/a |
| 3/4 | 4 (102) | 1,710 (7.6) | 1,975 (8.8) | 2,255 (10.0) | 2,255 (10.0) | n/a | n/a | n/a | n/a |

1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{nom}$ (nominal embedment).

4 Tabular values are lightweight concrete and no additional reduction factor is needed.

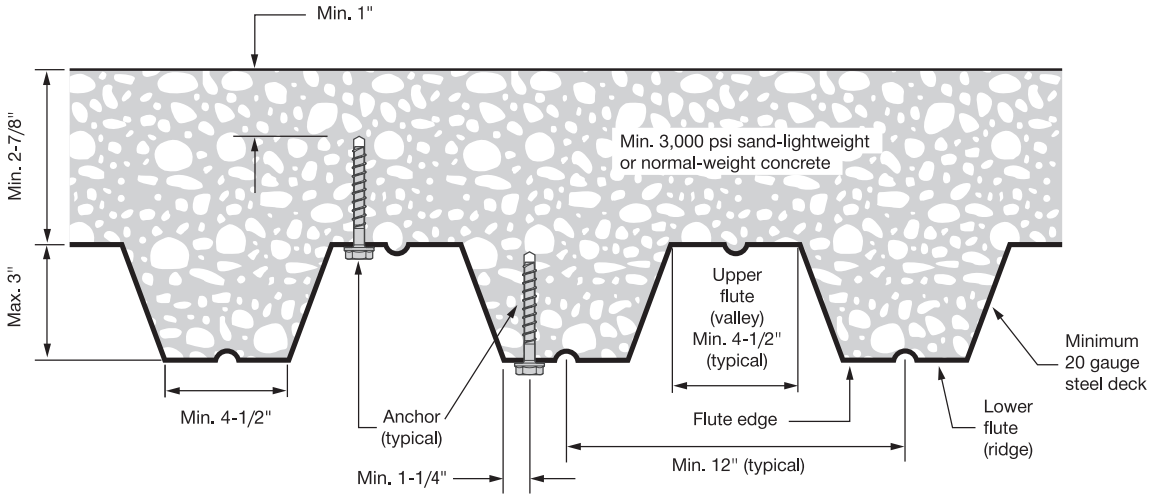
5 No additional reduction factors for spacing or edge distance need to be applied.

6 Comparison to steel values in table 4 is not required. Values in tables 16 and 17 control.

7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

8 For the following anchor sizes, an additional factor for seismic shear must be applied to the cracked concrete tabular values for seismic conditions:
1/4-inch diameter - $\alpha_{v,seis}$ = 0.75
3/8-inch diameter - $\alpha_{v,seis}$ = 0.60
1/2-inch diameter - $\alpha_{v,seis}$ = 0.60
5/8-inch diameter - $\alpha_{v,seis}$ = 0.60
3/4-inch diameter - $\alpha_{v,seis}$ = 0.70

**Figure 3 — Installation of Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in soffit of concrete over steel deck floor and roof assemblies[1]**




1 Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum concrete cover above the drilled hole is satisfied. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

**Figure 4 — Installation of Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC on the top of sand-lightweight concrete over metal floor and roof assemblies**

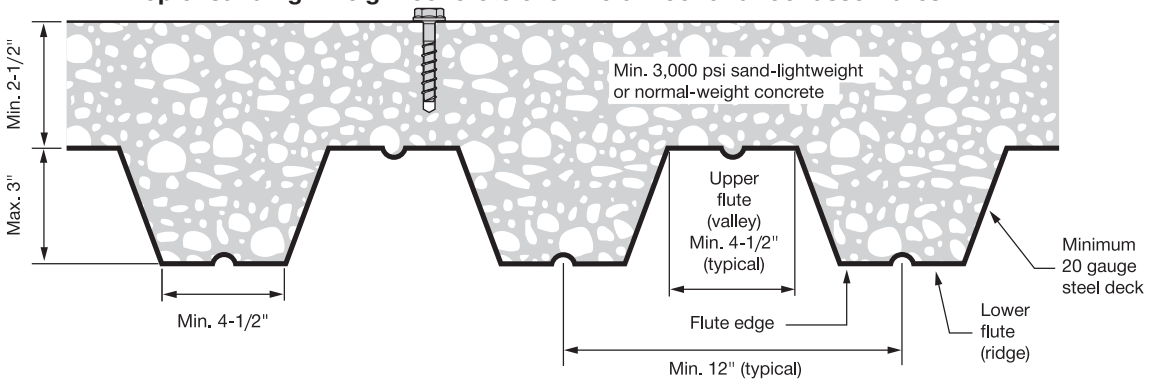





**Table 18 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the top of uncracked concrete over metal deck[1,2,3,4,5]**

| Nominal anchor diameter in. | Nominal embedment depth in. (mm) | Tension - $\phi N_n$ | | Shear - $\phi V_n$ | |
|---|---|---|---|---|---|
| | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) |
| 1/4 | 1-5/8 (41) | 620 (2.8) | 675 (3.0) | 1,180 (5.2) | 1,360 (6.0) |
| 3/8 | 1-5/8 (41) | 1,000 (4.4) | 1,155 (5.1) | 1,075 (4.8) | 1,245 (5.5) |

**Table 19 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the top of cracked concrete over metal deck[1,2,3,4,5]**

| Nominal anchor diameter in. | Nominal embed. depth in. (mm) | Tension - $\phi N_n$ | | Shear - $\phi V_n$ | |
|---|---|---|---|---|---|
| | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) |
| 1/4 | 1-5/8 (41) | 315 (1.4) | 345 (1.5) | 835 (3.7) | 965 (4.3) |
| 3/8 | 1-5/8 (41) | 520 (2.3) | 600 (2.7) | 760 (3.4) | 880 (3.9) |

1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 20 and 21 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.

4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-inch diameter - $\alpha_{N,seis}$ = 0.60
3/8-inch diameter- $\alpha_{N,seis}$ = 0.75.
No reduction needed for seismic shear. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

## Table 20 — Load adjustment factors for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the top of uncracked concrete over metal deck[1,2]

| 1/4-in. and 3/8-in. KH-EZ uncracked concrete over metal deck | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Anchor diameter $d_a$ | | in. | 1/4 | 3/8 | 1/4 | 3/8 | 1/4 | 3/8 | 1/4 | 3/8 | 1/4 | 3/8 | 1/4 | 3/8 |
| | | (mm) | (6.4) | (9.5) | (6.4) | (9.5) | (6.4) | (9.5) | (6.4) | (9.5) | (6.4) | (9.5) | (6.4) | (9.5) |
| Nominal embed. $h_{nom}$ | | in. | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 |
| | | (mm) | (41) | (41) | (41) | (41) | (41) | (41) | (41) | (41) | (41) | (41) | (41) | (41) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | 0.44 | 0.58 | n/a | n/a | 0.44 | 0.58 | 0.44 | 0.58 | n/a | n/a |
| | 2 | (51) | n/a | n/a | 0.50 | 0.67 | n/a | n/a | 0.50 | 0.67 | 0.50 | 0.67 | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | 0.63 | 0.83 | n/a | n/a | 0.63 | 0.83 | 0.63 | 0.83 | 0.78 | 0.83 |
| | 3 | (76) | 0.92 | 0.95 | 0.75 | 1.00 | 0.68 | 0.71 | 0.75 | 1.00 | 0.75 | 1.00 | 0.85 | 0.91 |
| | 3-1/4 | (83) | 0.96 | 0.99 | 0.81 | | 0.70 | 0.72 | 0.81 | | 0.81 | | | |
| | 3-1/2 | (89) | 0.99 | 1.00 | 0.88 | | 0.71 | 0.74 | 0.88 | | 0.88 | | | |
| | 4 | (102) | 1.00 | | 1.00 | | 0.74 | 0.78 | 1.00 | | 1.00 | | | |
| | 4-1/2 | (114) | | | | | 0.77 | 0.81 | | | | | | |
| | 5 | (127) | | | | | 0.80 | 0.84 | | | | | | |
| | 5-1/2 | (140) | | | | | 0.83 | 0.88 | | | | | | |
| | 6 | (152) | | | | | 0.86 | 0.91 | | | | | | |
| | 6-1/2 | (165) | | | | | 0.89 | 0.95 | | | | | | |
| | 7 | (178) | | | | | 0.92 | 0.98 | | | | | | |
| | 7-1/2 | (191) | | | | | 0.95 | 1.00 | | | | | | |
| | 8 | (203) | | | | | 0.98 | | | | | | | |
| | 9 | (229) | | | | | 1.00 | | | | | | | |

## Table 21 — Load adjustment factors for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the top of cracked concrete over metal deck[1,2]

| 1/4-in. and 3/8-in. KH-EZ cracked concrete over metal deck | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Anchor diameter $d_a$ | | in. | 1/4 | 3/8 | 1/4 | 3/8 | 1/4 | 3/8 | 1/4 | 3/8 | 1/4 | 3/8 | 1/4 | 3/8 |
| | | (mm) | (6.4) | (9.5) | (6.4) | (9.5) | (6.4) | (9.5) | (6.4) | (9.5) | (6.4) | (9.5) | (6.4) | (9.5) |
| Nominal embed. $h_{nom}$ | | in. | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 | 1-5/8 |
| | | (mm) | (41) | (41) | (41) | (41) | (41) | (41) | (41) | (41) | (41) | (41) | (41) | (41) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | 0.99 | 1.00 | n/a | n/a | 0.51 | 0.62 | 0.99 | 1.00 | n/a | n/a |
| | 2 | (51) | n/a | n/a | 1.00 | | n/a | n/a | 0.62 | 0.76 | 1.00 | | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | | | n/a | n/a | 0.87 | 1.00 | | | 0.78 | 0.83 |
| | 3 | (76) | 0.92 | 0.95 | | | 0.68 | 0.71 | 1.00 | | | | 0.85 | 0.91 |
| | 3-1/4 | (83) | 0.96 | 0.99 | | | 0.70 | 0.73 | | | | | | |
| | 3-1/2 | (89) | 0.99 | 1.00 | | | 0.71 | 0.74 | | | | | | |
| | 4 | (102) | 1.00 | | | | 0.74 | 0.78 | | | | | | |
| | 4-1/2 | (114) | | | | | 0.77 | 0.81 | | | | | | |
| | 5 | (127) | | | | | 0.80 | 0.85 | | | | | | |
| | 5-1/2 | (140) | | | | | 0.83 | 0.88 | | | | | | |
| | 6 | (152) | | | | | 0.86 | 0.92 | | | | | | |
| | 6-1/2 | (165) | | | | | 0.89 | 0.95 | | | | | | |
| | 7 | (178) | | | | | 0.92 | 0.98 | | | | | | |
| | 7-1/2 | (191) | | | | | 0.95 | 1.00 | | | | | | |
| | 8 | (203) | | | | | 0.98 | | | | | | | |
| | 9 | (229) | | | | | 1.00 | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

☐ - For concrete thickness greater than or equal to 3-1/4-inches, the anchor can be designed using either table 2 or table 3 of this section.

## DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-3027. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

**Table 22 — Steel resistance for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC carbon steel screw anchor[1,2]**

| Nominal anchor diameter in. | Nominal embedment in. (mm) | | | Tensile [3] $N_{sar}$ lb (kN) | Shear [4] $V_{sar}$ lb (kN) | Seismic shear [5] $V_{sar,eq}$ lb (kN) |
|---|---|---|---|---|---|---|
| 1/4 | 1-5/8 (41) | | 2-1/2 (64) | 3,370 (15.0) | 855 (3.8) | 770 (3.4) |
| 3/8 | 1-5/8 (41) | | 2-1/8 (54) | 5,475 (24.4) | 2,030 (9.0) | 2,030 (9.0) |
| | 2-1/2 (64) | | 3-1/4 (83) | 6,150 (27.4) | 2,865 (12.7) | 1,720 (7.7) |
| 1/2 | 2-1/4 (57) | 3 (76) | 4-1/4 (108) | 10,780 (48.0) | 5,110 (22.7) | 3,065 (13.6) |
| 5/8 | 3-1/4 (83) | 4 (102) | 5 (127) | 14,405 (64.1) | 6,200 (27.6) | 3,720 (16.5) |
| 3/4 | 4 (102) | | 6-1/4 (159) | 19,050 (84.7) | 9,205 (40.9) | 6,385 (28.4) |

1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KH-EZ carbon steel screw anchors are to be considered brittle steel elements.
3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with $V_{sar} < 0.6\ A_{se,V}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \le 0.60\ A_{se,V}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D. See PTG Ed. 21 Section 3.1.9 for additional information on seismic applications.

## Table 23 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC design information in accordance with CSA A23.3 Annex D1[1]

| Design parameter | Symbol | Units | Nominal anchor diameter | | | | | | | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | | 3/8 | | | | 1/2 | | | 5/8 | | | 3/4 | | A23.3 |
| Head Style and coating | | | Hex, P, PM, PL, C head | | Hex, C head | | Hex, C head (Including CRC) | | Hex head (Including CRC) | | | Hex head (Including CRC) | | | Hex head (Including CRC) | | |
| Nominal anchor diameter | $d_a$ | in. (mm) | 0.25 (6.4) | | 0.375 (9.5) | | | | 0.5 (12.7) | | | 0.625 (15.9) | | | 0.75 (19.1) | | |
| Effective embedment[2] | $h_{ef}$ | in. (mm) | 1.18 (30) | 1.92 (49) | 1.11 (28) | 1.54 (39) | 1.86 (47) | 2.50 (64) | 1.52 (39) | 2.16 (55) | 3.22 (82) | 2.39 (61) | 3.03 (77) | 3.88 (99) | 2.92 (74) | 4.84 (123) | |
| Min. nominal embedment[2] | $h_{nom}$ | in. (mm) | 1-5/8 (41) | 2-1/2 (64) | 1-5/8 (41) | 2-1/8 (54) | 2-1/2 (64) | 3-1/4 (83) | 2-1/4 (57) | 3 (76) | 4-1/4 (108) | 3-1/4 (83) | 4 (102) | 5 (127) | 4 (102) | 6-1/4 (159) | |
| Minimum concrete thickness[3] | $h_{min}$ | in. (mm) | 3-1/4 (83) | 4-1/8 (105) | 3-1/4 (83) | 3-2/3 (93) | 4 (102) | 4-3/4 (121) | 4-1/2 (114) | 4-3/4 (121) | 6-3/4 (171) | 5 (127) | 6 (152) | 7 (178) | 6 (152) | 8-1/8 (206) | |
| Critical edge distance | $c_{ac}$ | in. (mm) | 2 (51) | 2.78 (71) | 2.63 (67) | 2.75 (70) | 2.92 (74) | 3.75 (95) | 2.75 (70) | 3.75 (95) | 5.25 (133) | 3.63 (92) | 4.57 (116) | 5.82 (148) | 4.41 (112) | 7.28 (185) | |
| Minimum spacing at critical edge distance | $s_{min,cac}$ | in. (mm) | 1.5 (38) | | 2.25 (57) | | | | 3 (76) | | | | | | | | |
| Minimum edge distance | $c_{min}$ | in. (mm) | 1.50 (38) | | | | | | 1.75 (44) | | | | | | | | |
| Minimum anchor spacing at minimum edge distance | for s > | in. (mm) | 3.0 (76) | | | | | | | | | 4 (102) | | | | | |
| Mininimum hole depth in concrete | $h_0$ | in. (mm) | 2 (51) | 2-7/8 (73) | 1-7/8 (48) | 2-3/8 (60) | 2-3/4 (70) | 3-1/2 (89) | 2-5/8 (67) | 3-3/8 (86) | 4-5/8 (117) | 3-5/8 (92) | 4-3/8 (111) | 5-3/8 (137) | 4-3/8 (111) | 6-5/8 (168) | |
| Minimum specified ultimate strength | $f_{uta}$ | psi (N/mm²) | 125,000 (860) | | 106,975 (738) | | 120,300 (830) | | 112,540 (776) | | | 90,180 (622) | | | 81,600 (563) | | |
| Effective tensile stress area | $A_{se,N}$ | in² (mm²) | 0.045 (29.0) | | 0.086 (55.5) | | | | 0.161 (103.9) | | | 0.268 (172.9) | | | 0.392 (252.9) | | |
| Steel embed. material resistance factor for reinforcement | $\phi_s$ | - | 0.85 | | | | | | | | | | | | | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes[4] | R | - | 0.70 | | | | | | | | | | | | | | D.5.3 |
| Resistance modification factor for shear, steel failure modes[4] | R | - | 0.65 | | | | | | | | | | | | | | D.5.3 |
| Factored steel resistance in tension | $N_{sar}$ | lb (kN) | 3,370 (15.0) | | 5,475 (24.4) | | 6,150 (27.4) | | 10,780 (48.0) | | | 14,405 (64.1) | | | 19,050 (84.7) | | D.6.1.2 |
| Factored steel resistance in shear | $V_{sar}$ | lb (kN) | 855 (3.8) | | 2,030 (9.0) | | 2,865 (12.7) | | 5,110 (22.7) | | | 6,200 (27.6) | | | 9,205 (40.9) | | D.7.1.2 |
| Factored steel resistance in shear, seismic | $V_{sar,eq}$ | lb (kN) | 770 (3.4) | | 2,030 (9.0) | | 1,720 (7.7) | | 3,065 (13.6) | | | 3,720 (16.5) | | | 6,385 (28.4) | | |
| Coeff. for factored conc. breakout resistance, uncracked concrete | $k_{c,uncr}$ | lb | 10 | | | | | | 11.25 | | | | | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete | $k_{c,cr}$ | - | 7 | | | | | | | | | | | | | | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked concrete[5] | $\psi_{c,N}$ | - | 1.0 | | | | | | | | | | | | | | D.6.2.6 |
| Anchor category | - | - | 3 | | 1 | | | | | | | | | | | | D.5.3 (c ) |
| Concrete material resistance factor | $\phi_c$ | - | 0.65 | | | | | | | | | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[6] | R | - | 0.75 | | 1.00 | | | | | | | | | | | | D.5.3 (c ) |
| Factored pullout resistance in 20 MPa uncracked concrete[7] | $N_{pr,uncr}$ | lb (kN) | 665 (3.0) | 1,645 (7.3) | NA | | | | | | | | | | | | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete[7] | $N_{pr,cr}$ | lb (kN) | 340 (1.5) | 815 (3.6) | 510 (2.3) | NA | | | | | | | | | | | D.6.3.2 |
| Factored seismic pullout resistance in 20 MPa cracked concrete[7] | $N_{pr,eq}$ | lb (kN) | 275 (1.2) | 815 (3.6) | 510 (2.3) | NA | | | | | | | | | | | D.6.3.2 |

1 Design information in this table is taken from ICC-ES ESR-3027, tables 1, 3, and 5, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 on Page 2 of this document.
3 For concrete over metal deck applications where the concrete thickness over the top flute is less than $h_{min}$ in this table, see figure 4 and tables 20 and 21 of this document.
4 The KH-EZ is considered a brittle steel element as defined by CSA A23.3 Annex D section D.2.
5 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
6 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
7 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-3027 for additional information.

## Table 24 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC carbon steel screw anchor factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4 | 1.18 (30) | 1-5/8 (41) | 665 (3.0) | 710 (3.2) | 750 (3.3) | 820 (3.6) | 805 (3.6) | 900 (4.0) | 985 (4.4) | 1,135 (5.1) |
| | 1.92 (49) | 2-1/2 (64) | 1,645 (7.3) | 1,840 (8.2) | 2,015 (9.0) | 2,325 (10.4) | 2,225 (9.9) | 2,490 (11.1) | 2,725 (12.1) | 3,145 (14.0) |
| 3/8 | 1.11 (28) | 1-5/8 (41) | 980 (4.4) | 1,095 (4.9) | 1,200 (5.3) | 1,385 (6.2) | 980 (4.4) | 1,095 (4.9) | 1,200 (5.3) | 1,385 (6.2) |
| | 1.54 (39) | 2-1/8 (54) | 1,600 (7.1) | 1,785 (8.0) | 1,960 (8.7) | 2,260 (10.1) | 1,600 (7.1) | 1,785 (8.0) | 1,960 (8.7) | 2,260 (10.1) |
| | 1.86 (47) | 2-1/2 (64) | 2,120 (9.4) | 2,375 (10.6) | 2,600 (11.6) | 3,000 (13.3) | 2,120 (9.4) | 2,375 (10.6) | 2,600 (11.6) | 3,000 (13.3) |
| | 2.50 (64) | 3-1/4 (83) | 3,305 (14.7) | 3,695 (16.4) | 4,050 (18.0) | 4,675 (20.8) | 3,305 (14.7) | 3,695 (16.4) | 4,050 (18.0) | 4,675 (20.8) |
| 1/2 | 1.52 (39) | 2-1/4 (57) | 1,765 (7.8) | 1,970 (8.8) | 2,160 (9.6) | 2,495 (11.1) | 1,765 (7.8) | 1,970 (8.8) | 2,160 (9.6) | 2,495 (11.1) |
| | 2.16 (55) | 3 (76) | 2,990 (13.3) | 3,340 (14.9) | 3,660 (16.3) | 4,225 (18.8) | 2,990 (13.3) | 3,340 (14.9) | 3,660 (16.3) | 4,225 (18.8) |
| | 3.22 (82) | 4-1/4 (108) | 5,440 (24.2) | 6,080 (27.0) | 6,660 (29.6) | 7,690 (34.2) | 10,875 (48.4) | 12,160 (54.1) | 13,320 (59.3) | 15,380 (68.4) |
| 5/8 | 2.39 (61) | 3-1/4 (83) | 3,475 (15.5) | 3,890 (17.3) | 4,260 (18.9) | 4,920 (21.9) | 3,475 (15.5) | 3,890 (17.3) | 4,260 (18.9) | 4,920 (21.9) |
| | 3.03 (77) | 4 (102) | 4,985 (22.2) | 5,573 (24.8) | 6,105 (27.2) | 7,049 (31.4) | 10,736 (47.8) | 12,004 (53.4) | 13,149 (58.5) | 15,183 (67.5) |
| | 3.88 (99) | 5 (127) | 7,195 (32.0) | 8,040 (35.8) | 8,810 (39.2) | 10,170 (45.2) | 14,385 (64.0) | 16,085 (71.5) | 17,620 (78.4) | 20,345 (90.5) |
| 3/4 | 2.92 (74) | 4 (102) | 4,695 (20.9) | 5,250 (23.4) | 5,750 (25.6) | 6,640 (29.5) | 9,390 (41.8) | 10,500 (46.7) | 11,505 (51.2) | 13,280 (59.1) |
| | 4.84 (123) | 6-1/4 (159) | 10,020 (44.6) | 11,205 (49.8) | 12,275 (54.6) | 14,170 (63.0) | 20,040 (89.2) | 22,410 (99.7) | 24,545 (109.2) | 28,345 (126.1) |

3.3.6

## Table 25 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC carbon steel screw anchor factored resistance with concrete/pullout failure in cracked concrete[1,2,3,4,5]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4 | 1.18 (30) | 1-5/8 (41) | 340 (1.5) | 360 (1.6) | 385 (1.7) | 415 (1.9) | 565 (2.5) | 630 (2.8) | 690 (3.1) | 795 (3.5) |
| | 1.92 (49) | 2-1/2 (64) | 815 (3.6) | 910 (4.1) | 1,000 (4.4) | 1,155 (5.1) | 1,560 (6.9) | 1,740 (7.7) | 1,910 (8.5) | 2,205 (9.8) |
| 3/8 | 1.11 (28) | 1-5/8 (41) | 510 (2.3) | 570 (2.5) | 620 (2.8) | 720 (3.2) | 685 (3.0) | 765 (3.4) | 840 (3.7) | 970 (4.3) |
| | 1.54 (39) | 2-1/8 (54) | 1,120 (5.0) | 1,250 (5.6) | 1,370 (6.1) | 1,585 (7.0) | 1,120 (5.0) | 1,250 (5.6) | 1,370 (6.1) | 1,585 (7.0) |
| | 1.86 (47) | 2-1/2 (64) | 1,485 (6.6) | 1,660 (7.4) | 1,820 (8.1) | 2,100 (9.3) | 1,485 (6.6) | 1,660 (7.4) | 1,820 (8.1) | 2,100 (9.3) |
| | 2.50 (64) | 3-1/4 (83) | 2,315 (10.3) | 2,590 (11.5) | 2,835 (12.6) | 3,275 (14.6) | 2,315 (10.3) | 2,590 (11.5) | 2,835 (12.6) | 3,275 (14.6) |
| 1/2 | 1.52 (39) | 2-1/4 (57) | 1,095 (4.9) | 1,225 (5.5) | 1,345 (6.0) | 1,550 (6.9) | 1,095 (4.9) | 1,225 (5.5) | 1,345 (6.0) | 1,550 (6.9) |
| | 2.16 (55) | 3 (76) | 1,860 (8.3) | 2,080 (9.2) | 2,275 (10.1) | 2,630 (11.7) | 1,860 (8.3) | 2,080 (9.2) | 2,275 (10.1) | 2,630 (11.7) |
| | 3.22 (82) | 4-1/4 (108) | 3,385 (15.1) | 3,785 (16.8) | 4,145 (18.4) | 4,785 (21.3) | 6,765 (30.1) | 7,565 (33.7) | 8,290 (36.9) | 9,570 (42.6) |
| 5/8 | 2.39 (61) | 3-1/4 (83) | 2,165 (9.6) | 2,420 (10.8) | 2,650 (11.8) | 3,060 (13.6) | 2,165 (9.6) | 2,420 (10.8) | 2,650 (11.8) | 3,060 (13.6) |
| | 3.03 (77) | 4 (102) | 3,139 (14.0) | 3,509 (15.6) | 3,844 (17.1) | 4,439 (19.7) | 6,760 (30.1) | 7,558 (33.6) | 8,279 (36.8) | 9,560 (42.5) |
| | 3.88 (99) | 5 (127) | 4,475 (19.9) | 5,005 (22.3) | 5,480 (24.4) | 6,330 (28.2) | 8,950 (39.8) | 10,005 (44.5) | 10,965 (48.8) | 12,660 (56.3) |
| 3/4 | 2.92 (74) | 4 (102) | 2,920 (13.0) | 3,265 (14.5) | 3,580 (15.9) | 4,130 (18.4) | 5,845 (26.0) | 6,535 (29.1) | 7,155 (31.8) | 8,265 (36.8) |
| | 4.84 (123) | 6-1/4 (159) | 6,235 (27.7) | 6,970 (31.0) | 7,635 (34.0) | 8,820 (39.2) | 12,470 (55.5) | 13,945 (62.0) | 15,275 (67.9) | 17,635 (78.4) |

1 See PTG Ed. 21 Section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 15 as necessary. Compare to the steel values in table 22. The lesser of the values is to be used for the design.
4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.60 All other sizes - $\alpha_{N,seis}$ = 0.75
No reduction needed for seismic shear. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

## Table 26 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6]

| Nominal anchor diameter in. | Nominal embedment in. (mm) | Installation in lower flute | | | | Installation in upper flute | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Shear - $V_r$ | | Tension - $N_r$ | | Shear - $V_r$ | |
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 30 MPa (4,350psi) lb (kN) | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 30 MPa (4,350psi) lb (kN) | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 30 MPa (4,350psi) lb (kN) | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 30 MPa (4,350psi) lb (kN) |
| 1/4 | 1-5/8 (41) | 585 (2.6) | 660 (2.9) | 665 (3.0) | 665 (3.0) | 720 (3.2) | 810 (3.6) | 665 (3.0) | 665 (3.0) |
| | 2-1/2 (64) | 1,200 (5.3) | 1,470 (6.5) | 1,220 (5.4) | 1,220 (5.4) | 1,255 (5.6) | 1,535 (6.8) | 1,805 (8.0) | 1,805 (8.0) |
| 3/8 | 1-5/8 (41) | 830 (3.7) | 1,020 (4.5) | 835 (3.7) | 835 (3.7) | 950 (4.2) | 1,165 (5.2) | 2,030 (9.0) | 2,030 (9.0) |
| | 2-1/2 (64) | 1,430 (6.4) | 1,755 (7.8) | 835 (3.7) | 835 (3.7) | 1,865 (8.3) | 2,285 (10.2) | 3,365 (15.0) | 3,365 (15.0) |
| | 3-1/4 (83) | 2,505 (11.1) | 3,070 (13.7) | 1,990 (8.9) | 1,990 (8.9) | n/a | n/a | n/a | n/a |
| 1/2 | 2-1/4 (57) | 835 (3.7) | 1,020 (4.5) | 885 (3.9) | 885 (3.9) | 890 (4.0) | 1,090 (4.8) | 4,335 (19.3) | 4,335 (19.3) |
| | 3 (76) | 1,955 (8.7) | 2,395 (10.7) | 1,615 (7.2) | 1,615 (7.2) | n/a | n/a | n/a | n/a |
| | 4-1/4 (108) | 3,425 (15.2) | 4,195 (18.7) | 1,985 (8.8) | 1,985 (8.8) | n/a | n/a | n/a | n/a |
| 5/8 | 3-1/4 (83) | 2,670 (11.9) | 3,270 (14.5) | 1,915 (8.5) | 1,915 (8.5) | n/a | n/a | n/a | n/a |
| | 5 (127) | 6,070 (27.0) | 7,430 (33.1) | 2,315 (10.3) | 2,315 (10.3) | n/a | n/a | n/a | n/a |
| 3/4 | 4 (102) | 2,670 (11.9) | 3,270 (14.5) | 2,075 (9.2) | 2,075 (9.2) | n/a | n/a | n/a | n/a |

## Table 27 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in the soffit of cracked lightweight concrete over metal deck[1,2,3,4,5,6]

| Nominal anchor diameter in. | Nominal embedment in. (mm) | Installation in lower flute | | | | Installation in upper flute | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Tension - $N_r$[7] | | Shear - $V_r$[8] | | Tension - $N_r$[7] | | Shear - $V_r$[8] | |
| | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 30 MPa (4,350psi) lb (kN) | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 30 MPa (4,350psi) lb (kN) | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 30 MPa (4,350psi) lb (kN) | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 30 MPa (4,350psi) lb (kN) |
| 1/4 | 1-5/8 (41) | 300 (1.3) | 340 (1.5) | 665 (3.0) | 665 (3.0) | 365 (1.6) | 445 (2.0) | 665 (3.0) | 665 (3.0) |
| | 2-1/2 (64) | 595 (2.6) | 730 (3.2) | 1,220 (5.4) | 1,220 (5.4) | 625 (2.8) | 765 (3.4) | 1,805 (8.0) | 1,805 (8.0) |
| 3/8 | 1-5/8 (41) | 520 (2.3) | 635 (2.8) | 835 (3.7) | 835 (3.7) | 755 (3.4) | 930 (4.1) | 2,030 (9.0) | 2,030 (9.0) |
| | 2-1/2 (64) | 1,015 (4.5) | 1,245 (5.5) | 835 (3.7) | 835 (3.7) | 1,325 (5.9) | 1,620 (7.2) | 3,365 (15.0) | 3,365 (15.0) |
| | 3-1/4 (83) | 1,775 (7.9) | 2,175 (9.7) | 1,990 (8.9) | 1,990 (8.9) | n/a | n/a | n/a | n/a |
| 1/2 | 2-1/4 (57) | 525 (2.3) | 640 (2.8) | 885 (3.9) | 885 (3.9) | 630 (2.8) | 770 (3.4) | 4,335 (19.3) | 4,335 (19.3) |
| | 3 (76) | 1,235 (5.5) | 1,510 (6.7) | 1,615 (7.2) | 1,615 (7.2) | n/a | n/a | n/a | n/a |
| | 4-1/4 (108) | 2,155 (9.6) | 2,640 (11.7) | 1,985 (8.8) | 1,985 (8.8) | n/a | n/a | n/a | n/a |
| 5/8 | 3-1/4 (83) | 1,680 (7.5) | 2,060 (9.2) | 1,915 (8.5) | 1,915 (8.5) | n/a | n/a | n/a | n/a |
| | 5 (127) | 3,820 (17.0) | 4,680 (20.8) | 2,315 (10.3) | 2,315 (10.3) | n/a | n/a | n/a | n/a |
| 3/4 | 4 (102) | 1,680 (7.5) | 2,060 (9.2) | 2,075 (9.2) | 2,075 (9.2) | n/a | n/a | n/a | n/a |

1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compresive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{nom}$ (nominal embedment).
4 Tabular values are lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.60
All other sizes - $\alpha_{N,seis}$ = 0.75.
See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.
8 For the following anchor sizes, an additional factor for seismic shear must be applied to the cracked concrete tabular values for seismic conditions:
1/4-inch diameter - $\alpha_{v,seis}$ = 0.75
3/8-inch diameter - $\alpha_{v,seis}$ = 0.60
1/2-inch diameter - $\alpha_{v,seis}$ = 0.60
5/8-inch diameter - $\alpha_{v,seis}$ = 0.60
3/4-inch diameter - $\alpha_{v,seis}$ = 0.70

### Table 28 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC steel screw anchor factored resistance in the top of uncracked concrete over metal deck[1,2,3,4,5]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $N_r$ | | Shear - $V_r$ | |
|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| 1/4 | 1.18 (30) | 1-5/8 (41) | 665 (3.0) | 750 (3.3) | 805 (3.6) | 985 (4.4) |
| 3/8 | 1.11 (28) | 1-5/8 (41) | 980 (4.4) | 1,200 (5.3) | 980 (4.4) | 1,200 (5.3) |

### Table 29 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC steel anchor factored resistance in the top of cracked concrete over metal deck[1,2,3,4,5]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $N_r$ | | Shear - $V_r$ | |
|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| 1/4 | 1.18 (30) | 1-5/8 (41) | 340 (1.5) | 385 (1.7) | 565 (2.5) | 690 (3.1) |
| 3/8 | 1.11 (28) | 1-5/8 (41) | 510 (2.3) | 620 (2.8) | 685 (3.0) | 840 (3.7) |

1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 20 and 21 as necessary. Compare to the steel values in table 22. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-inch diameter - $\alpha_{N,seis}$ = 0.60
3/8-inch diameter- $\alpha_{N,seis}$ = 0.75.
No reduction needed for seismic shear. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

**Table 30 — Allowable tension loads for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC installed in grout-filled masonry walls (lb)[1,2,3,4,5]**

| Nominal anchor diameter in. | Embedment in.[6] | Loads @ $c_{cr}$ and $s_{cr}$ | Spacing | | | Edge distance |
|---|---|---|---|---|---|---|
| | | | Critical - $s_{cr}$ in.[7] | Minimum - $s_{min}$ in.[7] | Load reduction factor at $s_{min}$[8] | Critical - $c_{cr}$ Minimum- $c_{min}$ in.[9] |
| 1/4 | 1-5/8 | 530[10] | 4 | 2 | 0.70 | 4 |
| | 2-1/2 | 910[11] | | 4 | 1.00 | |
| 3/8 | 1-5/8 | 535[11] | 4 | 2 | 0.70 | 4 |
| | 2-1/2 | 895 | 6 | 4 | 0.80 | |
| | 3-1/4 | 1,210 | | | | |
| 1/2 | 2-1/4 | 710 | 4 | 2 | 0.60 | 4 |
| | 3 | 1,110 | 8 | 4 | | |
| | 4-1/4 | 1,515 | | | | |
| 5/8 | 3-1/4 | 1,155 | 10 | 4 | 0.60 | 4 |
| | 5 | 1,735 | | | | |
| 3/4 | 4 | 1,680 | 12 | 4 | 0.60 | 4 |
| | 6-1/4 | 2,035 | | | | |

**Table 31 — Allowable shear loads for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC installed in grout-filled masonry walls (lb)[1,2,3,4,5]**

| Nominal anchor diameter in. | Embedment in.[6] | Load at $c_{cr}$ and $s_{cr}$ | Spacing | | | Edge distance | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Critical - $s_{cr}$ in.[7] | Minimum - $s_{min}$ in.[7] | Load reduction factor at $s_{min}$[8] | Critical - $c_{cr}$ in.[9] | Minimum - $c_{min}$ in.[9] | Load reduction factor at $c_{min}$ | |
| | | | | | | | | perpendicular to edge | parallel to edge |
| 1/4 | 1-5/8 | 675[10] | 4 | 4 | 1.00 | 4 | 4 | 1.00 | 1.00 |
| | 2-1/2 | 840[11] | | | | | | 1.00 | 1.00 |
| 3/8 | 1-5/8 | 1,140[11] | 6 | 4 | 0.94 | 6 | 4 | 0.61 | 1.00 |
| | 2-1/2 | 1,165 | | | | | | 0.70 | 1.00 |
| | 3-1/4 | 1,190 | | | | | | 0.70 | 1.00 |
| 1/2 | 2-1/4 | 1,845 | 8 | 4 | 0.88 | 8 | 4 | 0.50 | 1.00 |
| | 3 | 2,055 | | | | | | 0.45 | 0.94 |
| | 4-1/4 | 2,745 | | | | | | 0.40 | 0.89 |
| 5/8 | 3-1/4 | 3,040 | 10 | 4 | 0.36 | 10 | 4 | 0.36 | 0.82 |
| | 5 | 3,485 | | | | | | 0.34 | 0.92 |
| 3/4 | 4 | 3,040 | 10 | 4 | 0.36 | 10 | 4 | 0.36 | 0.82 |
| | 6-1/4 | 3,485 | | | | | | 0.34 | 0.92 |

1 All values are for anchors installed in fully grouted masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight, medium-weight or normal-weight.

2 Anchors may not be installed within one inch in any direction of a vertical joint.

3 Linear interpolation of load values between minimum spacing $s_{min}$ and critical spacing $s_{cr}$ and between minimum edge distance $c_{min}$ and critical edge distance $c_{cr}$ is permitted.

4 For combined loading: For 1/4-in. $\frac{T_{applied}}{T_{allowable}} + \frac{V_{applied}}{V_{allowable}} \leq 1$ For 3/8- through 3/4-in. $\left(\frac{T_{applied}}{T_{allowable}}\right)^{5/3} + \left(\frac{V_{applied}}{V_{allowable}}\right)^{5/3} \leq 1$

5 See Figure 5 on Page 21 of this document for anchor locations for anchor locations.

6 Embedment depth is measured from the outside face of the concrete masonry embedment.

7 Critical spacing $s_{cr}$ is the anchor spacing where full load values may be used. The minimum spacing $s_{min}$ is the minimum spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of the adjacent anchor.

8 Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than $c_{cr}$ or $s_{cr}$ must be multiplied by the appropriate load reduction factor based on actual edge distance (c) or spacing (s).

9 The critical edge distance $c_{cr}$ is the edge distance where full load values may be used. The minimum edge distance $c_{min}$ is the minimum edge distance for which values are available and installation is recommended. For tension, $c_{cr}$ equals $c_{min}$. Edge distance is measured from the center of the anchor to the closest edge.

10 Load values must be reduced by 21% for installations within 1-1/4 inches of the bed joint.

11 Load values must be reduced by 13% for installations within 1-1/4 inches of the bed joint.

**Table 32 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC allowable loads installed in top-of-grout-filled concrete masonry walls or horizontal members of wall openings[1,2,3]**

| Nominal anchor diameter in. | Minimum embedment depth in. | Edge distance[4] in. | Critical spacing[5] in. | Minimum end distance[6] in. | Tension lb | Shear lb | |
|---|---|---|---|---|---|---|---|
| | | | | | | Load direction | |
| | | | | | | Parallel to edge of masonry wall | Perpendicular to edge of masonry wall |
| 1/4 | 1 5/8 | 1 1/2 | 4 | 4 | 205 | 180 | 135 |
| | | 3 3/4 | | | 205 | 275 | 275 |
| | 2 1/2 | 1 1/2 | | | 355 | 345 | 155 |
| | | 3 3/4 | | | 390 | 415 | 330 |
| 3/8 | 1 5/8 | 1 1/2 | 6 | 6 | 245 | 345 | 175 |
| | | 3 3/4 | | | 245 | 345 | 345 |
| | 3 1/4 | 1 1/2 | | | 465 | 490 | 200 |
| | | 3 3/4 | | | 540 | 800 | 625 |
| 1/2 | 2 1/4 | 1 3/4 | 8 | 8 | 390 | 460 | 200 |
| | | 3 3/4 | | | 610 | 525 | 500 |
| | 4 1/4 | 1 3/4 | | | 540 | 885 | 245 |
| | | 3 3/4 | | | 750 | 1275 | 550 |
| 5/8 | 5 | 1 3/4 | 10 | 10 | 975 | 930 | 245 |
| | | 3 3/4 | | | 975 | 2190 | 630 |
| 3/4 | 6 1/4 | 3 3/4 | 12 | 12 | 975 | 2430 | 630 |

**Table 33 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC allowable loads installed in end-of-wall or vertical members of wall openings[1,2]**

| Nominal anchor diameter in. | Minimum embedment depth in. | Edge distance[4] in. | Critical spacing[5] in. | Minimum end distance[6] in. | Tension lb | Shear lb | |
|---|---|---|---|---|---|---|---|
| | | | | | | Load direction | |
| | | | | | | Parallel to edge of masonry wall | Perpendicular to edge of masonry wall |
| 1/4 | 1 5/8 | 1 1/2 | 4 | 4 | 360 | 525 | 205 |
| | | 3 3/4 | | | 380 | 595 | 585 |
| | 2 1/2 | 1 1/2 | | | 590 | 610 | 225 |
| | | 3 3/4 | | | 755 | 635 | 585 |
| 3/8 | 1 5/8 | 1 1/2 | 6 | 6 | 355 | 725 | 215 |
| | | 3 3/4 | | | 465 | 1010 | 825 |
| | 3 1/4 | 1 1/2 | | | 565 | 875 | 240 |
| | | 3 3/4 | | | 1020 | 1195 | 1050 |
| 1/2 | 2 1/4 | 1 3/4 | 8 | 8 | 500 | 855 | 260 |
| | | 3 3/4 | | | 525 | 1100 | 1050 |
| | 4 1/4 | 1 3/4 | | | 650 | 925 | 280 |
| | | 3 3/4 | | | 1150 | 1240 | 1050 |
| 5/8 | 5 | 3 3/4 | 10 | 10 | 1605 | 2215 | 1050 |
| 3/4 | 6 1/4 | 3 3/4 | 12 | 12 | 1865 | 2550 | 1050 |

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight, medium-weight or normal-weight conforming to ASTM C90. Allowable loads are calculated using safety factor of 5.

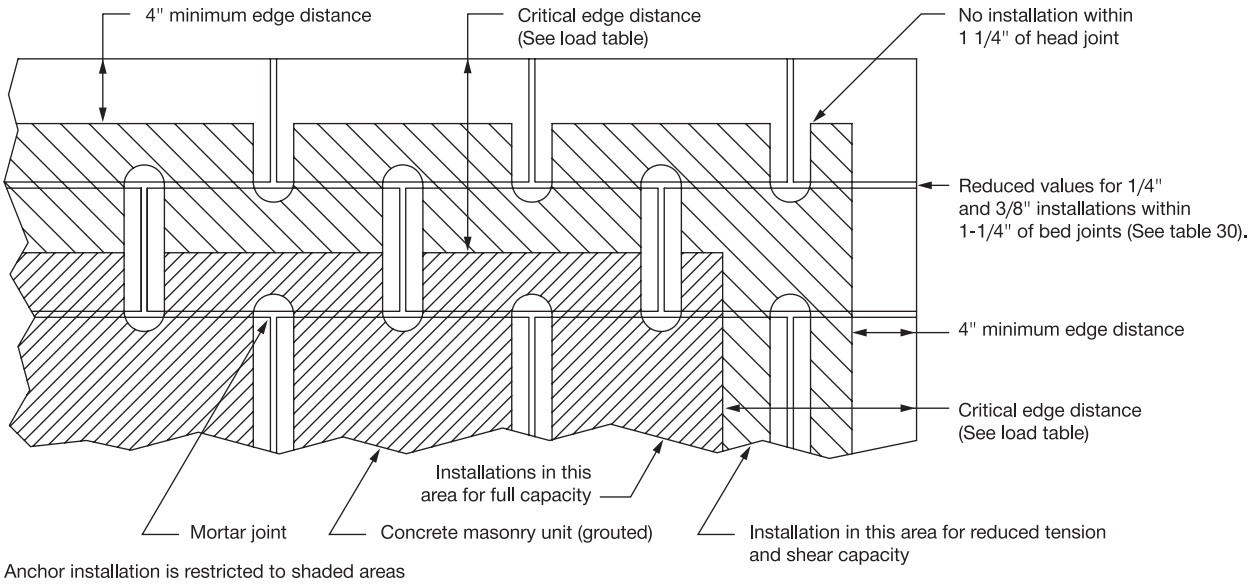
2 See figure 6 and 7 for allowable anchor installation locations on the top of grout-filled concrete masonry walls. Anchors may not be installed within one inch of a vertical joint. See figure 7 for anchor installation locations in end-of-wall and vertical members of wall openings.

3 Anchors may not be installed within 1-1/4" in any direction of a head joint.

4 For load values at edge distances between listed values linear interpolation is permitted.

5 Critical spacing equals minimum spacing.

6 Minimum end distance applicable to top-of-wall and end-of-wall and does not apply for wall openings such as windows.




Anchor installation is restricted to shaded areas

**Figure 5 — Acceptable locations (shaded areas) for Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC anchors in grout-filled concrete masonry**

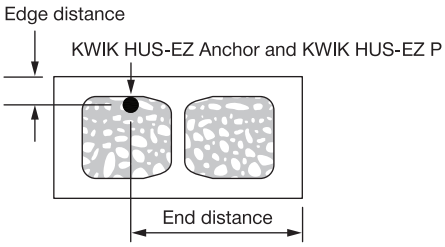



**Figure 6 — Edge and end distances for the Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC anchor installed in the top of CMU masonry wall construction**

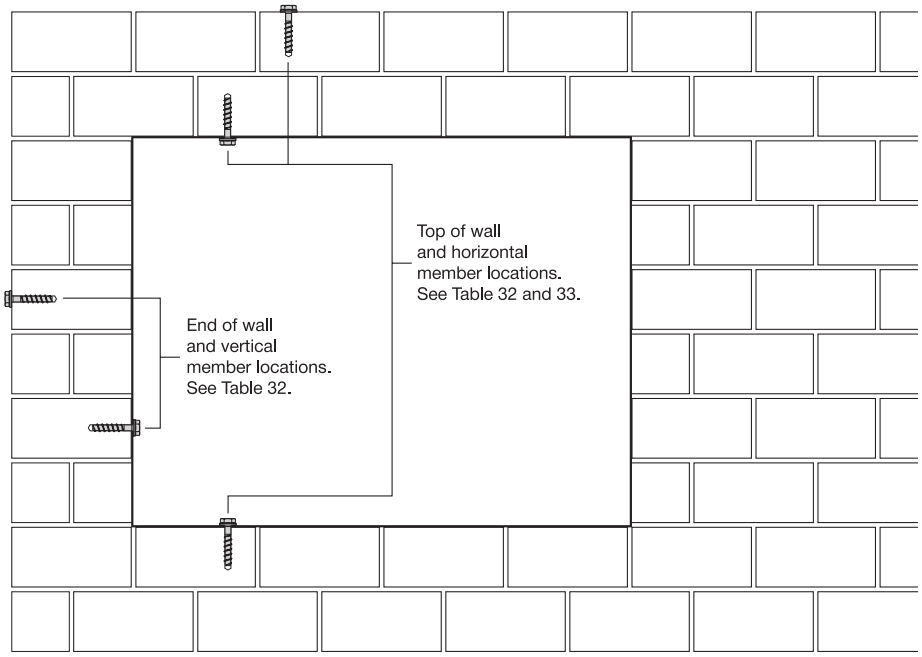



**Figure 7 — Anchor locations in end of wall or wall opening applications**

# DESIGN INFORMATION IN HOLLOW CORE CONCRETE PER ALLOWABLE STRESS DESIGN

**Table 34 — Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC allowable stress design values for installations into hollow core concrete panels[1,2]**

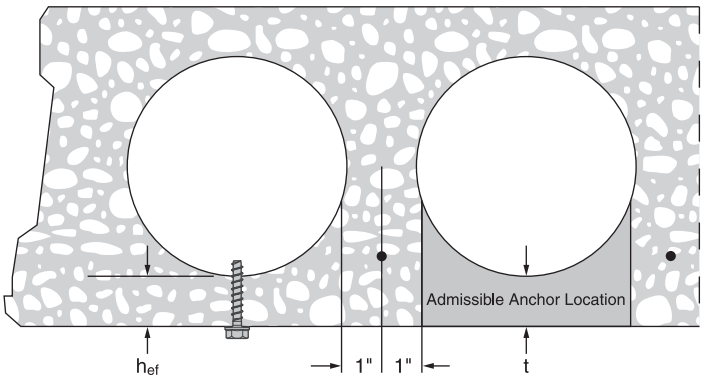
| Anchor diameter (inches) | Min. effective embedment $h_{ef}$ (inches) | Allowable load[3] | | Ultimate load | |
|---|---|---|---|---|---|
| | | Tension | Shear | Tension | Shear |
| 1/4 | 1-1/8 | 400 | 610 | 1600 | 2440 |
| | 1-3/8 | 455 | 755 | 1810 | 3025 |
| 3/8 | 1-1/8 | 435 | 890 | 1740 | 3560 |
| | 1-3/8 | 590 (2.6) | 1405 (6.3) | 2360 (10.5) | 5620 (25.0) |

1 The admissible anchor location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm admissible anchor location.

2 Minimum compressive strength of prestressed concrete is 7,000 psi. Published ultimate loads represent the average results conducted in local base materials. Due to variations in materials and dimensionl configurations, on-site testing is required to determine the actual performance.

3 Allowable loads calculated with a factor of safety of 4.

**Figure 8 — Installation of Hilti KH-EZ, KH-EZ P, KH-EZ PM, KH-EZ PL, KH-EZ C and KH-EZ CRC in hollow core concrete**

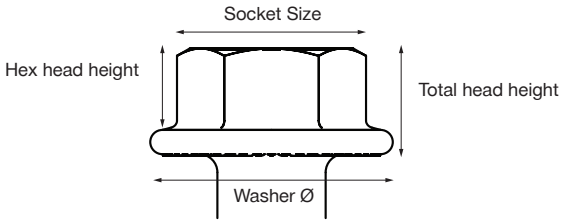





## KH-EZ (CRC)

| KH-EZ Ø | Socket Size | Washer Ø | Total head height | Hex head height |
|---|---|---|---|---|
| 1/4” | 7/16” | 0.65” | 0.24” | 0.16” |
| 3/8” | 9/16” | 0.78” | 0.35” | 0.26” |
| 1/2” | 3/4” | 1.03” | 0.49” | 0.35” |
| 5/8” | 15/16” | 1.28” | 0.57” | 0.43” |
| 3/4” | 1-1/8” | 1.48” | 0.70” | 0.53” |

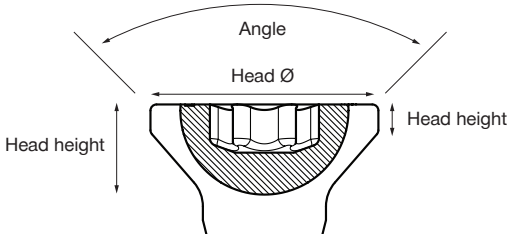
1 KH-EZ CRC does not come in ¼“ diameter.
Ø = diameter




## KH-EZ C

| KH-EZ Ø | Torx Size | Head Ø | Head height | Flat height | Angle |
|---|---|---|---|---|---|
| 1/4” | TX30 | 0.47” | 0.16” | 0.04” | 82° |
| 3/8” | TX50 | 0.74” | 0.28” | 0.09” | 82° |

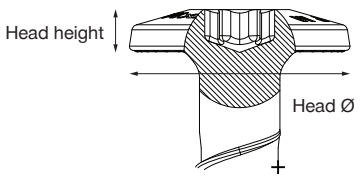
Ø = diameter




## KH-EZ P/PM/PL

| Pan Size | Torx Size | Head Ø | Head height |
|---|---|---|---|
| P | TX30 | 0.52” | 0.13” |
| PM | TX30 | 0.69” | 0.13” |
| PL | TX30 | 0.86” | 0.18” |

Ø = diameter



## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at **www.hilti.com**. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## ORDERING INFORMATION







### Order Information

| Description | Hole Diameter | Total Length without Anchor Head | Minimum Embedment Depth | Qty (pcs) / Box |
|---|---|---|---|---|
| KH-EZ P 1/4''x1 7/8'' | 1/4'' | 1 7/8 | 1 5/8 | 100 |
| KH-EZ P 1/4''x2 5/8'' | 1/4'' | 2 5/8 | 1 5/8 | 100 |
| KH-EZ PM 1/4''x2 5/8'' | 1/4'' | 2 5/8 | 1 5/8 | 100 |
| KH-EZ PM 1/4''x1 7/8'' | 1/4'' | 1 7/8 | 1 5/8 | 100 |
| KH-EZ PL 1/4''x2 5/8'' | 1/4'' | 2 5/8 | 1 5/8 | 100 |
| KH-EZ C 1/4''x2'' | 1/4'' | 2 | 1 5/8 | 100 |
| KH-EZ C 1/4''x2 1/2'' | 1/4'' | 2 1/2 | 1 5/8 | 100 |
| KH-EZ C 1/4''x3'' | 1/4'' | 3 | 1 5/8 | 100 |
| KH-EZ C 1/4''x4'' | 1/4'' | 4 | 1 5/8 | 100 |
| KH-EZ 1/4''x1 7/8'' | 1/4'' | 1 7/8 | 1 5/8 | 100 |
| KH-EZ 1/4''x2 5/8'' | 1/4'' | 2 5/8 | 1 5/8 | 100 |
| KH-EZ 1/4''x3'' | 1/4'' | 3 | 1 5/8 | 100 |
| KH-EZ 1/4''x3 1/2'' | 1/4'' | 3 1/2 | 1 5/8 | 100 |
| KH-EZ 1/4''x4'' | 1/4'' | 4 | 1 5/8 | 100 |
| KH-EZ 3/8''x1 7/8'' | 3/8'' | 1 7/8 | 1 5/8 | 50 |
| KH-EZ 3/8''x2 1/8'' | 3/8'' | 2 1/8 | 1 5/8 | 50 |
| KH-EZ (CRC) 3/8''x3'' | 3/8'' | 3 | 2 1/2 | 50 |
| KH-EZ 3/8''x3 1/2'' | 3/8'' | 3 1/2 | 2 1/2 | 50 |
| KH-EZ (CRC) 3/8''x4'' | 3/8'' | 4 | 3 1/4 | 50 |
| KH-EZ (CRC) 3/8''x5'' | 3/8'' | 5 | 3 1/4 | 50 |
| KH-EZ C 3/8''x2 1/2'' | 3/8'' | 2 1/2 | 1 5/8 | 50 |
| KH-EZ C 3/8''x3'' | 3/8'' | 3 | 2 1/2 | 50 |
| KH-EZ C 3/8''x4'' | 3/8'' | 4 | 2 1/2 | 50 |
| KH-EZ 1/2''x2 1/2'' | 1/2'' | 2 1/2 | 2 1/4 | 25 |
| KH-EZ (CRC) 1/2''x3'' | 1/2'' | 3 | 2 1/4 | 25 |
| KH-EZ 1/2''x3 1/2'' | 1/2'' | 3 1/2 | 2 1/4 | 25 |
| KH-EZ (CRC) 1/2''x4'' | 1/2'' | 4 | 2 1/4 | 25 |
| KH-EZ 1/2''x4 1/2'' | 1/2'' | 4 1/2 | 3 | 25 |
| KH-EZ (CRC) 1/2''x5'' | 1/2'' | 5 | 3 | 25 |
| KH-EZ (CRC) 1/2''x6'' | 1/2'' | 6 | 3 | 25 |
| KH-EZ 5/8''x3 1/2'' | 5/8'' | 3 1/2 | 3 1/4 | 15 |
| KH-EZ 5/8''x4'' | 5/8'' | 4 | 3 1/4 | 15 |
| KH-EZ (CRC) 5/8''x5 1/2'' | 5/8'' | 5 1/2 | 3 1/4 | 15 |
| KH-EZ (CRC) 5/8''x6 1/2'' | 5/8'' | 6 1/2 | 3 1/4 | 15 |
| KH-EZ (CRC) 5/8''x8'' | 5/8'' | 8 | 3 1/4 | 15 |
| KH-EZ 3/4''x4 1/2'' | 3/4'' | 4 1/2 | 4 | 10 |
| KH-EZ (CRC) 3/4''x5 1/2'' | 3/4'' | 5 1/2 | 4 | 10 |
| KH-EZ (CRC) 3/4''x7'' | 3/4'' | 7 | 4 | 10 |
| KH-EZ 3/4''x8'' | 3/4'' | 8 | 4 | 10 |
| KH-EZ (CRC) 3/4''x9'' | 3/4'' | 9 | 4 | 10 |

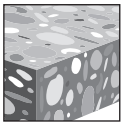
# 3.3.7 KWIK HUS-EZ SS316 SCREW ANCHOR

## PRODUCT DESCRIPTION

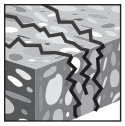
### KWIK HUS EZ SS316 STAINLESS STEEL SCREW ANCHOR

| Anchor System | | Features and Benefits |
|---|---|---|
|  | Stainless Steel<br>KH-EZ SS316<br>1/4" - 1/2" | • OSHA Table 1926.1153 Table 1 compliant installation when installed with Hilti vacuum and DRS system or Hilti SafeSet hollow drill bit technology<br>• Easy installation using impact tool<br>• Product and length identification marks helps facilitate quality control after installation<br>• Through fixture installation improves productivity and more accurate installation.<br>• Full stainless steel 316 screw with carbide cutting elements to help enable quality setting and exceptional load values in a wide variety of base materials.<br>• Anchor is fully removable.<br>• Anchor diameter is same as drill bit diameter. No special diameter bit required.<br>• Suitable for reduced edge distances and spacing.<br>• Corrosion resistant coating allows for use in outdoor corrosive environments.<br>• Installation process allows for adjustability. |
|  | Stainless Steel<br>KH-EZ C SS316<br>1/4" - 3/8" | |

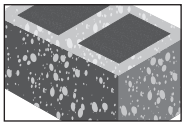
3.3.7



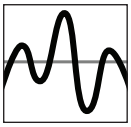
Uncracked concrete



Cracked concrete



Grout-filled concrete masonry



Seismic Design Categories A-F




SafeSet™ System with Hollow Drill Bit




Profis Anchor design software

| Approvals/Listings | |
|---|---|
| **ICC-ES (International Code Council)** | ESR-3027 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193<br>ESR-3056 in grout-filled CMU per ICC-ES AC106 |
| **City of Los Angeles** | City of Los Angeles 2020 LABC Supplement (within ESR-3027 and ESR-3056) |
| **Florida Building Code** | 2020 FBC w/ HVHZ (within ESR-3027 and ESR-3056) |

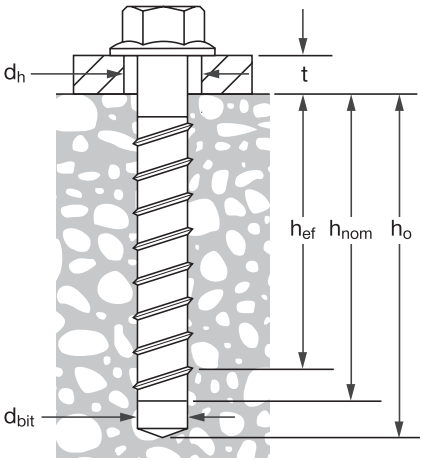
## INSTALLATION PARAMETERS

**Table 1 — Hilti KH-EZ SS316 and KH-EZ C SS316 specifications**

| Setting information | Symbol | Units | Nominal anchor diameter | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | | 3/8 | | | 1/2 | | |
| Head style | | | Hex and C head | | Hex and C head | | | Hex head | | |
| Nominal bit diameter | $d_{bit}$ | in. | 1/4 | | 3/8 | | | 1/2 | | |
| Minimum nominal embedment | $h_{nom}$ | in. | 1-5/8 | 2-1/2 | 2 | 2-1/2 | 3-1/4 | 2-1/4 | 3 | 4-1/4 |
| Minimum effective embedment | $h_{ef}$ | in. | 1.19 | 1.93 | 1.49 | 1.92 | 2.55 | 1.56 | 2.20 | 3.26 |
| Minimum hole depth | $h_o$ | in. | 2 | 2-7/8 | 2-1/4 | 2-3/4 | 3-1/2 | 2-5/8 | 3-3/8 | 4-5/8 |
| Minimum Fixture hole diameter | $d_h$ | in. | 3/8 | | 1/2 | | | 5/8 | | |
| Anchor Length = $h_{nom}$ + t | $\ell$ | | See ordering information | | | | | | | |
| Maximum impact wrench torque rating concrete[1] | $T_{impact,max}$ | ft-lb (Nm) | 100 (136) | | 157 (213) | | | 332 (450) | | |
| Maximum impact wrench torque rating masonry[1,2] | $T_{impact,max}$ | ft-lb (Nm) | 66 (89) | | 100 (136) | | | 157 (213) | | |
| Wrench size | | in. | 7/16 | | 9/16 | | | 3/4 | | |

1 Because of variability in measurement procedures, the published torque of an impact tool may not correlate properly with the above setting torques. Over torquing can damage the anchor and/or reduce its holding capacity.
2 For more information on KH-EZ SS316 installed in masonry, see ESR-3056 and Design Information for Masonry in this document.

**Figure 1 — Hilti KH-EZ SS316 and KH-EZ C SS316 specifications**




## DESIGN INFORMATION IN CONCRETE PER ACI 318

### ACI 318 Chapter 17 design

The load values contained in this document are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-3027 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8 of the North American Product Technical Guide, Volume 2: Anchor Fastening Technical Guide, Edition 22 (PTG Ed. 21). Data tables from ESR-3027 are not contained in this document, but can be found at www.icc-es.org or at www.hilti.com.

**Table 2 — Hilti KH-EZ SS316 and KH-EZ C SS316 design strength based on concrete failure modes in uncracked concrete per ACI 318 Ch. 17[1,2,3,4]**

| Nominal anchor diameter in. | Effective Embed. in. (mm)" | Nominal embed. in. (mm)" | Tension - $\phi N_n$ | | | | Shear - $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 1/4 | 1.19 (30) | 1 5/8 (41) | 855 (3.8) | 940 (4.2) | 1,085 (4.8) | 1,325 (5.9) | 1,090 (4.8) | 1,195 (5.3) | 1,380 (6.1) | 1,690 (7.5) |
| | 1.93 (49) | 2 1/2 (64) | 1,450 (6.4) | 1,585 (7.1) | 1,830 (8.1) | 2,245 (10.0) | 2,250 (10.0) | 2,465 (11.0) | 2,850 (12.7) | 3,490 (15.5) |
| 3/8 | 1.49 (38) | 2 (51) | 1,595 (7.1) | 1,750 (7.8) | 2,020 (9.0) | 2,470 (11.0) | 1,720 (7.7) | 1,885 (8.4) | 2,175 (9.7) | 2,665 (11.9) |
| | 1.92 (49) | 2 1/2 (64) | 2,335 (10.4) | 2,555 (11.4) | 2,955 (13.1) | 3,615 (16.1) | 2,515 (11.2) | 2,755 (12.3) | 3,180 (14.1) | 3,895 (17.3) |
| | 2.55 (65) | 3 1/4 (83) | 3,575 (15.9) | 3,915 (17.4) | 4,520 (20.1) | 5,535 (24.6) | 7,695 (34.2) | 8,430 (37.5) | 9,735 (43.3) | 11,925 (53.0) |
| 1/2 | 1.56 (40) | 2 1/4 (57) | 1,445 (6.4) | 1,585 (7.1) | 1,830 (8.1) | 2,240 (10.0) | 1,840 (8.2) | 2,015 (9.0) | 2,330 (10.4) | 2,850 (12.7) |
| | 2.20 (56) | 3 (76) | 2,425 (10.8) | 2,655 (11.8) | 3,065 (13.6) | 3,755 (16.7) | 3,085 (13.7) | 3,380 (15.0) | 3,900 (17.3) | 4,775 (21.2) |
| | 3.26 (83) | 4 1/4 (108) | 4,370 (19.4) | 4,790 (21.3) | 5,530 (24.6) | 6,770 (30.1) | 11,125 (49.5) | 12,185 (54.2) | 14,070 (62.6) | 17,235 (76.7) |

**Table 3 — Hilti KH-EZ SS316 and KH-EZ C SS316 design strength based on concrete failure modes in cracked concrete per ACI 318 Ch.17 [1,2,3,4,5]**

| Nominal anchor diameter in. | Effective Embed. in. (mm)" | Nominal embed. in. (mm)" | Tension - $\phi N_n$ | | | | Shear - $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 1/4 | 1.19 (30) | 1 5/8 (41) | 315 (1.4) | 320 (1.4) | 335 (1.5) | 355 (1.6) | 770 (3.4) | 845 (3.8) | 975 (4.3) | 1,195 (5.3) |
| | 1.93 (49) | 2 1/2 (64) | 495 (2.2) | 530 (2.4) | 585 (2.6) | 670 (3.0) | 1,595 (7.1) | 1,750 (7.8) | 2,020 (9.0) | 2,470 (11.0) |
| 3/8 | 1.49 (38) | 2 (51) | 980 (4.4) | 1,075 (4.8) | 1,240 (5.5) | 1,520 (6.8) | 1,080 (4.8) | 1,185 (5.3) | 1,370 (6.1) | 1,675 (7.5) |
| | 1.92 (49) | 2 1/2 (64) | 1,440 (6.4) | 1,575 (7.0) | 1,820 (8.1) | 2,230 (9.9) | 1,585 (7.1) | 1,735 (7.7) | 2,000 (8.9) | 2,450 (10.9) |
| | 2.55 (65) | 3 1/4 (83) | 2,250 (10.0) | 2,465 (11.0) | 2,845 (12.7) | 3,485 (15.5) | 4,845 (21.6) | 5,310 (23.6) | 6,130 (27.3) | 7,505 (33.4) |
| 1/2 | 1.56 (40) | 2 1/4 (57) | 1,125 (5.0) | 1,235 (5.5) | 1,425 (6.3) | 1,745 (7.8) | 1,430 (6.4) | 1,570 (7.0) | 1,810 (8.1) | 2,220 (9.9) |
| | 2.20 (56) | 3 (76) | 1,885 (8.4) | 2,065 (9.2) | 2,385 (10.6) | 2,920 (13.0) | 2,400 (10.7) | 2,625 (11.7) | 3,035 (13.5) | 3,715 (16.5) |
| | 3.26 (83) | 4 1/4 (108) | 3,400 (15.1) | 3,725 (16.6) | 4,300 (19.1) | 5,265 (23.4) | 8,655 (38.5) | 9,480 (42.2) | 10,945 (48.7) | 13,405 (59.6) |

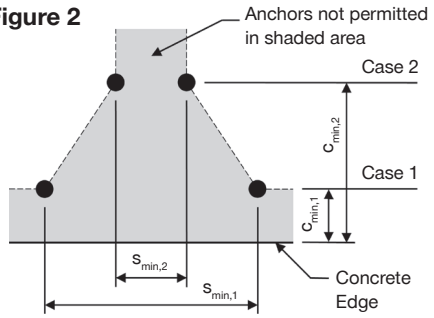
1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in Tables 6 through 11 as necessary. Compare to the steel values in Table 4. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.68. For all-lightweight, $\lambda_a$ = 0.60.
5 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors: 1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.51
All other sizes - $\alpha_{N,seis}$ = 0.75
No reduction needed for seismic shear. See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

## Table 4 — Steel design strength for Hilti KH-EZ SS316 and KH-EZ C SS316 anchors[1,2]

| Anchor diameter in. (mm) | Nominal embedment depth in. (mm) | | | Tensile [3] $\phi N_{sa}$ lb (kN) | Shear [4] $\phi V_{sa}$ lb (kN) | Seismic shear [5] $\phi V_{sa,eq}$ lb (kN) |
|---|---|---|---|---|---|---|
| 1/4 (6.4) | 1-5/8 (41 | | 2-1/2 (64) | 4,535 (20.2) | 1,190 (5.3) | 780 (3.5) |
| 3/8 (9.5) | 2 (51) | 2-1/2 (64) | 3-1/4 (83) | 9,850 (43.8) | 2,835 (12.6) | 2,835 (12.6) |
| 1/2 (12.7) | 2-1/4 (57) | 3 (76) | 4-1/4 (108) | 15,525 (69.1) | 3,115 (13.9) | 3,115 (13.9) |

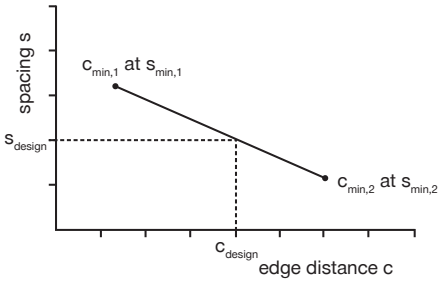
1 See PTG Ed. 21 Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KH-EZ SS316 and KH-EZ C SS316 screw anchors are to be considered ductile steel elements.
3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.
5 Seismic shear values determined by seismic shear tests with $\phi_{Vsa} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.
See PTG Ed. 21 Section 3.1.8 for additional information on seismic applications.

**Figure 2**




For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$




## Table 5 — Hilti KH-EZ SS316 and KH-EZ C SS316 specifications[1]

| Setting information | Symbol | Units | Nominal anchor diameter | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | | 3/8 | | | 1/2 | | |
| Effective minimum embedment | $h_{ef}$ | in. | 1.18 | 1.92 | 1.11 | 1.54 | 2.50 | 1.50 | 2.16 | 3.22 |
| Minimum member thickness | $h_{min}$ | in. | 3-1/4 | 4-1/8 | 3-1/4 | 3-2/3 | 4-7/8 | 4-1/2 | 4-3/4 | 6-3/4 |
| Case 1 | $c_{min,1}$ | in. | 2 | | 3 | | | 1.75 | | |
| | for $s_{min,1} \geq$ | in. | 1.5 | | 2.25 | | | 3 | | |
| Case 2 | $c_{min,2}$ | in. | 1.5 | | 1.5 | | | 1.75 | | |
| | for $s_{min,2} \geq$ | in. | 3 | | 3 | | | 3 | | |

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2.
Linear interpolation for a specific edge distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacings.

**Table 6 — Load adjustment factors for 1/4-in. diameter KH-EZ SS316 and KH-EZ C SS316 in uncracked concrete[1,2]**

| 1/4-in. KH-EZ SS316 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | ∥ to edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 |
| | | (mm) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) |
| Spacing (s)/edge distance($c_a$)/concrete thickness (h) - in. (mm) | 1-1/2 | (38) | 0.710 | 0.630 | 0.329 | 0.244 | 0.553 | 0.532 | 0.177 | 0.086 | 0.329 | 0.171 | n/a | n/a |
| | 2 | (51) | 0.780 | 0.673 | 0.420 | 0.288 | 0.570 | 0.543 | 0.272 | 0.132 | 0.420 | 0.264 | n/a | n/a |
| | 2-7/8 | (73) | 0.903 | 0.748 | 0.604 | 0.373 | 0.601 | 0.562 | 0.469 | 0.227 | 0.604 | 0.373 | n/a | n/a |
| | 3 | (76) | 0.920 | 0.759 | 0.630 | 0.389 | 0.605 | 0.565 | 0.500 | 0.242 | 0.630 | 0.389 | n/a | n/a |
| | 3-1/4 | (83) | 0.955 | 0.781 | 0.683 | 0.421 | 0.614 | 0.570 | 0.564 | 0.273 | 0.683 | 0.421 | 0.675 | n/a |
| | 4 | (102) | 1.000 | 0.845 | 0.840 | 0.518 | 0.640 | 0.586 | 0.770 | 0.373 | 0.840 | 0.518 | 0.748 | n/a |
| | 4-1/8 | (105) | | 0.856 | 0.867 | 0.534 | 0.644 | 0.589 | 0.807 | 0.391 | 0.867 | 0.534 | 0.760 | 0.597 |
| | 5 | (127) | | 0.932 | 1.000 | 0.648 | 0.675 | 0.608 | 1.000 | 0.521 | 1.000 | 0.648 | 0.837 | 0.657 |
| | 6 | (152) | | 1.000 | | 0.777 | 0.710 | 0.630 | | 0.685 | | 0.777 | 0.917 | 0.720 |
| | 8 | (203) | | | | 1.000 | 0.780 | 0.673 | | 1.000 | | 1.000 | 1.000 | 0.831 |
| | 10 | (254) | | | | | 0.850 | 0.716 | | | | | | 0.929 |
| | 12 | (305) | | | | | 0.920 | 0.759 | | | | | | 1.000 |
| | > 14 | (356) | | | | | 0.990 | 0.802 | | | | | | |

**Table 7 — Load adjustment factors for 1/4-in. diameter KH-EZ SS316 and KH-EZ C SS316 in cracked concrete[1,2]**

| 1/4-in. KH-EZ SS316 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | ∥ to edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 |
| | | (mm) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) | (41) | (64) |
| Spacing (s)/edge distance($c_a$)/concrete thickness (h) - in. (mm) | 1-1/2 | (38) | 0.710 | 0.630 | 0.876 | 0.649 | 0.590 | 0.559 | 0.398 | 0.212 | 0.796 | 0.425 | n/a | n/a |
| | 2 | (51) | 0.780 | 0.673 | 1.000 | 0.767 | 0.620 | 0.579 | 0.613 | 0.327 | 1.000 | 0.654 | n/a | n/a |
| | 2-7/8 | (73) | 0.903 | 0.748 | | 0.994 | 0.673 | 0.614 | 1.000 | 0.563 | | 0.994 | n/a | n/a |
| | 3 | (76) | 0.920 | 0.759 | | 1.000 | 0.680 | 0.619 | | 0.600 | | 1.000 | n/a | n/a |
| | 3-1/4 | (83) | 0.955 | 0.781 | | | 0.695 | 0.629 | | 0.677 | | | 0.884 | n/a |
| | 4 | (102) | 1.000 | 0.845 | | | 0.741 | 0.658 | | 0.924 | | | 0.981 | n/a |
| | 4-1/8 | (105) | | 0.856 | | | 0.748 | 0.663 | | 0.968 | | | 0.996 | 0.808 |
| | 5 | (127) | | 0.932 | | | 0.801 | 0.698 | | 1.000 | | | 1.000 | 0.889 |
| | 6 | (152) | | 1.000 | | | 0.861 | 0.737 | | | | | | 0.974 |
| | 8 | (203) | | | | | 0.981 | 0.816 | | | | | | 1.000 |
| | 10 | (254) | | | | | 1.000 | 0.895 | | | | | | |
| | 12 | (305) | | | | | | 0.974 | | | | | | |
| | > 14 | (356) | | | | | | 1.000 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check table 5 and figure 2 of this document to calculate permissable edge distance, spacing and concrete thickness combinations.

## Table 8 — Load adjustment factors for 3/8-in. diameter KH-EZ SS316 and KH-EZ C SS316 in uncracked concrete[1,2]

| 3/8-in. KH-EZ SS316 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | | Edge distance in shear: ∥ to edge $f_{RV}$ | | | Conc. thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | | in. | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 |
| | | (mm) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-1/2 | (38) | 0.668 | 0.630 | 0.598 | 0.282 | 0.244 | 0.213 | 0.542 | 0.533 | 0.525 | 0.126 | 0.086 | 0.056 | 0.253 | 0.173 | 0.113 | n/a | n/a | n/a |
| | 2 | (51) | 0.724 | 0.674 | 0.631 | 0.344 | 0.289 | 0.245 | 0.556 | 0.543 | 0.533 | 0.194 | 0.133 | 0.087 | 0.344 | 0.266 | 0.174 | n/a | n/a | n/a |
| | 2-1/4 | (57) | 0.752 | 0.695 | 0.647 | 0.378 | 0.312 | 0.261 | 0.563 | 0.549 | 0.537 | 0.232 | 0.159 | 0.104 | 0.378 | 0.312 | 0.207 | n/a | n/a | n/a |
| | 3 | (76) | 0.836 | 0.760 | 0.696 | 0.503 | 0.391 | 0.313 | 0.584 | 0.565 | 0.549 | 0.357 | 0.244 | 0.160 | 0.503 | 0.391 | 0.313 | n/a | n/a | n/a |
| | 3-1/2 | (89) | 0.891 | 0.804 | 0.729 | 0.587 | 0.456 | 0.350 | 0.598 | 0.576 | 0.557 | 0.450 | 0.308 | 0.201 | 0.587 | 0.456 | 0.350 | 0.626 | n/a | n/a |
| | 3-3/4 | (95) | 0.919 | 0.826 | 0.745 | 0.629 | 0.488 | 0.369 | 0.605 | 0.581 | 0.561 | 0.499 | 0.341 | 0.223 | 0.629 | 0.488 | 0.369 | 0.648 | n/a | n/a |
| | 4 | (102) | 0.947 | 0.847 | 0.761 | 0.671 | 0.521 | 0.392 | 0.612 | 0.587 | 0.565 | 0.550 | 0.376 | 0.246 | 0.671 | 0.521 | 0.392 | 0.669 | 0.589 | n/a |
| | 4-3/4 | (121) | 1.000 | 0.912 | 0.810 | 0.797 | 0.618 | 0.466 | 0.633 | 0.603 | 0.578 | 0.711 | 0.486 | 0.318 | 0.797 | 0.618 | 0.466 | 0.729 | 0.642 | 0.557 |
| | 5 | (127) | | 0.934 | 0.827 | 0.839 | 0.651 | 0.490 | 0.640 | 0.609 | 0.582 | 0.768 | 0.525 | 0.343 | 0.839 | 0.651 | 0.490 | 0.748 | 0.659 | 0.572 |
| | 6 | (152) | | 1.000 | 0.892 | 1.000 | 0.781 | 0.588 | 0.668 | 0.630 | 0.598 | 1.000 | 0.691 | 0.451 | 1.000 | 0.781 | 0.588 | 0.819 | 0.722 | 0.626 |
| | 8 | (203) | | | 1.000 | | 1.000 | 0.784 | 0.724 | 0.674 | 0.631 | | 1.000 | 0.695 | | 1.000 | 0.784 | 0.946 | 0.833 | 0.723 |
| | 10 | (254) | | | | | | 0.980 | 0.780 | 0.717 | 0.663 | | | 0.971 | | | 0.980 | 1.000 | 0.932 | 0.808 |
| | 12 | (305) | | | | | | 1.000 | 0.836 | 0.760 | 0.696 | | | 1.000 | | | 1.000 | | 1.000 | 0.886 |
| | 14 | (356) | | | | | | | 0.891 | 0.804 | 0.729 | | | | | | | | | 0.957 |
| | 16 | (406) | | | | | | | 0.947 | 0.847 | 0.761 | | | | | | | | | 1.000 |
| | 18 | (457) | | | | | | | 1.000 | 0.891 | 0.794 | | | | | | | | | |
| | 20 | (508) | | | | | | | | 0.934 | 0.827 | | | | | | | | | |
| | > 24 | (610) | | | | | | | | 1.000 | 0.892 | | | | | | | | | |

## Table 9 — Load adjustment factors for 3/8-in. diameter KH-EZ SS316 and KH-EZ C SS316 in cracked concrete[1,2]

| 3/8-in. KH-EZ SS316 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | | Edge distance in shear: ∥ to edge $f_{RV}$ | | | Conc. thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | | in. | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 | 2 | 2-1/2 | 3-1/4 |
| | | (mm) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) | (51) | (64) | (83) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-1/2 | (38) | 0.668 | 0.630 | 0.598 | 0.753 | 0.651 | 0.569 | 0.580 | 0.565 | 0.532 | 0.336 | 0.241 | 0.083 | 0.671 | 0.483 | 0.167 | n/a | n/a | n/a |
| | 2 | (51) | 0.724 | 0.674 | 0.631 | 0.918 | 0.770 | 0.652 | 0.607 | 0.586 | 0.542 | 0.517 | 0.372 | 0.128 | 0.918 | 0.743 | 0.257 | n/a | n/a | n/a |
| | 2-1/4 | (57) | 0.752 | 0.695 | 0.647 | 1.000 | 0.832 | 0.696 | 0.621 | 0.597 | 0.548 | 0.617 | 0.443 | 0.153 | 1.000 | 0.832 | 0.307 | n/a | n/a | n/a |
| | 3 | (76) | 0.836 | 0.760 | 0.696 | | 1.000 | 0.834 | 0.661 | 0.629 | 0.564 | 0.949 | 0.683 | 0.236 | | 1.000 | 0.472 | n/a | n/a | n/a |
| | 3-1/2 | (89) | 0.891 | 0.804 | 0.729 | | | 0.933 | 0.688 | 0.651 | 0.574 | 1.000 | 0.860 | 0.297 | | | 0.595 | 0.867 | n/a | n/a |
| | 3-3/4 | (95) | 0.919 | 0.826 | 0.745 | | | 0.984 | 0.701 | 0.662 | 0.580 | | 0.954 | 0.330 | | | 0.660 | 0.897 | n/a | n/a |
| | 4 | (102) | 0.947 | 0.847 | 0.761 | | | 1.000 | 0.715 | 0.672 | 0.585 | | 1.000 | 0.363 | | | 0.727 | 0.927 | 0.830 | n/a |
| | 4-3/4 | (121) | 1.000 | 0.912 | 0.810 | | | | 0.755 | 0.705 | 0.601 | | | 0.470 | | | 0.941 | 1.000 | 0.905 | 0.635 |
| | 5 | (127) | | 0.934 | 0.827 | | | | 0.768 | 0.715 | 0.606 | | | 0.508 | | | 1.000 | | 0.928 | 0.651 |
| | 6 | (152) | | 1.000 | 0.892 | | | | 0.822 | 0.758 | 0.627 | | | 0.668 | | | | | 1.000 | 0.714 |
| | 8 | (203) | | | 1.000 | | | | 0.929 | 0.845 | 0.670 | | | 1.000 | | | | | | 0.824 |
| | 10 | (254) | | | | | | | 1.000 | 0.931 | 0.712 | | | | | | | | | 0.921 |
| | 12 | (305) | | | | | | | | 1.000 | 0.755 | | | | | | | | | 1.000 |
| | 14 | (356) | | | | | | | | | 0.797 | | | | | | | | | |
| | 16 | (406) | | | | | | | | | 0.840 | | | | | | | | | |
| | 18 | (457) | | | | | | | | | 0.882 | | | | | | | | | |
| | 20 | (508) | | | | | | | | | 0.924 | | | | | | | | | |
| | > 24 | (610) | | | | | | | | | 1.000 | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check table 5 and figure 2 of this document to calculate permissable edge distance, spacing and concrete thickness combinations.

### Table 10 — Load adjustment factors for 1/2-in. diameter KH-EZ SS316 in uncracked concrete[1,2]

| 1/2-in. KH-EZ SS316 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | | Edge distance in shear: ∥ to edge $f_{RV}$ | | | Conc. thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | | in. | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 |
| | | (mm) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.303 | 0.247 | 0.357 | n/a | n/a | n/a | 0.149 | 0.089 | 0.073 | 0.297 | 0.177 | 0.147 | n/a | n/a | n/a |
| | 2 | (51) | n/a | n/a | n/a | 0.333 | 0.266 | 0.378 | n/a | n/a | n/a | 0.181 | 0.108 | 0.090 | 0.333 | 0.217 | 0.179 | n/a | n/a | n/a |
| | 3 | (76) | 0.821 | 0.727 | 0.653 | 0.481 | 0.348 | 0.465 | 0.580 | 0.557 | 0.550 | 0.333 | 0.199 | 0.165 | 0.481 | 0.348 | 0.330 | n/a | n/a | n/a |
| | 4 | (102) | 0.927 | 0.803 | 0.704 | 0.641 | 0.455 | 0.560 | 0.607 | 0.576 | 0.567 | 0.513 | 0.306 | 0.254 | 0.641 | 0.455 | 0.508 | n/a | n/a | n/a |
| | 4-1/2 | (114) | 0.981 | 0.841 | 0.730 | 0.721 | 0.511 | 0.611 | 0.620 | 0.585 | 0.575 | 0.612 | 0.366 | 0.303 | 0.721 | 0.511 | 0.606 | 0.693 | n/a | n/a |
| | 4-3/4 | (121) | 1.000 | 0.860 | 0.743 | 0.761 | 0.540 | 0.637 | 0.627 | 0.590 | 0.579 | 0.664 | 0.397 | 0.328 | 0.761 | 0.540 | 0.637 | 0.712 | 0.600 | n/a |
| | 5 | (127) | | 0.879 | 0.756 | 0.801 | 0.568 | 0.667 | 0.634 | 0.595 | 0.584 | 0.717 | 0.428 | 0.355 | 0.801 | 0.568 | 0.667 | 0.731 | 0.615 | n/a |
| | 6 | (152) | | 0.955 | 0.807 | 0.962 | 0.682 | 0.800 | 0.660 | 0.614 | 0.600 | 0.943 | 0.563 | 0.466 | 0.962 | 0.682 | 0.800 | 0.801 | 0.674 | n/a |
| | 6-3/4 | (171) | | 1.000 | 0.845 | 1.000 | 0.767 | 0.900 | 0.680 | 0.628 | 0.613 | 1.000 | 0.672 | 0.556 | 1.000 | 0.767 | 0.900 | 0.849 | 0.715 | 0.672 |
| | 8 | (203) | | | 0.909 | | 0.909 | 1.000 | 0.714 | 0.652 | 0.634 | | 0.867 | 0.718 | | 0.909 | 1.000 | 0.925 | 0.778 | 0.731 |
| | 10 | (254) | | | 1.000 | | 1.000 | | 0.767 | 0.689 | 0.667 | | 1.000 | 1.000 | | 1.000 | | 1.000 | 0.870 | 0.817 |
| | 12 | (305) | | | | | | | 0.821 | 0.727 | 0.700 | | | | | | | | 0.953 | 0.895 |
| | 16 | (406) | | | | | | | 0.927 | 0.803 | 0.767 | | | | | | | | 1.000 | 1.000 |
| | 20 | (508) | | | | | | | 1.000 | 0.879 | 0.834 | | | | | | | | | |
| | > 24 | (610) | | | | | | | | 0.955 | 0.901 | | | | | | | | | |

### Table 11 — Load adjustment factors for 1/2-in. diameter KH-EZ SS316 in cracked concrete[1,2]

| 1/2-in. KH-EZ SS316 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear [3] $f_{AV}$ | | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | | Edge distance in shear: ∥ to edge $f_{RV}$ | | | Conc. thickness factor in shear [4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | | in. | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 | 2-1/4 | 3 | 4-1/4 |
| | | (mm) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) | (57) | (76) | (108) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.808 | 0.657 | 0.548 | n/a | n/a | n/a | 0.352 | 0.225 | 0.067 | 0.703 | 0.450 | 0.135 | n/a | n/a | n/a |
| | 2 | (51) | n/a | n/a | n/a | 0.887 | 0.708 | 0.580 | n/a | n/a | n/a | 0.430 | 0.275 | 0.082 | 0.859 | 0.550 | 0.165 | n/a | n/a | n/a |
| | 3 | (76) | 0.821 | 0.727 | 0.653 | 1.000 | 0.929 | 0.713 | 0.642 | 0.606 | 0.547 | 0.789 | 0.505 | 0.151 | 1.000 | 0.929 | 0.303 | n/a | n/a | n/a |
| | 4 | (102) | 0.927 | 0.803 | 0.704 | | 1.000 | 0.859 | 0.690 | 0.641 | 0.563 | 1.000 | 0.777 | 0.233 | | 1.000 | 0.466 | n/a | n/a | n/a |
| | 4-1/2 | (114) | 0.981 | 0.841 | 0.730 | | | 0.937 | 0.714 | 0.658 | 0.571 | | 0.927 | 0.278 | | 1.000 | 0.556 | 0.924 | n/a | n/a |
| | 4-3/4 | (121) | 1.000 | 0.860 | 0.743 | | | 0.977 | 0.725 | 0.667 | 0.575 | | 1.000 | 0.302 | | 1.000 | 0.603 | 0.949 | 0.818 | n/a |
| | 5 | (127) | | 0.879 | 0.756 | | | 1.000 | 0.737 | 0.676 | 0.579 | | | 0.326 | | | 0.651 | 0.974 | 0.839 | n/a |
| | 6 | (152) | | 0.955 | 0.807 | | | | 0.785 | 0.711 | 0.595 | | | 0.428 | | | 0.856 | 1.000 | 0.919 | n/a |
| | 6-3/4 | (171) | | 1.000 | 0.845 | | | | 0.820 | 0.738 | 0.607 | | | 0.511 | | | 1.000 | | 0.975 | 0.653 |
| | 8 | (203) | | | 0.909 | | | | 0.880 | 0.782 | 0.626 | | | 0.659 | | | | | 1.000 | 0.711 |
| | 10 | (254) | | | 1.000 | | | | 0.974 | 0.852 | 0.658 | | | 0.921 | | | | | | 0.794 |
| | 12 | (305) | | | | | | | 1.000 | 0.923 | 0.689 | | | 1.000 | | | | | | 0.870 |
| | 16 | (406) | | | | | | | | 1.000 | 0.752 | | | | | | | | | 1.000 |
| | 20 | (508) | | | | | | | | | 0.816 | | | | | | | | | |
| | > 24 | (610) | | | | | | | | | 0.879 | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check table 5 and figure 2 of this document to calculate permissable edge distance, spacing and concrete thickness combinations.

## DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-3027. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to PTG Ed. 21 Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

**Table 12 — Steel resistance for Hilti KH-EZ SS316 and KH-EZ C SS316 screw anchor[1,2]**

| Nominal anchor diameter in. | Tensile[3] $N_{sar}$ lb (kN) | Shear[4] $V_{sar}$ lb (kN) | Seismic shear[5] $V_{sar,eq}$ lb (kN) |
|---|---|---|---|
| 1/4 | 3,595 (16.0) | 1,010 (4.5) | 665 (3.0) |
| 3/8 | 7,810 (34.7) | 2,405 (10.7) | 2,405 (10.7) |
| 1/2 | 12,315 (54.8) | 2,645 (11.8) | 2,645 (11.8) |

1 See PTG Ed. 21 section 3.1.8 to convert design strength value to ASD value.
2 Hilti KH-EZ SS316 and KH-EZ C SS316 stainless steel screw anchors are to be considered ductile steel elements.
3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with $V_{sar} < 0.6\ A_{se,V}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \leq 0.60\ A_{se,V}\ \phi_s\ f_{uta}\ R$ as noted in CSA A23.3 Annex D. See PTG Ed. 21 section 3.1.8 for additional information on seismic applications.

## Table 13 — KH-EZ SS316 and KH-EZ C SS316 design information in accordance with CSA A23.3 Annex D[1]

| Design parameter | Symbol | Units | Nominal anchor diameter | | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | | 3/8 | | | 1/2 | | | A23.3 |
| Nominal anchor diameter | $d_a$ | in. (mm) | 0.25 (6.4) | | 0.375 (9.5) | | | 0.5 (12.7) | | | |
| Effective embedment [2] | $h_{ef}$ | in. (mm) | 1.19 (30) | 1.93 (49) | 1.49 (38) | 1.92 (49) | 2.55 (65) | 1.56 (40) | 2.20 (56) | 3.26 (83) | |
| Min. nominal embedment [2] | $h_{nom}$ | in. (mm) | 1-5/8 (41) | 2-1/2 (64) | 2 (51) | 2-1/2 (64) | 3-1/4 (83) | 2-1/4 (57) | 3 (76) | 4-1/4 (108) | |
| Min. concrete thickness | $h_{min}$ | in. (mm) | 3-1/4 (83) | 4 1/8 (105) | 3-1/2 (89) | 4 (102) | 4 3/4 (121) | 4 1/2 (114) | 4 3/4 (121) | 6 3/4 (171) | |
| Critical edge distance | $c_{ac}$ | in. (mm) | 4.76 (121) | 7.72 (196) | 5.96 (151) | 7.68 (195) | 10.20 (259) | 6.24 (158) | 8.80 (224) | 7.50 (191) | |
| Minimum spacing at critical edge distance | $s_{min,cac}$ | in. (mm) | 1.5 (38) | | 2.25 (57) | | | 3 (76) | | | |
| Minimum edge distance | $c_{min}$ | in. (mm) | 1.5 (38) | | | | | 1.75 (44) | | | |
| Minimum spacing at minimum edge distance | for s > | in. (mm) | 3 (76) | | | | | | | | |
| Min. hole depth in concrete | $h_0$ | in. (mm) | 2 (51) | 2-7/8 (73) | 2-1/4 (57) | 2-3/4 (70) | 3-1/2 (89) | 2-5/8 (67) | 3-3/8 (86) | 4-5/8 (117) | |
| Min. specified ultimate strength | $f_{uta}$ | psi (N/mm2) | 153,000 (1055) | | 139,300 (961) | | | 120,100 (828) | | | |
| Effective tensile stress area | $A_{se,N}$ | in2 (mm2) | 0.040 (25.8) | | 0.094 (60.6) | | | 0.172 (111.0) | | | |
| Steel embed. material resistance factor for reinforcement | $\phi_s$ | - | 0.85 | | | | | | | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes [3] | R | - | 0.70 | | | | | | | | D.5.3 |
| Resistance modification factor for shear, steel failure modes [3] | R | - | 0.65 | | | | | | | | |
| Factored steel resistance in tension | $N_{sar}$ | lb (kN) | 3,595 (16.0) | | 7,810 (34.7) | | | 12,315 (54.8) | | | D.6.1.2 |
| Factored steel resistance in shear | $V_{sar}$ | lb (kN) | 1,010 (4.5) | | 2,405 (10.7) | | | 2,645 (11.8) | | | D.7.1.2 |
| Factored steel resistance in shear, seismic | $V_{sar,eq}$ | lb (kN) | 665 (3.0) | | 2,405 (10.7) | | | 2,645 (11.8) | | | |
| Coeff. for factored conc. breakout resistance, uncracked concrete | $k_{c,uncr}$ | - | 10.0 | | 11.3 | | | | | | |
| Coeff. for factored conc. breakout resistance, cracked concrete | $k_{c,cr}$ | - | 7.1 | | | | | 8.8 | | | |
| Modification factor for anchor resistance, tension, uncracked conc. [4] | $\psi_{c,N}$ | - | 1.0 | | | | | | | | D.6.2.6 |
| Anchor category | - | - | 2 | 3 | 1 | | | 2 | | | |
| Concrete material resistance factor | $\phi_c$ | - | 0.65 | | | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B [5] | R | - | 0.85 | 0.75 | 1.00 | | | 0.85 | | | |
| Factored pullout resistance in 20 MPa uncracked concrete [6] | $N_{pr,uncr}$ | lb (kN) | NA | | | | | | | | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete [6] | $N_{pr,cr}$ | lb (kN) | 340 (1.5) | 580 (2.6) | 1,060 (4.7) | 1,555 (6.9) | NA | | | | D.6.3.2 |
| Factored seismic pullout resistance in 20 MPa cracked concrete [6] | $N_{pr,eq}$ | lb (kN) | 225 (1.0) | 580 (2.6) | 1,060 (4.7) | 1,555 (6.9) | NA | | | | D.6.3.2 |

1 Design information in this table is taken from ICC-ES ESR-3027, tables 2 and 4, and converted for use with CSA A23.3 Annex D.
2 See figure 1 of this document.
3 The KH-EZ SS316 and KH-EZ C SS316 is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3 Chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-3027 for additional information.

## Table 14 — Hilti KH-EZ SS316 and KH-EZ C SS316 screw anchor factored resistance with concrete / pullout failure in uncracked concrete[1,2,3,4]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4 | 1.19 (30) | 1-5/8 (41) | 925 (4.1) | 1,030 (4.6) | 1,130 (5.0) | 1,305 (5.8) | 925 (4.1) | 1,030 (4.6) | 1,130 (5.0) | 1,305 (5.8) |
| | 1.93 (49) | 2-1/2 (64) | 1,680 (7.5) | 1,880 (8.4) | 2,060 (9.2) | 2,380 (10.6) | 1,680 (7.5) | 1,880 (8.4) | 2,060 (9.2) | 2,380 (10.6) |
| 3/8 | 1.49 (38) | 2 (51) | 1,710 (7.6) | 1,915 (8.5) | 2,095 (9.3) | 2,420 (10.8) | 1,710 (7.6) | 1,915 (8.5) | 2,095 (9.3) | 2,420 (10.8) |
| | 1.92 (49) | 2-1/2 (64) | 2,505 (11.1) | 2,800 (12.5) | 3,065 (13.6) | 3,540 (15.8) | 2,505 (11.1) | 2,800 (12.5) | 3,065 (13.6) | 3,540 (15.8) |
| | 2.55 (65) | 3-1/4 (83) | 3,830 (17.0) | 4,285 (19.1) | 4,695 (20.9) | 5,420 (24.1) | 3,830 (17.0) | 4,285 (19.1) | 4,695 (20.9) | 5,420 (24.1) |
| 1/2 | 1.56 (40) | 2-1/4 (57) | 1,560 (6.9) | 1,745 (7.8) | 1,910 (8.5) | 2,205 (9.8) | 1,560 (6.9) | 1,745 (7.8) | 1,910 (8.5) | 2,205 (9.8) |
| | 2.20 (56) | 3 (76) | 2,610 (11.6) | 2,920 (13.0) | 3,195 (14.2) | 3,690 (16.4) | 2,610 (11.6) | 2,920 (13.0) | 3,195 (14.2) | 3,690 (16.4) |
| | 3.26 (83) | 4-1/4 (108) | 4,710 (20.9) | 5,265 (23.4) | 5,765 (25.7) | 6,660 (29.6) | 9,415 (41.9) | 10,530 (46.8) | 11,535 (51.3) | 13,320 (59.2) |

## Table 15 — Hilti KH-EZ SS316 and KH-EZ C SS316 screw anchor factored resistance with concrete / pullout failure in cracked concrete[1,2,3,4,5]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4 | 1.19 (30) | 1-5/8 (41) | 330 (1.5) | 350 (1.6) | 370 (1.7) | 405 (1.8) | 655 (2.9) | 735 (3.3) | 805 (3.6) | 925 (4.1) |
| | 1.93 (49) | 2-1/2 (64) | 770 (3.4) | 860 (3.8) | 945 (4.2) | 1,090 (4.8) | 1,195 (5.3) | 1,335 (5.9) | 1,465 (6.5) | 1,690 (7.5) |
| 3/8 | 1.49 (38) | 2 (51) | 1,055 (4.7) | 1,180 (5.3) | 1,295 (5.8) | 1,495 (6.7) | 1,080 (4.8) | 1,210 (5.4) | 1,325 (5.9) | 1,530 (6.8) |
| | 1.92 (49) | 2-1/2 (64) | 1,550 (6.9) | 1,735 (7.7) | 1,900 (8.5) | 2,195 (9.8) | 1,580 (7.0) | 1,765 (7.9) | 1,935 (8.6) | 2,235 (9.9) |
| | 2.55 (65) | 3-1/4 (83) | 2,420 (10.8) | 2,705 (12.0) | 2,960 (13.2) | 3,420 (15.2) | 2,420 (10.8) | 2,705 (12.0) | 2,960 (13.2) | 3,420 (15.2) |
| 1/2 | 1.56 (40) | 2-1/4 (57) | 1,220 (5.4) | 1,365 (6.1) | 1,495 (6.6) | 1,725 (7.7) | 1,220 (5.4) | 1,365 (6.1) | 1,495 (6.6) | 1,725 (7.7) |
| | 2.20 (56) | 3 (76) | 2,040 (9.1) | 2,285 (10.2) | 2,500 (11.1) | 2,890 (12.8) | 2,040 (9.1) | 2,285 (10.2) | 2,500 (11.1) | 2,890 (12.8) |
| | 3.26 (83) | 4-1/4 (108) | 3,685 (16.4) | 4,120 (18.3) | 4,510 (20.1) | 5,210 (23.2) | 7,365 (32.8) | 8,235 (36.6) | 9,020 (40.1) | 10,420 (46.3) |

1 See PTG Ed. 21 section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 11 as necessary. Compare to the steel values in table 12. The lesser of the values is to be used for the design.
4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.51 All other sizes - $\alpha_{N,seis}$ = 0.75
No reduction needed for seismic shear. See PTG Ed. 21 section 3.1.8 for additional information on seismic applications.

# DESIGN INFORMATION IN MASONRY

### Table 16 — Allowable tension loads for Hilti KH-EZ SS316 and KH-EZ C SS316 installed in grout-filled masonry walls walls (lb)[1,2,3,4,5]

| Nominal anchor diameter in. | Embedment in.[6] | Loads @ $c_{cr}$ and $s_{cr}$ | Spacing | | | Edge distance | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical - $s_{cr}$ in.[7] | Minimum - $s_{min}$ in.[7] | Load reduction factor at $s_{min}$[8] | Critical - $C_{cr}$ in.[9] | Minimum - $C_{min}$ in.[9] | Load reduction factor at $c_{min}$[8] |
| 1/4 | 1-5/8 | 125 | 4 | 4 | 1.00 | 4 | 4 | 1.00 |
| | 2-1/2 | 194 | | | 1.00 | | | 1.00 |
| 3/8 | 2 | 332 | 6 | 4 | 0.74 | 6 | 4 | 0.71 |
| | 3-1/4 | 629 | | | 0.62 | | | 0.86 |
| 1/2 | 2-1/4 | 331 | 8 | 4 | 0.56 | 8 | 4 | 0.91 |
| | 4-1/4 | 874 | | | 0.56 | | | 0.75 |

### Table 17 — Allowable Shear loads for Hilti KH-EZ SS316 and KH-EZ C SS316 installed in grout-filled masonry walls (lb)[1,2,3,4,5]

| Nominal anchor diameter in. | Embedment in.[6] | Load at $c_{cr}$ and $s_{cr}$ | Spacing | | | Edge distance | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Critical - $s_{cr}$ in.[7] | Minimum - $s_{min}$ in.[7] | Load reduction factor at $s_{min}$[8] | Critical - $c_{cr}$ in.[9] | Minimum - $c_{min}$ in.[9] | Load reduction factor at $c_{min}$ | |
| | | | | | | | | perpendicular to edge | parallel to edge |
| 1/4 | 1-5/8 | 468 | 4 | 4 | 0.95 | 4 | 4 | 1.00 | 1.00 |
| | 2-1/2 | 574 | | | | | | 1.00 | 1.00 |
| 3/8 | 2 | 742 | 6 | 4 | | 6 | 4 | 0.90 | 1.00 |
| | 3-1/4 | 1,006 | | | | | | 0.98 | 0.99 |
| 1/2 | 2-1/4 | 1,039 | 8 | 4 | | 8 | 4 | 0.82 | 0.97 |
| | 4-1/4 | 1,787 | | | | | | 0.48 | 0.94 |



1 All values are for anchors installed in fully grouted masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight, medium-weight or normal-weight.

2 Anchors may not be installed within one inch in any direction of a vertical joint.

3 Linear interpolation of load values between minimum spacing $s_{min}$ and critical spacing $s_{cr}$ and between minimum edge distance $c_{min}$ and critical edge distance $c_{cr}$ is permitted.

4 For combined loading: $\left(\frac{T_{applied}}{T_{allowable}}\right) + \left(\frac{V_{applied}}{V_{allowable}}\right) \leq 1$

5 See figure 5 of this document for anchor locations.

6 Embedment depth is measured from the outside face of the concrete masonry embedment.

7 Critical spacing $s_{cr}$ is the anchor spacing where full load values may be used. The minimum spacing $s_{min}$ is the minimum spacing for which values are available and installation is recommended. Spacing is measured from the center of one anchor to the center of the adjacent anchor.

8 Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than $c_{cr}$ or $s_{cr}$ must be multiplied by the appropriate load reduction factor based on actual edge distance (c) or spacing (s).

9 The critical edge distance $c_{cr}$ is the edge distance where full load values may be used. The minimum edge distance $c_{min}$ is the minimum edge distance for which values are available and installation is recommended. Edge distance is measured from the center of the anchor to the closest edge.

### Table 18 — Hilti KH-EZ SS316 allowable loads installed in top of grout-filled concrete masonry walls[1,2,3]

| Nominal anchor diameter in. | Minimum embedment depth in. | Edge distance[4] in. | Critical spacing[5] in. | Minimum end distance[6] in. | Tension lb | Shear lb | |
|---|---|---|---|---|---|---|---|
| | | | | | | Load direction | |
| | | | | | | Parallel to edge of masonry wall | Perpendicular to edge of masonry wall |
| 1/2 | 4 1/4 | 1 3/4 | 8 | 8 | 614 | 809 | 200 |

1 All values are for anchors installed in fully grouted concrete masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight, medium-weight or normal-weight conforming to ASTM C90. Allowable loads are calculated using safety factor of 5.

2 See figure 6 and 7 for allowable anchor installation locations on the top of grout-filled concrete masonry walls. Anchors may not be installed within 1-1/4 inch of a vertical joint.

3 Anchors may not be installed within 1-1/4" in any direction of a head joint.

4 For load values at edge distances between listed values linear interpolation is permitted.

5 Critical spacing equals minimum spacing.

6 Minimum end distance applicable to top-of-wall and end-of-wall and does not apply for wall openings such as windows.

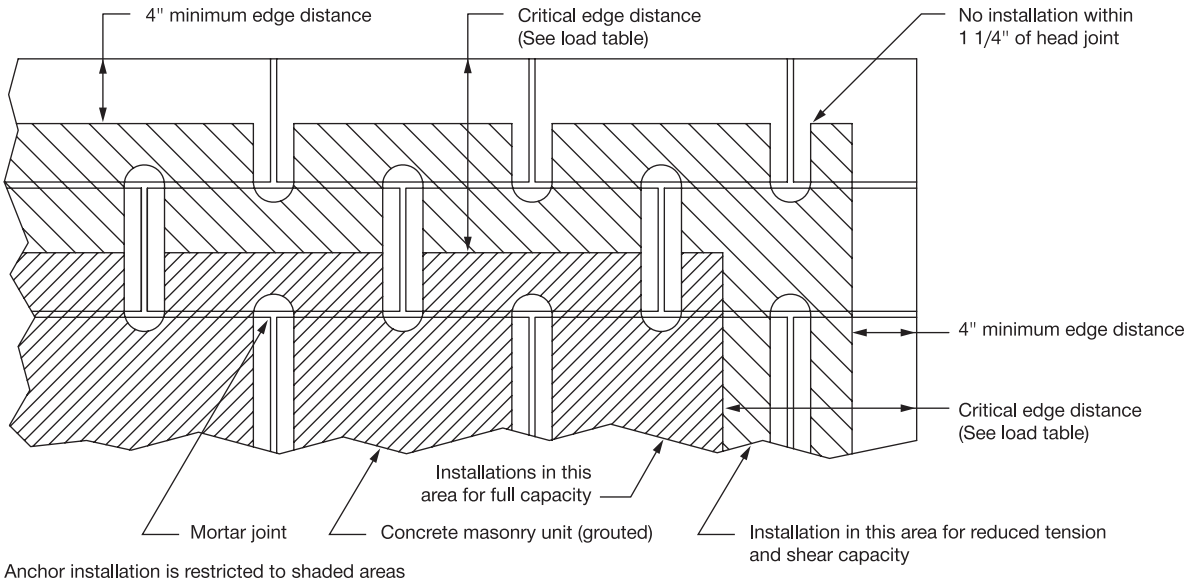



**Figure 5 – Acceptable locations (shaded areas) for Hilti KH-EZ SS316 anchors in grout-filled concrete masonry**

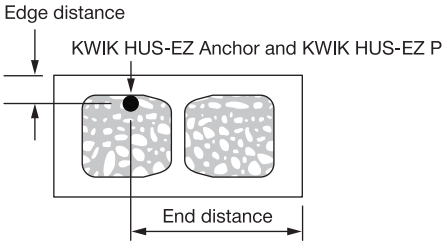
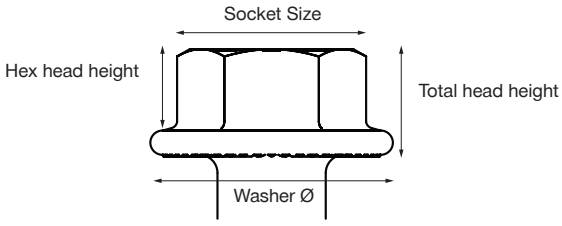



**Figure 6 – Edge and end distances for the Hilti KH-EZ SS316 anchor installed in the top of CMU masonry wall construction**

### KH-EZ SS316

| KH-EZ Ø | Socket Size | Washer Ø | Total head height | Hex head height |
|---|---|---|---|---|
| 1/4” | 7/16” | 0.65” | 0.26” | 0.16” |
| 3/8” | 9/16” | 0.78” | 0.35” | 0.25” |
| 1/2” | 3/4” | 1.03” | 0.49” | 0.34” |

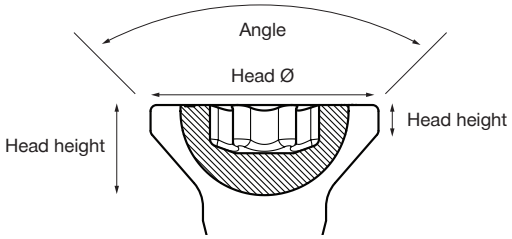
Ø = diameter




### KH-EZ C

| KH-EZ Ø | Torx Size | Head Ø | Head height | Flat height | Angle |
|---|---|---|---|---|---|
| 1/4” | TX30 | 0.45” | 0.15” | 0.04” | 82° |
| 3/8” | TX50 | 0.74” | 0.29” | 0.09” | 82° |

Ø = diameter



## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at **www.hilti.com**. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## ORDERING INFORMATION







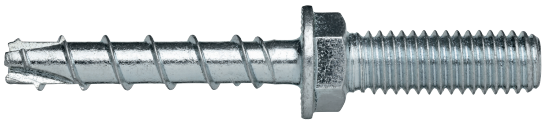
### Order Information

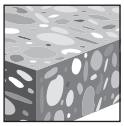
| Description | Hole Diameter | Total Length | Minimum Embedment Depth | Qty (pcs) / Box |
|---|---|---|---|---|
| KH-EZ SS316 1/4''x2'' | 1/4'' | 2 | 1 5/8 | 100 |
| KH-EZ SS316 1/4''x2 1/2'' | 1/4'' | 2 1/2 | 1 5/8 | 100 |
| KH-EZ SS316 1/4''x3'' | 1/4'' | 3 | 1 5/8 | 100 |
| KH-EZ C SS316 1/4''x2'' | 1/4'' | 2 | 1 5/8 | 100 |
| KH-EZ C SS316 1/4''x2 1/2'' | 1/4'' | 2 1/2 | 1 5/8 | 100 |
| KH-EZ C SS316 1/4''x3'' | 1/4'' | 3 | 1 5/8 | 100 |
| KH-EZ SS316 3/8''x2 1/2'' | 3/8'' | 2 1/2 | 2 | 50 |
| KH-EZ SS316 3/8''x3'' | 3/8'' | 3 | 2 | 50 |
| KH-EZ SS316 3/8''x4'' | 3/8'' | 4 | 2 1/2 | 50 |
| KH-EZ SS316 3/8''x5'' | 3/8'' | 5 | 2 1/2 | 50 |
| KH-EZ C SS316 3/8''x2 1/2'' | 3/8'' | 2 1/2 | 2 | 50 |
| KH-EZ C SS316 3/8''x3'' | 3/8'' | 3 | 2 1/2 | 50 |
| KH-EZ C SS316 3/8''x4'' | 3/8'' | 4 | 2 1/2 | 50 |
| KH-EZ SS316 1/2''x3'' | 1/2'' | 3 | 2 1/4 | 25 |
| KH-EZ SS316 1/2''x4'' | 1/2'' | 4 | 3 | 25 |
| KH-EZ SS316 1/2''x5'' | 1/2'' | 5 | 3 | 25 |

# 3.3.8 KWIK HUS-EZ I AND KWIK HUS-EZ E CARBON STEEL SCREW ANCHOR

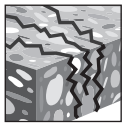
## PRODUCT DESCRIPTION

**KWIK HUS EZ I and KWIK HUS-EZ E carbon steel anchors**

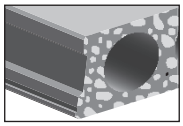
| Anchor System | | Features and Benefits |
|---|---|---|
|  | Carbon Steel<br>1/4", 3/8"<br>KWIK HUS-EZ I | • OSHA compliant installation options including the Hilti SafeSet™ hollow drill bit technology<br>• Easy installation using impact tool or torque wrench<br>• Product and length identification marks facilitate quality control after installation<br>• Thread design enables quality setting and exceptional load values in wide variety of base material strengths<br>• 1/4" diameter available in internally and externally threaded head styles<br>• Anchor is fully removable<br>• Anchor diameter is same as drill bit diameter. No special diameter bit requiredt.<br>• Suitable for reduced edge distances and spacing<br>• Suitable for seismic and non-seismic areas |
|  | Carbon Steel 1/4"<br>KWIK HUS EZ E | |



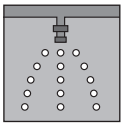
Uncracked concrete



Cracked concrete



Hollowcore concrete



Fire sprinkler listings

SafeSet™ System with Hollow Drill Bit




Profis Anchor design software

| Approvals/Listings | |
|---|---|
| **ICC-ES (International Code Council)** | ESR-3027 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193 |
| **City of Los Angeles** | City of Los Angeles 2020 LABC Supplement (within ESR-3027) |
| **FM (Factory Mutual)** | Pipe hanger components for automatic sprinkler systems for KH-EZ I and KH-EZ E |
| **ANSI/MSS SP-58-2018** | Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information. |

## INSTALLATION PARAMETERS

**Table 1 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E specifications[1,2]**

| Setting information | Symbol | Units | Nominal anchor diameter | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | | | | | 3/8 |
| Head style | | | KH-EZ E | KH-EZ I | | | | |
| Internal thread or external thread diameter | | in. | 3/8 | 1/4 | | 3/8 | | 1/2 |
| Nominal bit diameter | $d_{bit}$ | in. | 1/4 | | | | | 3/8 |
| Nominal embedment | $h_{nom}$ | in. | 1-5/8 | 1-5/8 | 2-1/2 | 1-5/8 | 2-1/2 | 2-1/8 |
| Effective embedment | $h_{ef}$ | in. | 1.18 | 1.18 | 1.92 | 1.18 | 1.92 | 1.54 |
| Minimum hole depth | $h_o$ | in. | 2 | 2 | 2-7/8 | 2 | 2-7/8 | 2-3/8 |
| Installation torque | $T_{inst}$ | ft-lb (N-m) | 18 (24) | | | | | 40 (54) |
| Wrench size | | in. | 1/2 | 3/8 | | 1/2 | | 11/16 |

1 $T_{inst}$ is the maximum installation torque that may be applied with a torque wrench.

2 See table 5 and figure 2 of section 3.3.6 for spacing, edge distance, and concrete thickness parameters

**Figure 1 — KWIK HUS-EZ I anchor installation details**

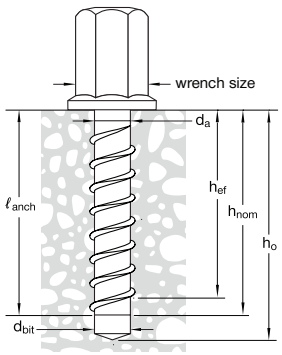
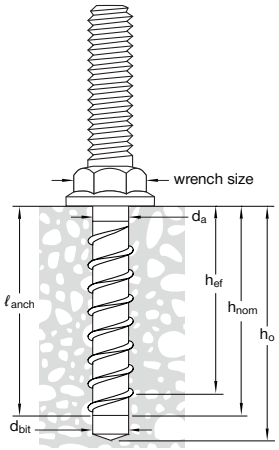



**Figure 2 — KWIK HUS-EZ E anchor installation details**



# DESIGN INFORMATION IN CONCRETE PER ACI 318

## ACI 318 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-3027 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-3027 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

**Table 2 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E design strength with concrete / pullout failure in uncracked concrete[1,2,3,4]**

| Nominal anchor diameter in. | Nominal embed. depth in. (mm) | Tension - $\phi N_n$ | | | | | | | Shear - $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 5,000 psi (34.5 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 7,000 psi (48.3 MPa) lb (kN) | $f'_c$ = 8,000 psi (55.2 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 1/4 | 1-5/8 | 585 | 620 | 675 | 725 | 765 | 800 | 830 | 1,075 | 1,180 | 1,360 | 1,670 |
| | (41) | (2.6) | (2.8) | (3.0) | (3.2) | (3.4) | (3.6) | (3.7) | (4.8) | (5.2) | (6.0) | (7.4) |
| | 2-1/2 | 1,525 | 1,670 | 1,930 | 2,160 | 2,365 | 2,555 | 2,730 | 2,235 | 2,450 | 2,825 | 3,460 |
| | (64) | (6.8) | (7.4) | (8.6) | (9.6) | (10.5) | (11.4) | (12.1) | (9.9) | (10.9) | (12.6) | (15.4) |
| 3/8 | 2-1/8 | 1,490 | 1,635 | 1,885 | 2,110 | 2,310 | 2,495 | 2,665 | 1,605 | 1,760 | 2,030 | 2,485 |
| | (54) | (6.6) | (7.3) | (8.4) | (9.4) | (10.3) | (11.1) | (11.9) | (7.1) | (7.8) | (9.0) | (11.1) |

**Table 3 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E design strength with concrete/pullout failure in cracked concrete[1,2,3,4,5]**

| Nominal anchor diameter in. | Nominal embed. depth in. (mm) | Tension - $\phi N_n$ | | | | | | | Shear - $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 5,000 psi (34.5 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 7,000 psi (48.3 MPa) lb (kN) | $f'_c$ = 8,000 psi (55.2 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) |
| 1/4 | 1-5/8 | 300 | 315 | 345 | 370 | 390 | 410 | 425 | 765 | 835 | 965 | 1,180 |
| | (41) | (1.3) | (1.4) | (1.5) | (1.6) | (1.7) | (1.8) | (1.9) | (3.4) | (3.7) | (4.3) | (5.2) |
| | 2-1/2 | 760 | 830 | 960 | 1,070 | 1,175 | 1,270 | 1,355 | 1,585 | 1,735 | 2,000 | 2,450 |
| | (64) | (3.4) | (3.7) | (4.3) | (4.8) | (5.2) | (5.6) | (6.0) | (7.1) | (7.7) | (8.9) | (10.9) |
| 3/8 | 2-1/8 | 1,055 | 1,155 | 1,335 | 1,495 | 1,635 | 1,765 | 1,890 | 1,135 | 1,245 | 1,440 | 1,760 |
| | (54) | (4.7) | (5.1) | (5.9) | (6.7) | (7.3) | (7.9) | (8.4) | (5.0) | (5.5) | (6.4) | (7.8) |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 5 and 6 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.

4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60

5 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:
1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.60
1/4-in diameter by 2-1/2-in nominal embedment depth - $\alpha_{N,seis}$ = 0.75
3/8-in diameter by 2-1/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.75
No reduction needed for seismic shear. See Section 3.1.8 for additional information on seismic applications.

**Table 4 — Steel design strength for Hilti KWIK HUS-EZ I and KWIK HUS-EZ E anchors[1,2]**

| Nominal anchor diameter in. | Nominal internal thread diameter in. | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) | Seismic shear[5] $\phi V_{sa}$ lb (kN) |
|---|---|---|---|---|
| 1/4 | 1/4-20 UNC | 3,680 (16.4) | 815 (3.6) | 365 (1.6) |
| | 3/8-16 UNC | 3,680 (16.4) | 790 (3.5) | 670 (3.0) |
| 3/8 | 1/2-13 UNC | 5,990 (26.6) | 1,130 (5.0) | 1,130 (5.0) |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Hilti KWIK HUS-EZ I anchors are to be considered brittle steel elements.

3 Tension $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

4 Shear determined by static tests with $\phi V_{sa} < \phi 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.

5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17. See Section 3.1.8 for additional information on seismic applications.

**Table 5 — Load adjustment factors for 1/4-in. diameter Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in uncracked concrete[1,2]**

| 1/4-in. KH-EZ uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. (mm) | 1-5/8 (41) | 2-1/2 (64) | 1-5/8 (41) | 2-1/2 (64) | 1-5/8 (41) | 2-1/2 (64) | 1-5/8 (41) | 2-1/2 (64) | 1-5/8 (41) | 2-1/2 (64) | 1-5/8 (41) | 2-1/2 (64) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 1-1/2 | (38) | 0.71 | 0.63 | 0.78 | 0.65 | 0.59 | 0.56 | 0.40 | 0.21 | 0.78 | 0.42 | n/a | n/a |
| | 2 | (51) | 0.78 | 0.67 | 1.00 | 0.77 | 0.62 | 0.58 | 0.61 | 0.33 | 1.00 | 0.65 | n/a | n/a |
| | 2-1/2 | (64) | 0.85 | 0.72 | | 0.90 | 0.65 | 0.60 | 0.86 | 0.46 | | 0.90 | n/a | n/a |
| | 3 | (76) | 0.92 | 0.76 | | 1.00 | 0.68 | 0.62 | 1.00 | 0.60 | | 1.00 | n/a | n/a |
| | 3-1/4 | (83) | 0.96 | 0.78 | | | 0.70 | 0.63 | | 0.68 | | | 0.88 | n/a |
| | 3-1/2 | (89) | 0.99 | 0.80 | | | 0.71 | 0.64 | | 0.76 | | | 0.92 | n/a |
| | 4 | (102) | 1.00 | 0.85 | | | 0.74 | 0.66 | | 0.92 | | | 0.98 | n/a |
| | 4-1/8 | (105) | | 0.86 | | | 0.75 | 0.66 | | 0.97 | | | 1.00 | 0.81 |
| | 4-1/2 | (114) | | 0.89 | | | 0.77 | 0.68 | | 1.00 | | | | 0.84 |
| | 5 | (127) | | 0.93 | | | 0.80 | 0.70 | | | | | | 0.89 |
| | 5-1/2 | (140) | | 0.98 | | | 0.83 | 0.72 | | | | | | 0.93 |
| | 6 | (152) | | 1.00 | | | 0.86 | 0.74 | | | | | | 0.97 |
| | 7 | (178) | | | | | 0.92 | 0.78 | | | | | | 1.00 |
| | 8 | (203) | | | | | 0.98 | 0.82 | | | | | | |
| | 9 | (229) | | | | | 1.00 | 0.86 | | | | | | |
| | 10 | (254) | | | | | | 0.89 | | | | | | |
| | 11 | (279) | | | | | | 0.93 | | | | | | |
| | 12 | (305) | | | | | | 0.97 | | | | | | |
| | 14 | (356) | | | | | | 1.00 | | | | | | |

**Table 6 — Load adjustment factors for 1/4-in. diameter Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in cracked concrete[1,2]**

| 1/4-in. KH-EZ cracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. (mm) | 1-5/8 (41) | 2-1/2 (64) | 1-5/8 (41) | 2-1/2 (64) | 1-5/8 (41) | 2-1/2 (64) | 1-5/8 (41) | 2-1/2 (64) | 1-5/8 (41) | 2-1/2 (64) | 1-5/8 (41) | 2-1/2 (64) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 1-1/2 | (38) | 0.71 | 0.63 | 0.88 | 0.65 | 0.59 | 0.56 | 0.40 | 0.21 | 0.80 | 0.43 | n/a | n/a |
| | 2 | (51) | 0.78 | 0.67 | 1.00 | 0.77 | 0.62 | 0.58 | 0.62 | 0.33 | 1.00 | 0.66 | n/a | n/a |
| | 2-1/2 | (64) | 0.85 | 0.72 | | 0.90 | 0.65 | 0.60 | 0.87 | 0.46 | | 0.90 | n/a | n/a |
| | 3 | (76) | 0.92 | 0.76 | | 1.00 | 0.68 | 0.62 | 1.00 | 0.60 | | 1.00 | n/a | n/a |
| | 3-1/4 | (83) | 0.96 | 0.78 | | | 0.70 | 0.63 | | 0.68 | | | 0.89 | n/a |
| | 3-1/2 | (89) | 0.99 | 0.80 | | | 0.71 | 0.64 | | 0.76 | | | 0.92 | n/a |
| | 4 | (102) | 1.00 | 0.85 | | | 0.74 | 0.66 | | 0.93 | | | 0.98 | n/a |
| | 4-1/8 | (105) | | 0.86 | | | 0.75 | 0.66 | | 0.97 | | | 1.00 | 0.81 |
| | 4-1/2 | (114) | | 0.89 | | | 0.77 | 0.68 | | 1.00 | | | | 0.85 |
| | 5 | (127) | | 0.93 | | | 0.80 | 0.70 | | | | | | 0.89 |
| | 5-1/2 | (140) | | 0.98 | | | 0.83 | 0.72 | | | | | | 0.93 |
| | 6 | (152) | | 1.00 | | | 0.86 | 0.74 | | | | | | 0.98 |
| | 7 | (178) | | | | | 0.92 | 0.78 | | | | | | 1.00 |
| | 8 | (203) | | | | | 0.98 | 0.82 | | | | | | |
| | 9 | (229) | | | | | 1.00 | 0.86 | | | | | | |
| | 10 | (254) | | | | | | 0.90 | | | | | | |
| | 11 | (279) | | | | | | 0.94 | | | | | | |
| | 12 | (305) | | | | | | 0.98 | | | | | | |
| | 14 | (356) | | | | | | 1.00 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 5 and figure 2 of section 3.3.6 to calculate permissable edge distance, spacing and concrete thickness combinations.

## Table 7 — Load Adjustment Factors for 3/8-in. diameter KWIK HUS-EZ I and KWIK HUS-EZ E in uncracked concrete [1,2]

| 3/8-in. KH-EZ uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear [3] $f_{AV}$ | | | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | | | Edge distance in shear: II to and away from edge $f_{RV}$ | | | | Conc. thickness factor in shear [4] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | in. | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 |
| | (mm) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-1/2 | (38) | n/a | n/a | n/a | n/a | 0.58 | 0.62 | 0.63 | 0.57 | n/a | n/a | n/a | n/a | 0.49 | 0.32 | 0.25 | 0.08 | 0.58 | 0.62 | 0.50 | 0.17 | n/a | n/a | n/a | n/a |
| 2 | (51) | n/a | n/a | n/a | n/a | 0.76 | 0.75 | 0.75 | 0.66 | n/a | n/a | n/a | n/a | 0.75 | 0.49 | 0.38 | 0.13 | 0.76 | 0.75 | 0.75 | 0.26 | n/a | n/a | n/a | n/a |
| 2-1/4 | (57) | 0.84 | 0.74 | 0.70 | 0.65 | 0.86 | 0.82 | 0.81 | 0.70 | 0.65 | 0.62 | 0.60 | 0.55 | 0.90 | 0.59 | 0.46 | 0.16 | 0.90 | 0.82 | 0.81 | 0.31 | n/a | n/a | n/a | n/a |
| 2-1/2 | (64) | 0.88 | 0.77 | 0.72 | 0.67 | 0.95 | 0.91 | 0.88 | 0.75 | 0.67 | 0.63 | 0.61 | 0.55 | 1.00 | 0.69 | 0.54 | 0.18 | 1.00 | 0.91 | 0.88 | 0.37 | n/a | n/a | n/a | n/a |
| 3 | (76) | 0.95 | 0.82 | 0.77 | 0.70 | 1.00 | 1.00 | 1.00 | 0.85 | 0.71 | 0.66 | 0.63 | 0.56 | | 0.90 | 0.71 | 0.24 | | 1.00 | 1.00 | 0.48 | n/a | n/a | n/a | n/a |
| 3-1/4 | (83) | 0.99 | 0.85 | 0.79 | 0.72 | | | | 0.90 | 0.72 | 0.67 | 0.64 | 0.57 | | 1.00 | 0.80 | 0.27 | | | | 0.54 | 0.95 | n/a | n/a | n/a |
| 3-1/2 | (89) | 1.00 | 0.88 | 0.81 | 0.73 | | | | 0.95 | 0.74 | 0.68 | 0.65 | 0.58 | | | 0.89 | 0.30 | | | | 0.61 | 0.98 | n/a | n/a | n/a |
| 4 | (102) | | 0.93 | 0.86 | 0.77 | | | | 1.00 | 0.78 | 0.71 | 0.68 | 0.59 | | | 1.00 | 0.37 | | | | 0.74 | 1.00 | 0.91 | 0.84 | n/a |
| 4-1/2 | (114) | | 0.99 | 0.90 | 0.80 | | | | | 0.81 | 0.73 | 0.70 | 0.60 | | | | 0.44 | | | | 0.88 | | | 0.89 | n/a |
| 4-3/4 | (121) | | 1.00 | 0.93 | 0.82 | | | | | 0.83 | 0.75 | 0.71 | 0.60 | | | | 0.48 | | | | 0.96 | | | 0.91 | 0.639 |
| 5 | (127) | | | 0.95 | 0.83 | | | | | 0.84 | 0.76 | 0.72 | 0.61 | | | | 0.52 | | | | 1.00 | | | 0.94 | 0.655 |
| 6 | (152) | | | 1.00 | 0.90 | | | | | 0.91 | 0.81 | 0.76 | 0.63 | | | | 0.68 | | | | | | | 1.00 | 0.718 |
| 7 | (178) | | | | 0.97 | | | | | 0.98 | 0.86 | 0.81 | 0.65 | | | | 0.86 | | | | | | | | 0.775 |
| 8 | (203) | | | | 1.00 | | | | | 1.00 | 0.91 | 0.85 | 0.67 | | | | 1.00 | | | | | | | | 0.829 |
| 9 | (229) | | | | | | | | | | 0.97 | 0.90 | 0.69 | | | | | | | | | | | | 0.879 |
| 10 | (254) | | | | | | | | | | 1.00 | 0.94 | 0.71 | | | | | | | | | | | | 0.927 |
| 11 | (279) | | | | | | | | | | | 0.98 | 0.74 | | | | | | | | | | | | 0.972 |
| 12 | (305) | | | | | | | | | | | 1.00 | 0.76 | | | | | | | | | | | | 1.000 |
| 14 | (356) | | | | | | | | | | | | 0.80 | | | | | | | | | | | | |
| 16 | (406) | | | | | | | | | | | | 0.84 | | | | | | | | | | | | |
| 18 | (457) | | | | | | | | | | | | 0.89 | | | | | | | | | | | | |
| 20 | (508) | | | | | | | | | | | | 0.93 | | | | | | | | | | | | |
| 24 | (610) | | | | | | | | | | | | 1.000 | | | | | | | | | | | | |

## Table 8 — Load Adjustment Factors for 3/8-in. diameter Hilti KWIK HUS-EZ I and KWIZ HUS-EZ E in cracked concrete [1,2]

3.3.6

| 3/8-in. KH-EZ cracked concrete | | Spacing factor in tension $f_{AN}$ | | | | Edge distance factor in tension $f_{RN}$ | | | | Spacing factor in shear [3] $f_{AV}$ | | | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | | | Edge distance in shear: II to and away from edge $f_{RV}$ | | | | Conc. thickness factor in shear [4] $f_{HV}$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | in. | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 | 1-5/8 | 2-1/8 | 2-1/2 | 3-1/4 |
| | (mm) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) | (41) | (54) | (64) | (83) |
| Spacing (s)/edge distance ($c_a$)/concrete thickness (h) - in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1-1/2 | (38) | n/a | n/a | n/a | n/a | 0.92 | 0.74 | 0.66 | 0.57 | n/a | n/a | n/a | n/a | 0.49 | 0.32 | 0.25 | 0.09 | 0.92 | 0.64 | 0.50 | 0.17 | n/a | n/a | n/a | n/a |
| 2 | (51) | n/a | n/a | n/a | n/a | 1.00 | 0.90 | 0.79 | 0.66 | n/a | n/a | n/a | n/a | 0.76 | 0.50 | 0.39 | 0.13 | 1.00 | 0.90 | 0.77 | 0.26 | n/a | n/a | n/a | n/a |
| 2-1/4 | (57) | 0.84 | 0.74 | 0.70 | 0.65 | 1.00 | 0.98 | 0.85 | 0.70 | 0.66 | 0.62 | 0.60 | 0.55 | 0.90 | 0.59 | 0.46 | 0.16 | 1.00 | 0.98 | 0.85 | 0.31 | n/a | n/a | n/a | n/a |
| 2-1/2 | (64) | 0.88 | 0.77 | 0.72 | 0.67 | 1.00 | 1.00 | 0.92 | 0.75 | 0.67 | 0.63 | 0.61 | 0.55 | 1.00 | 0.69 | 0.54 | 0.18 | 1.00 | 1.00 | 0.92 | 0.37 | n/a | n/a | n/a | n/a |
| 3 | (76) | 0.95 | 0.82 | 0.77 | 0.70 | 1.00 | | 1.00 | 0.85 | 0.71 | 0.66 | 0.63 | 0.56 | 1.00 | 0.91 | 0.71 | 0.24 | 1.00 | 1.00 | 1.00 | 0.48 | n/a | n/a | n/a | n/a |
| 3-1/4 | (83) | 0.99 | 0.85 | 0.79 | 0.72 | | | | 0.90 | 0.73 | 0.67 | 0.64 | 0.57 | | 1.00 | 0.80 | 0.27 | | | | 0.55 | 0.95 | n/a | n/a | n/a |
| 3-1/2 | (89) | 1.00 | 0.88 | 0.81 | 0.73 | | | | 0.95 | 0.74 | 0.68 | 0.65 | 0.58 | | | 0.90 | 0.31 | | | | 0.61 | 0.98 | n/a | n/a | n/a |
| 4 | (102) | | 0.93 | 0.86 | 0.77 | | | | 1.00 | 0.78 | 0.71 | 0.68 | 0.59 | | | 1.00 | 0.37 | | | | 0.75 | 1.00 | 0.91 | 0.84 | n/a |
| 4-1/2 | (114) | | 0.99 | 0.90 | 0.80 | | | | | 0.81 | 0.73 | 0.70 | 0.60 | | | | 0.44 | | | | 0.89 | | 0.97 | 0.89 | n/a |
| 4-3/4 | (121) | | 1.00 | 0.93 | 0.82 | | | | | 0.83 | 0.75 | 0.71 | 0.60 | | | | 0.48 | | | | 0.97 | | 1.00 | 0.92 | 0.64 |
| 5 | (127) | | | 0.95 | 0.83 | | | | | 0.85 | 0.76 | 0.72 | 0.61 | | | | 0.52 | | | | 1.00 | | | 0.94 | 0.66 |
| 6 | (152) | | | 1.00 | 0.90 | | | | | 0.92 | 0.81 | 0.77 | 0.63 | | | | 0.69 | | | | | | | 1.00 | 0.72 |
| 7 | (178) | | | | 0.97 | | | | | 0.98 | 0.87 | 0.81 | 0.65 | | | | 0.86 | | | | | | | | 0.78 |
| 8 | (203) | | | | 1.00 | | | | | 1.00 | 0.92 | 0.85 | 0.67 | | | | 1.00 | | | | | | | | 0.83 |
| 9 | (229) | | | | | | | | | | 0.97 | 0.90 | 0.69 | | | | | | | | | | | | 0.88 |
| 10 | (254) | | | | | | | | | | 1.00 | 0.94 | 0.72 | | | | | | | | | | | | 0.93 |
| 11 | (279) | | | | | | | | | | | 0.99 | 0.74 | | | | | | | | | | | | 0.97 |
| 12 | (305) | | | | | | | | | | | 1.00 | 0.76 | | | | | | | | | | | | 1.00 |
| 14 | (356) | | | | | | | | | | | | 0.80 | | | | | | | | | | | | |
| 16 | (406) | | | | | | | | | | | | 0.85 | | | | | | | | | | | | |
| 18 | (457) | | | | | | | | | | | | 0.89 | | | | | | | | | | | | |
| 20 | (508) | | | | | | | | | | | | 0.93 | | | | | | | | | | | | |
| 24 | (610) | | | | | | | | | | | | 1.00 | | | | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check table 5 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

**Table 9 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6]**

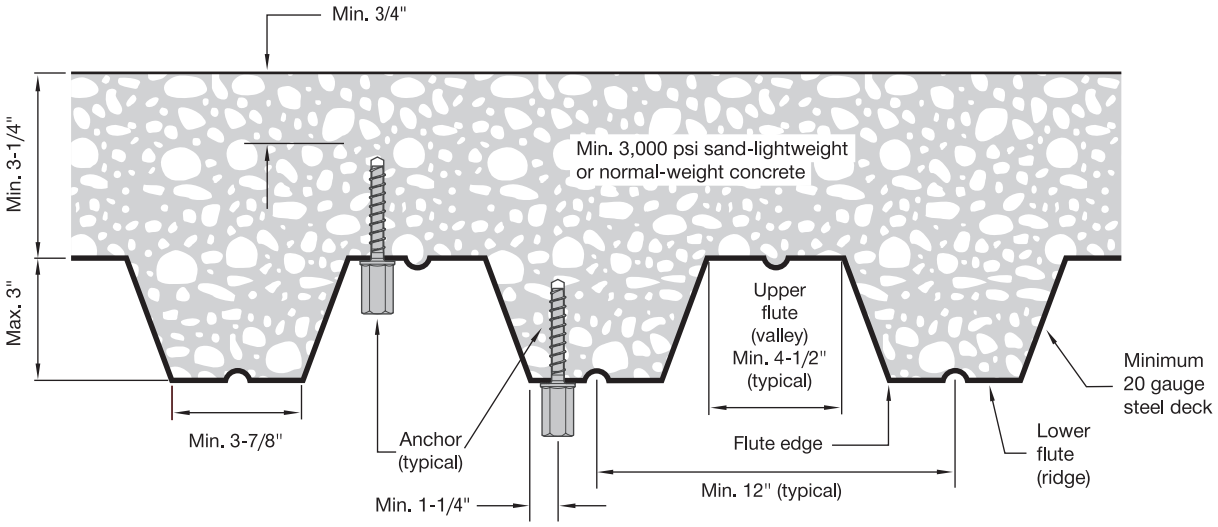
| Nominal anchor diameter in. | Nominal internal thread diameter in. | Nominal embed. depth in. (mm) | Installation in lower flute | | | | Installation in upper flute | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tension - $\phi N_n$ | | Shear - $\phi V_n$ | | Tension - $\phi N_n$ | | Shear - $\phi V_n$ | |
| | | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) |
| 1/4 | 1/4-20 UNC | 1-5/8 (41) | 545 (2.4) | 595 (2.6) | 515 (2.3) | 515 (2.3) | 670 (3.0) | 730 (3.2) | 610 (2.7) | 610 (2.7) |
| | | 2-1/2 (64) | 1,220 (5.4) | 1,410 (6.3) | 515 (2.3) | 515 (2.3) | 1,275 (5.7) | 1,470 (6.5) | 610 (2.7) | 610 (2.7) |
| | 3/8-16 UNC | 1-5/8 (41) | 545 (2.4) | 595 (2.6) | 615 (2.7) | 615 (2.7) | 670 (3.0) | 730 (3.2) | 915 (4.1) | 915 (4.1) |
| | | 2-1/2 (64) | 1,220 (5.4) | 1,410 (6.3) | 615 (2.7) | 615 (2.7) | 1,275 (5.7) | 1,470 (6.5) | 915 (4.1) | 915 (4.1) |
| 3/8 | 1/2-13 UNC | 2-1/8 (54) | 1,120 (5.0) | 1,295 (5.8) | 1,430 (6.4) | 1,430 (6.4) | 1,730 (7.7) | 2,000 (8.9) | 2,190 (9.7) | 2,190 (9.7) |

**Table 10 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in the soffit of cracked lightweight concrete over metal deck[1,2,3,4,5,6,7,8]**

| Nominal anchor diameter in. | Nominal internal thread diameter in. | Nominal embed. depth in. (mm) | Installation in lower flute | | | | Installation in upper flute | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tension - $\phi N_n$ | | Shear - $\phi V_n$ | | Tension - $\phi N_n$ | | Shear - $\phi V_n$ | |
| | | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) |
| 1/4 | 1/4-20 UNC | 1-5/8 (41) | 280 (1.2) | 305 (1.4) | 515 (2.3) | 515 (2.3) | 330 (1.5) | 360 (1.6) | 610 (2.7) | 610 (2.7) |
| | | 2-1/2 (64) | 605 (2.7) | 700 (3.1) | 515 (2.3) | 515 (2.3) | 635 (2.8) | 735 (3.3) | 610 (2.7) | 610 (2.7) |
| | 3/8-16 UNC | 1-5/8 (41) | 280 (1.2) | 325 (1.4) | 615 (2.7) | 615 (2.7) | 330 (1.5) | 380 (1.7) | 915 (4.1) | 915 (4.1) |
| | | 2-1/2 (64) | 605 (2.7) | 700 (3.1) | 615 (2.7) | 615 (2.7) | 635 (2.8) | 735 (3.3) | 915 (4.1) | 915 (4.1) |
| 3/8 | 1/2-13 UNC | 2-1/8 (54) | 795 (3.5) | 920 (4.1) | 1,430 (6.4) | 1,430 (6.4) | 1,225 (5.4) | 1,415 (6.3) | 2,190 (9.7) | 2,190 (9.7) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{nom}$ (nominal embedment).
4 Tabular values are lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison of the tabular values to the steel strength is not necessary. Tabular Values control.
7 Tabular values are for static loads only. For seismic tenison loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75.
8 For seismic shear, an additional factor must be applied to the cracked concrete tabular values for seismic conditions:
1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{V,seis}$ = 0.44
1/4-in diameter by 2-1/2-in nominal embedment depth - $\alpha_{V,seis}$ = 0.85
See Section 3.1.8 for additional information on seismic applications.

**Figure 2 — Installation of Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in soffit of concrete over steel deck floor and roof assemblies**




1 Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum concrete cover above the drilled hole is satisfied. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

## DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-3027. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.



For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

**Table 11 — Steel resistance for Hilti KWIK HUS-EZ I and KWIK HUS-EZ E carbon steel screw anchor[1,2]**

| Nominal anchor diameter in. | Internal thread diameter (UNC) | Tensile[3] $N_{sar}$ lb (kN) | Shear[4] $V_{sar}$ lb (kN) | Seismic shear[5] $V_{sar,eq}$ lb (kN) |
|---|---|---|---|---|
| 1/4 | 1/4-20 | 3,370 (15.0) | 750 (3.3) | 335 (1.5) |
| 1/4 | 3/8-16 | 3,370 (15.0) | 725 (3.2) | 620 (2.8) |
| 3/8 | 1/2-13 | 5,515 (24.5) | 1,040 (4.6) | 1,040 (4.6) |

1 See Section 3.1.8 of Hilti Product Technical Guide Ed 21 to convert factored resistance value to ASD value.

2 Hilti KWIK HUS-EZ I carbon steel screw anchors are to be considered brittle steel elements.

3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.

4 Shear determined by static shear tests with $V_{sar} < 0.6\ A_{se,V}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.

5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \leq 0.60\ A_{se,V}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D. See Section 3.1.8 of Hilti Product Technical Guide Ed 21 for additional information on seismic applications.

## Table 12 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E design information in accordance with CSA A23.3 Annex D[1]

| Design parameter | | Symbol | Units | Nominal anchor diameter | | | Ref |
|---|---|---|---|---|---|---|---|
| | | | | 1/4 | | 3/8 | A23.3 |
| Anchor O.D. | | $d_a$ | in.<br>(mm) | 0.25<br>(6.4) | | 0.375<br>(9.5) | |
| Effective embedment[2] | | $h_{ef}$ | in.<br>(mm) | 1.18<br>(30) | 1.92<br>(49) | 1.54<br>(39) | |
| Minimum nominal embedment[2] | | $h_{nom}$ | in.<br>(mm) | 1-5/8<br>(41) | 2-1/2<br>(64) | 2 1/8<br>(54) | |
| Minimum concrete thickness | | $h_{min}$ | in.<br>(mm) | 3-1/4<br>(83) | 4-1/8<br>(105) | 3 5/8<br>(92) | |
| Critical edge distance | | $c_{ac}$ | in.<br>(mm) | 2.00<br>(51) | 2.78<br>(71) | 2.75<br>(70) | |
| Minimum spacing at critical edge distance | | $s_{min,cac}$ | in.<br>(mm) | 1.5<br>(38) | | 2.25<br>(57) | |
| Minimum edge distance | | $c_{min}$ | in.<br>(mm) | 1.50<br>(38) | | 1.5<br>(38) | |
| Minimum anchor spacing at minimum edge distance | | for s > | in.<br>(mm) | 3.0<br>(76) | | 3<br>(76) | |
| Mininimum hole depth in concrete | | $h_0$ | in.<br>(mm) | 2<br>(51) | 2-7/8<br>(73) | 2 3/8<br>(60) | |
| Minimum specified ultimate strength | | $f_{uta}$ | psi<br>(N/mm²) | 125,000<br>(862) | | 106,975<br>(826) | |
| Effective tensile stress area | | $A_{se,N}$ | in²<br>(mm²) | 0.045<br>(29.0) | | 0.086<br>(55.5) | |
| Steel embed. material resistance factor for reinforcement | | $\phi_s$ | - | 0.85 | | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes[3] | | R | - | 0.70 | | | D.5.3 |
| Resistance modification factor for shear, steel failure modes[3] | | R | - | 0.65 | | | D.5.3 |
| Factored steel resistance in tension | | $N_{sar}$ | lb<br>(kN) | 3,370<br>(15.0) | | 5,475<br>(24.4) | D.6.1.2 |
| Factored steel resistance in shear | 1/4-20 UNC internal thread | $V_{sar}$ | lb<br>(kN) | 750<br>(3.3) | | N/A | D.7.1.2 |
| Factored steel resistance in shear, seismic | 1/4-20 UNC internal thread | $V_{sar,eq}$ | lb<br>(kN) | 335<br>(1.5) | | N/A | |
| Factored steel resistance in shear | 3/8-16 UNC internal thread | $V_{sar}$ | lb<br>(kN) | 725<br>(3.2) | | N/A | D.7.1.2 |
| Factored steel resistance in shear, seismic | 3/8-16 UNC internal thread | $V_{sar,eq}$ | lb<br>(kN) | 620<br>(2.8) | | N/A | |
| Factored steel resistance in shear | 1/2-13 UNC internal thread | $V_{sar}$ | lb<br>(kN) | N/A | | 1040<br>(4.6) | |
| Factored steel resistance in shear, seismic | 1/2-13 UNC internal thread | $V_{sar,eq}$ | lb<br>(kN) | N/A | | 1040<br>(4.6) | |
| Coeff. for factored conc. breakout resistance, uncracked concrete | | $k_{c,uncr}$ | - | 10 | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete | | $k_{c,cr}$ | - | 7 | | | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked conc.[4] | | $\psi_{c,N}$ | - | 1.0 | | | D.6.2.6 |
| Anchor category | | - | - | 3 | 1 | 1 | D.5.3 (c ) |
| Concrete material resistance factor | | $\phi_c$ | - | 0.65 | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | | R | - | 0.75 | 1.00 | 1.00 | D.5.3 (c ) |
| Factored pullout resistance in 20 MPa uncracked concrete[6] | | $N_{pr,uncr}$ | lb<br>(kN) | 665<br>(3.0) | 1,645<br>(7.3) | N/A | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete[6] | | $N_{pr,cr}$ | lb<br>(kN) | 340<br>(1.5) | 815<br>(3.6) | N/A | D.6.3.2 |
| Factored seismic pullout resistance in 20 MPa cracked concrete[6] | | $N_{pr,eq}$ | lb<br>(kN) | 275<br>(1.2) | 815<br>(3.6) | N/A | D.6.3.2 |

1 Design information in this table is taken from ICC-ES ESR-3027, tables 6, 7, and 8, and converted for use with CSA A23.3 Annex D.
2 See figure 1 of this section.
3 The KWIK HUS-EZ I is considered a brittle steel element as defined by CSA A23.3 Annex D section D.2.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-3027 for additional information.

## Table 13 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E carbon steel screw anchor factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Effectiveness Factor | Strength Reduction Factor Tension | Concrete material resistance factor | Pullout Strength (2500 psi concrete) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4 | 1.18 (30) | 1-5/8 (41) | 10 | 0.75 | 0.65 | 1305 (5.8) | 665 (3.0) | 710 (3.2) | 750 (3.3) | 820 (3.6) | 805 (3.6) | 900 (4.0) | 985 (4.4) | 1,135 (5.1) |
| | 1.92 (49) | 2-1/2 (64) | 10 | 1 | 0.65 | 2350 (10.5) | 1,645 (7.3) | 1,840 (8.2) | 2,015 (9.0) | 2,325 (10.3) | 2,225 (9.9) | 2,490 (11.1) | 2,725 (12.1) | 3,145 (14.0) |
| 3/8 | 1.54 (39) | 2-1/8 (54) | 10 | 1 | 0.65 | N/A | 1,595 (7.1) | 1,785 (7.9) | 1,955 (8.7) | 2,260 (10.0) | 1,595 (7.1) | 1,785 (7.9) | 1,955 (8.7) | 2,260 (10.0) |

## Table 14 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E carbon steel screw anchor factored resistance with concrete/pullout failure in cracked concrete[1,2,3,4,5]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Effectiveness Factor | Strength Reduction Factor Tension | Concrete material resistance factor | Pullout Strength (2500 psi concrete) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| $d_a$ in (mm) | $h_{ef}$ (mm) | $h_{nom}$ (mm) | $k_{cr}$ | R | $\Phi_c$ | $N_{p,uncr}$ ($N/mm^2$) | 20 | 25 | 30 | 40 | 20 | 25 | 30 | 40 |
| 1/4 | 1.18 (30) | 1-5/8 (41) | 7 | 0.75 | 0.65 | 665 (3.0) | 340 (1.5) | 360 (1.6) | 385 (1.7) | 415 (1.9) | 565 (2.5) | 630 (2.8) | 690 (3.1) | 795 (3.5) |
| | 1.92 (49) | 2-1/2 (64) | 7 | 1 | 0.65 | 1165 (5.2) | 815 (3.6) | 910 (4.1) | 1,000 (4.4) | 1,155 (5.1) | 1,800 (8.0) | 1,740 (7.7) | 1,910 (8.5) | 2,205 (9.8) |
| 3/8 | 1.54 (39) | 2-1/8 (54) | 7 | 1 | 0.65 | N/A | 1,120 (5.0) | 1,250 (5.6) | 1,370 (6.1) | 1,580 (7.0) | 1,120 (5.0) | 1,250 (5.6) | 1,370 (6.1) | 1,580 (7.0) |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 5 to 6 as necessary. Compare to the steel values in table 9. The lesser of the values is to be used for the design.

4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60

5 5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by the following reduction factors:

1/4-in diameter by 1-5/8-in nominal embedment depth - $\alpha_{N,seis}$ = 0.60

1/4-in diameter by 2-1/2-in nominal embedment depth - $\alpha_{N,seis}$ = 0.75.
No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

### Table 15 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6,7]

| Nominal anchor diameter in. | Nominal internal thread diameter in. | Nominal embed. depth in. (mm) | Installation in lower flute | | | | Installation in upper flute | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tension - $N_r$ | | Shear - $V_r$ | | Tension - $N_r$ | | Shear - $V_r$ | |
| | | | $f'_c$ = 20 MPa (2,900 psi) kN | $f'_c$ = 30 MPa (4,350 psi) kN | $f'_c$ = 20 MPa (2,900 psi) kN | $f'_c$ = 30 MPa (4,350 psi) kN | $f'_c$ = 20 MPa (2,900 psi) kN | $f'_c$ = 30 MPa (4,350 psi) kN | $f'_c$ = 20 MPa (2,900 psi) kN | $f'_c$ = 30 MPa (4,350 psi) kN |
| 1/4 | 1/4-20 UNC | 1-5/8 (41) | 585 (2.6) | 660 (2.9) | 475 (2.1) | 475 (2.1) | 720 (3.2) | 810 (3.6) | 560 (2.5) | 560 (2.5) |
| | | 2-1/2 (64) | 1,200 (5.3) | 1,470 (6.5) | | | 1,255 (5.6) | 1,535 (6.8) | | |
| 1/4 | 3/8-16 UNC | 1-5/8 (41) | 585 (2.6) | 660 (2.9) | 565 (2.5) | 565 (2.5) | 720 (3.2) | 810 (3.6) | 845 (3.8) | 845 (3.8) |
| | | 2-1/2 (64) | 1,200 (5.3) | 1,470 (6.5) | | | 1,255 (5.6) | 1,535 (6.8) | | |
| 3/8 | 1/2-13 UNC | 2-1/8 (54) | 1,100 (4.9) | 1,345 (6.0) | 1,315 (5.8) | 1,315 (5.8) | 1,865 (8.3) | 2,280 (10.1) | 2,015 (9.0) | 2,015 (9.0) |

### Table 16 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E in the soffit of cracked lightweight concrete over metal deck[1,2,3,4,5,6,7,8]

| Nominal anchor diameter in. | Nominal internal thread diameter in. | Nominal embed. depth in. (mm) | Installation in lower flute | | | | Installation in upper flute | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tension - $N_r$ | | Shear - $V_r$ | | Tension - $N_r$ | | Shear - $V_r$ | |
| | | | $f'_c$ = 20 MPa (2,900 psi) kN | $f'_c$ = 30 MPa (4,350 psi) kN | $f'_c$ = 20 MPa (2,900 psi) kN | $f'_c$ = 30 MPa (4,350 psi) kN | $f'_c$ = 20 MPa (2,900 psi) kN | $f'_c$ = 30 MPa (4,350 psi) kN | $f'_c$ = 20 MPa (2,900 psi) kN | $f'_c$ = 30 MPa (4,350 psi) kN |
| 1/4 | 1/4-20 UNC | 1-5/8 (41) | 300 (1.3) | 340 (1.5) | 475 (2.1) | 475 (2.1) | 365 (1.6) | 415 (1.8) | 560 (2.5) | 560 (2.5) |
| | | 2-1/2 (64) | 595 (2.6) | 730 (3.2) | | | 625 (2.8) | 765 (3.4) | | |
| 1/4 | 3/8-16 UNC | 1-5/8 (41) | 300 (1.3) | 340 (1.5) | 565 (2.5) | 565 (2.5) | 365 (1.6) | 415 (1.8) | 845 (3.8) | 845 (3.8) |
| | | 2-1/2 (64) | 595 (2.6) | 730 (3.2) | | | 625 (2.8) | 765 (3.4) | | |
| 3/8 | 1/2-13 UNC | 2-1/8 (54) | 780 (3.5) | 955 (4.2) | 1,315 (5.8) | 1,315 (5.8) | 1,305 (5.8) | 1,595 (7.1) | 2,015 (9.0) | 2,015 (9.0) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 6 3/8 inches.
4 Tabular value is for lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. For seismic conditions $\alpha_{N,seis}$ = 0.75
8 For seismic shear, an additional factor must be applied to the cracked concrete tabular values for seismic conditions: $\alpha_{v,seis}$ = 0.85
See Section 3.1.8 for additional information on seismic applications.

## ALLOWABLE STRESS DESIGN FOR FM SPRINKLER SYSTEMS

### Table 17 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E tested load values for FM approval for automatic sprinkler systems[1]

| Anchor diamenter in. | Hanger rod size | Nominal embedment in. | FM tension test load lb. | FM maximum pipe diameter in. |
|---|---|---|---|---|
| 1/4 | 3/8-16 UNC | 1-5/8 | 1,475 | 4 |
| | | 2-1/2 | | |
| 3/8 | 1/2-13 UNC | 2-1/8 | 3,800 | 8 |

1 Tested in accordance with FM Approval Standard for Pipe Hanger Components for Automatic Sprinklers Systems Class Numbers 1951, 1952 and 1953.

## DESIGN INFORMATION IN HOLLOW CORE CONCRETE PER ALLOWABLE STRESS DESIGN

**Table 18 — Hilti KWIK HUS-EZ I and KWIK HUS-EZ E load values for installations into hollow core concrete panels[1,2]**

| Hanger rod size | anchor diameter in. | Min. effective embedment $h_{ef}$ in. | Min.effective base material thickness t in. | Allowable load[3] | | Ultimate load | |
|---|---|---|---|---|---|---|---|
| | | | | Tension lb | Shear lb[4,5] | Tension lb | Shear lb[4,5] |
| 1/4-20 UNC | 1/4 | 1-3/8 | 1-3/8 | 455 | 485 | 1,810 | 1,930 |
| 3/8-16 UNC | 1/4 | | | | 755 | | 3,025 |
| 1/2-13 UNC | 3/8 | 1-1/8 | 1-1/8 | 435 | N/A | 1,750 | N/A |

1 The admissible anchor location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm admissible anchor location.

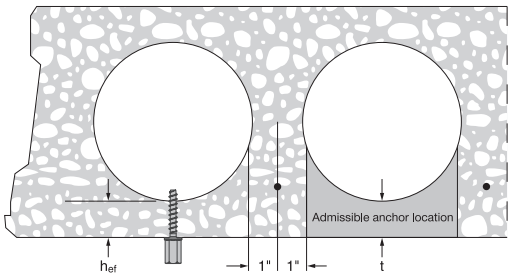
2 Minimum compressive strength of prestressed concrete is 7,000 psi. Published ultimate loads represent the average results conducted in local base materials. Due to variations in materials and dimensionl configurations, on-site testing is required to determine the actual performance.

3 Allowable loads calculated with a factor of safety of 4

4 The bottom of the shear plane adjacent to the top of the coupler.

5 Shear values controlled by the steel strength of the screws used to fasten the shear fixture to the KH EZ-I Screw Anchor. The minimum tensile strength of the screw was 125 ksi. Shear design values should consider the screw or threaded rod steel strength.

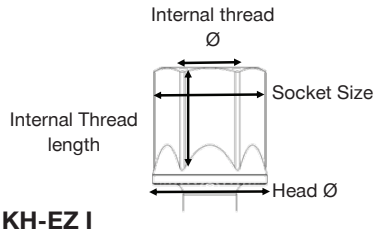
**Figure 3 — Installation of Hilti KWIK HUS–EZ I and KH-EZ E in hollow core concrete**




## INSTALLATION INSTRUCTIONS

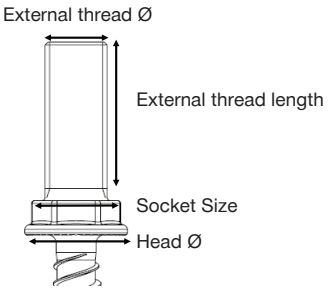
Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.






**KH-EZ I**

| KH-EZ Ø | Socket Size | Head Ø | Internal thread Ø | Internal thread length |
|---|---|---|---|---|
| 1/4'' | 3/8'' | 0.59'' | 1/4'' | 0.37'' |
| 1/4'' | 1/2'' | 0.65'' | 3/8'' | 0.45'' |
| 3/8'' | 11/16'' | 0.81'' | 1/2'' | 0.46'' |




**KH-EZ E**

| KH-EZ Ø | Socket Size | Min Socket Height | Head Ø | Internal thread Ø | Internal thread length | Total Head height |
|---|---|---|---|---|---|---|
| 1/4'' | 1/2'' | 1-1/2'' | 0.65'' | 3/8'' | 1.08'' | 1.32'' |

## ORDERING INFORMATION[1]

| Description | Internal thread diameter | Internal thread length | Drill bit diameter | Minimum embedment | Qty / box |
|---|---|---|---|---|---|
| **KWIK HUS-EZ 1/4x1-5/8 \| 1/4** | 1/4 | 3/8 | 1/4 | 1-5/8 | 100 |
| **KWIK HUS-EZ 1/4x2-1/2 \| 1/4** | 1/4 | 3/8 | 1/4 | 2-1/2 | 100 |
| **KWIK HUS-EZ 1/4x1-5/8 \| 3/8** | 3/8 | 7/16 | 1/4 | 1-5/8 | 100 |
| **KWIK HUS-EZ 1/4x2-1/2 \| 3/8** | 3/8 | 7/16 | 1/4 | 2-1/2 | 100 |
| **KWIK HUS-EZ 3/8x2-1/8 \| 1/2** | 1/2 | 1/2 | 3/8 | 2-1/8 | 100 |
| **KWIK HUS-EZ 1/4x1-5/8 E 3/8** | 3/8 | 1 | 1/4 | 1-5/8 | 100 |

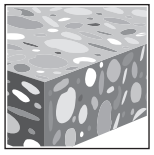
1 All dimensions in inches.

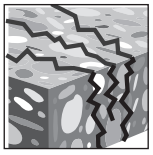
# 3.3.9 KB1 EXPANSION ANCHOR

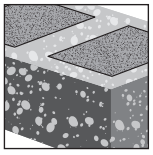
## PRODUCT DESCRIPTION

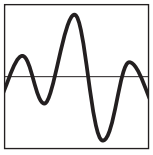
**KB1 Expansion Anchor**

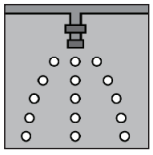
| Anchor System | Features and Benefits |
|---|---|
| Carbon Steel KB1<br>  | • Instructions For Use (IFU) provides multiple installation methods including Hilti Hollow Drill bit, or no hole cleaning with hammer drill and Hilti Dust Removal System (DRS) for virtually dustless installation (OSHA 1926.1153 Table 1 compliant).<br>• Accurate SafeSet™ installation when using the Hilti SIW-6AT-A22 impact wrench and the SI-AT-A22 Adaptive Torque Module.<br>• Product and length identification marks facilitate quality control after installation.<br>• Maximized thread lengths and multiple embedment depths to accommodate various base plate thicknesses.<br>• Functional coatings and profiled expansion wedges provide increased reliability.<br>• Mechanical expansion allows immediate load application.<br>• Raised impact section (dog point) prevents thread damage during installation. |


Uncracked concrete


Cracked concrete


Grout-filled concrete masonry


Seismic Design Categories A-F


Fire sprinkler listings



Profis Engineering design software



Hollow Drill Bit and Adaptive Torque Tool (AT)

## Approvals/ Listings

| | |
|---|---|
| **IAPMO Uniform ES**<br>• 2021 International Building Code / International Residential Code (IBC/IRC) | ER-678 in concrete per ACI 318 Ch. 17 / ACI 355.2<br>ER-677 in grout-filled CMU per AC01 |
| **City of Los Angeles** | 2020 LABC Supplement (within ER-677 & ER-678) |
| **Florida Building Code** | 2020 FBC Supplement with HVHZ (within ER-677 & ER-678) |
| **FM (Factory Mutual)** | Pipe hanger components for automatic sprinkler systems<br>3/8 (up to 4-inch nominal pipe diameter)<br>1/2 (up to 8-inch nominal pipe diameter)<br>3/4 (up to 12-inch nominal pipe diameter) |
| **UL and cUL (Underwriters Laboratory)** | Pipe hanger equipment for fire protection services<br>3/8 (up to 4-inch nominal pipe diameter)<br>1/2 (up to 8-inch nominal pipe diameter)<br>5/8 & 3/4 (up to 12-inch nominal pipe diameter) |
| **ANSI/MSS SP-58-2018** | Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information. |

## MATERIAL SPECIFICATIONS

**Carbon steel with electroplated zinc**

- Hilti KB1 anchor bodies manufactured from carbon steel with Fe/Zn plating per ASTM F1941 to a minimum thickness of 5 µm.
- Nuts conform to the requirements of ASTM A563, Grade A, Hex.
- Washers conform to the requirements of ASTM F844.
- Expansion sleeves (wedges) are manufactured from carbon steel.

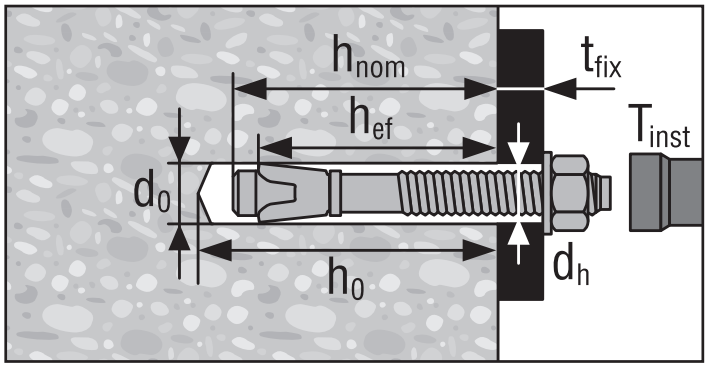
## INSTALLATION PARAMETERS

**Table 1 — Hilti KB1 setting information for installation in concrete and grout-filled concrete masonry units (CMU)**

| Setting information | Symbol | Units | Nominal anchor diameter (in) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3/8 | | 1/2 | | 5/8 | | 3/4 | |
| Nominal drill bit diameter | $d_o$ | in. | 3/8 | | 1/2 | | 5/8 | | 3/4 | |
| Effective minimum embedment | $h_{ef}$ | in. | 1-1/2 [1] | 2 | 2 | 3-1/4 | 2-3/4 | 4 | 3-1/4 | 4-3/4 |
| | | (mm) | (38) | (51) | (51) | (83) | (70) | (102) | (83) | (121) |
| Nominal minimum embedment | $h_{nom}$ | in. | 1-7/8 [1] | 2-3/8 | 2-3/8 | 3-5/8 | 3-1/4 | 4-1/2 | 4 | 5-1/2 |
| | | (mm) | (48) | (60) | (60) | (92) | (83) | (114) | (102) | (140) |
| Minimum hole depth | $h_0$ | in. | 2-1/8 [1] | 2-3/4 | 2-3/4 | 4-1/4 | 3-3/4 | 4-3/4 | 4-1/4 | 5-3/4 |
| | | (mm) | (54) | (70) | (70) | (108) | (95) | (121) | (108) | (146) |
| Fixture hole diameter | $d_h$ | in. | 7/16 | | 9/16 | | 11/16 | | 13/16 | |
| | | (mm) | (11.1) | | (14.3) | | (17.5) | | (20.6) | |
| Installation torque Concrete | $T_{inst,conc}$ | ft-lb | 20 | | 40 | | 60 | | 110 | |
| | | (Nm) | (27) | | (54) | | (81) | | (149) | |
| Installation torque Grout-filled CMU | $T_{inst,CMU}$ | ft-lb | 15 | | 25 | | 35 | | 50 | |
| | | (Nm) | (20) | | (34) | | (47) | | (68) | |

1 Effective embedment, $h_{ef}$ = 1-1/2-in. not applicable for grout-filled CMU base material.

**Figure 1 — Hilti KB1 setting information for installation in concrete and grout-filled (CMU)**



# DESIGN INFORMATION IN CONCRETE PER ACI 318

### ACI 318 Chapter 17 Design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of IAPMO UES ER-678 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables refer to section 3.1.8 of the North American Product Technical Guide: Volume 2: Anchor Fastening Technical Guide, Edition 19 (PTG 19). Data tables from ER-678 are not contained in this section but can be found at www.uniform-es.org or at www.hilti.com.

### Table 2 — Hilti KB1 design strength based on concrete failure modes in uncracked concrete [1,2,3,4]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension (lesser of concrete breakout / pullout) - $\Phi N_n$ | | | | Shear (lesser of concrete breakout or pryout) - $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 3/8 | 1-1/2 (38) | 1-7/8 (48) | 1,435 (6.4) | 1,570 (7.0) | 1,815 (8.1) | 2,220 (9.9) | 1,545 (6.9) | 1,690 (7.5) | 1,950 (8.7) | 2,390 (10.6) |
| | 2 (51) | 2-3/8 (60) | 2,070 (9.2) | 2,130 (9.5) | 2,230 (9.9) | 2,380 (10.6) | 2,375 (10.6) | 2,605 (11.6) | 3,005 (13.4) | 3,680 (16.4) |
| 1/2 | 2 (51) | 2-3/8 (60) | 2,205 (9.8) | 2,415 (10.7) | 2,790 (12.4) | 3,420 (15.2) | 2,375 (10.6) | 2,605 (11.6) | 3,005 (13.4) | 3,680 (16.4) |
| | 3-1/4 (83) | 3-5/8 (92) | 4,570 (20.3) | 5,005 (22.3) | 5,780 (25.7) | 7,080 (31.5) | 9,845 (43.8) | 10,785 (48.0) | 12,450 (55.4) | 15,250 (67.8) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 3,145 (14.0) | 3,445 (15.3) | 3,980 (17.7) | 4,875 (21.7) | 7,660 (34.1) | 8,395 (37.3) | 9,690 (43.1) | 11,870 (52.8) |
| | 4 (102) | 4-1/2 (114) | 5,875 (26.1) | 6,435 (28.6) | 7,435 (33.1) | 9,105 (40.5) | 13,440 (59.8) | 14,725 (65.5) | 17,000 (75.6) | 20,820 (92.6) |
| 3/4 | 3-1/4 (83) | 4 (102) | 4,570 (20.3) | 5,005 (22.3) | 5,780 (25.7) | 7,080 (31.5) | 9,845 (43.8) | 10,785 (48.0) | 12,450 (55.4) | 15,250 (67.8) |
| | 4-3/4 (121) | 5-1/2 (140) | 8,075 (35.9) | 8,845 (39.3) | 10,215 (45.4) | 12,510 (55.6) | 17,390 (77.4) | 19,050 (84.7) | 22,000 (97.9) | 26,945 (119.9) |

### Table 3 — Hilti KB1 design strength based on concrete failure modes in cracked concrete [1,2,3,4,5]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension (lesser of concrete breakout / pullout) - $\Phi N_n$ | | | | Shear (lesser of concrete breakout or pryout) - $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 3/8 | 1-1/2 (38) | 1-7/8 (48) | 1,015 (4.5) | 1,110 (4.9) | 1,285 (5.7) | 1,570 (7.0) | 1,095 (4.9) | 1,195 (5.3) | 1,385 (6.2) | 1,695 (7.5) |
| | 2 (51) | 2-3/8 (60) | 1,565 (7.0) | 1,710 (7.6) | 1,975 (8.8) | 2,420 (10.8) | 1,685 (7.5) | 1,845 (8.2) | 2,130 (9.5) | 2,605 (11.6) |
| 1/2 | 2 (51) | 2-3/8 (60) | 1,565 (7.0) | 1,710 (7.6) | 1,975 (8.8) | 2,420 (10.8) | 1,685 (7.5) | 1,845 (8.2) | 2,130 (9.5) | 2,605 (11.6) |
| | 3-1/4 (83) | 3-5/8 (92) | 3,235 (14.4) | 3,545 (15.8) | 4,095 (18.2) | 5,015 (22.3) | 6,970 (31.0) | 7,640 (34.0) | 8,820 (39.2) | 10,800 (48.0) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 2,520 (11.2) | 2,760 (12.3) | 3,185 (14.2) | 3,905 (17.4) | 5,425 (24.1) | 5,945 (26.4) | 6,865 (30.5) | 8,405 (37.4) |
| | 4 (102) | 4-1/2 (114) | 4,420 (19.7) | 4,840 (21.5) | 5,590 (24.9) | 6,845 (30.4) | 9,520 (42.3) | 10,430 (46.4) | 12,040 (53.6) | 14,750 (65.6) |
| 3/4 | 3-1/4 (83) | 4 (102) | 3,245 (14.4) | 3,555 (15.8) | 4,105 (18.3) | 5,025 (22.4) | 8,615 (38.3) | 9,435 (42.0) | 10,895 (48.5) | 13,345 (59.4) |
| | 4-3/4 (121) | 5-1/2 (140) | 5,780 (25.7) | 6,335 (28.2) | 7,315 (32.5) | 8,955 (39.8) | 15,220 (67.7) | 16,670 (74.2) | 19,250 (85.6) | 23,575 (104.9) |

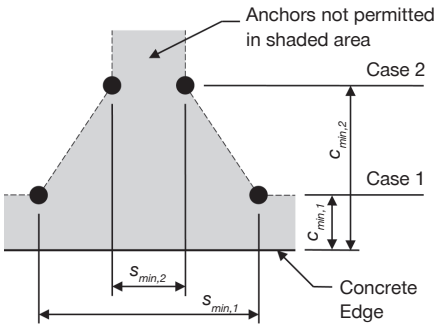
1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 13 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 $h_{ef}$ where $\alpha_{N,seis}$ = 0.67. No reduction needed for seismic shear. See Section 3.1.8 for additional information on seismic applications.

## Table 4 — Hilti KB1 design strength based on steel failure [1,2]

| Nominal anchor diameter in. | Tensile [3] $\Phi N_{sa}$ lb (kN) | Shear [4] $\Phi V_{sa}$ lb (kN) | Seismic Shear [5] $\Phi V_{sa}$ lb (kN) |
|---|---|---|---|
| 3/8 | 4,760 (21.2) | 1,655 (7.4) | 1,655 (7.4) |
| 1/2 | 8,145 (36.2) | 3,395 (15.1) | 3,395 (15.1) |
| 5/8 | 12,875 (57.3) | 5,790 (25.8) | 5,790 (25.8) |
| 3/4 | 18,220 (81.0) | 6,995 (31.1) | 5,950 (26.5) |
| 3/4x12 | 15,790 (70.2) | 6,460 (28.7) | 5,490 (24.4) |

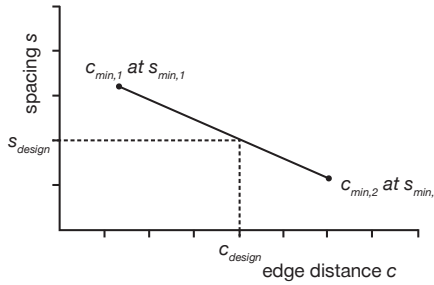
1 See Section 3.1.8 to convert design strength value to ASD value.
2 Hilti KB1 anchors are to be considered ductile steel elements, with the exception of the 3/4x12 KB1 which is a brittle steel element.
3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Ch. 17.
4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
5 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17. See Section 3.1.8 for additional information on seismic applications.

## Figure 2




For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$




3.3.9

## Table 5 — Hilti KB1 installation parameters in concrete [1]

| Setting information | Symbol | Units | Nominal anchor diameter (mm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3/8 | | 1/2 | | 5/8 | | 3/4 | |
| Effective minimum embedment | $h_{ef}$ | in. | 1-1/2 | 2 | 2 | 3-1/4 | 2-3/4 | 4 | 3-1/4 | 4-3/4 |
| | | (mm) | (38) | (51) | (51) | (83) | (70) | (102) | (83) | (121) |
| Minimum concrete thickness | $h_{min}$ | in. | 3-3/8 | 4 | 4 | 6 | 5 | 6 | 5-1/2 | 8 |
| | | (mm) | (83) | (102) | (102) | (152) | (127) | (152) | (140) | (203) |
| Case 1 | $c_{min,1}$ | in. | 8 | 2-1/2 | 4 | 2-3/4 | 5-1/2 | 4-1/4 | 9-1/2 | 4-1/2 |
| | | (mm) | (203) | (64) | (102) | (70) | (140) | (108) | (241) | (114) |
| | for $s_{min,1} \geq$ | in. | 8 | 7 | 8-1/2 | 7 | 8 | 4-1/4 | 5 | 7 |
| | | (mm) | (203) | (178) | (216) | (178) | (203) | (108) | (127) | (178) |
| Case 2 | $c_{min,2}$ | in. | 8 | 6 | 7 | 4 | 8 | 4-1/4 | 9-1/2 | 6-1/2 |
| | | (mm) | (203) | (152) | (178) | (102) | (203) | (108) | (241) | (165) |
| | for $s_{min,2} \geq$ | in. | 8 | 3-1/2 | 5 | 4 | 5-1/2 | 4-1/4 | 5 | 4 |
| | | (mm) | (203) | (89) | (127) | (102) | (140) | (108) | (127) | (102) |

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge distance c, where $c_{min1} < c < c_{min2}$ will determine the permissible spacings.

## Table 6 — Load adjustment factors for 3/8-in. diameter Hilti KB1 in uncracked concrete [1,2]

| 3/8-in. KB1 uncracked concrete | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | Edge distance in shear ∥ To edge $f_{RV}$ | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ in (mm) | | 1-1/2 (38) | 2 (51) | 1-1/2 (38) | 2 (51) | 1-1/2 (38) | 2 (51) | 1-1/2 (38) | 2 (51) | 1-1/2 (38) | 2 (51) | 1-1/2 (38) | 2 (51) |
| Embedment $h_{nom}$ in (mm) | | 1-7/8 (48) | 2-3/8 (60) | 1-7/8 (48) | 2-3/8 (60) | 1-7/8 (48) | 2-3/8 (60) | 1-7/8 (48) | 2-3/8 (60) | 1-7/8 (48) | 2-3/8 (60) | 1-7/8 (48) | 2-3/8 (60) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2-1/2 (64) | n/a | n/a | n/a | 0.52 | n/a | n/a | n/a | 0.35 | n/a | 0.52 | n/a | n/a |
| | 3-3/8 (86) | n/a | n/a | n/a | 0.68 | n/a | n/a | n/a | 0.55 | n/a | 0.68 | 0.53 | n/a |
| | 3-1/2 (89) | n/a | 0.79 | n/a | 0.70 | n/a | 0.62 | n/a | 0.59 | n/a | 0.70 | 0.54 | n/a |
| | 4 (102) | n/a | 0.83 | n/a | 0.80 | n/a | 0.63 | n/a | 0.72 | n/a | 0.80 | 0.58 | 0.73 |
| | 5 (127) | n/a | 0.92 | n/a | 1.00 | n/a | 0.67 | n/a | 1.00 | n/a | 1.00 | 0.65 | 0.82 |
| | 6 (152) | n/a | 1.00 | n/a | 1.00 | n/a | 0.70 | n/a | 1.00 | n/a | 1.00 | 0.71 | 0.89 |
| | 7 (178) | n/a | 1.00 | n/a | | n/a | 0.73 | n/a | | n/a | | 0.76 | 0.97 |
| | 8 (203) | 1.00 | | 1.00 | | 0.67 | 0.77 | 1.00 | | 1.00 | | 0.82 | 1.00 |
| | 9 (229) | | | | | 0.69 | 0.80 | | | | | 0.87 | |
| | 10 (254) | | | | | 0.71 | 0.83 | | | | | 0.91 | |
| | 11 (279) | | | | | 0.73 | 0.87 | | | | | 0.96 | |
| | 12 (305) | | | | | 0.75 | 0.90 | | | | | 1.00 | |
| | > 14 (356) | | | | | 0.79 | 0.97 | | | | | | |

## Table 7 — Load adjustment factors for 3/8-in. diameter Hilti KB1 in cracked concrete [1,2]

| 3/8-in. KB1 cracked concrete | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | Edge distance in shear ∥ To edge $f_{RV}$ | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ in (mm) | | 1-1/2 (38) | 2 (51) | 1-1/2 (38) | 2 (51) | 1-1/2 (38) | 2 (51) | 1-1/2 (38) | 2 (51) | 1-1/2 (38) | 2 (51) | 1-1/2 (38) | 2 (51) |
| Embedment $h_{nom}$ in (mm) | | 1-7/8 (48) | 2-3/8 (60) | 1-7/8 (48) | 2-3/8 (60) | 1-7/8 (48) | 2-3/8 (60) | 1-7/8 (48) | 2-3/8 (60) | 1-7/8 (48) | 2-3/8 (60) | 1-7/8 (48) | 2-3/8 (60) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2-1/2 (64) | n/a | n/a | n/a | 0.87 | n/a | n/a | n/a | 0.49 | n/a | 0.87 | n/a | n/a |
| | 3-3/8 (86) | n/a | n/a | n/a | 1.00 | n/a | n/a | n/a | 0.77 | n/a | 1.00 | 0.85 | n/a |
| | 3-1/2 (89) | n/a | 0.79 | n/a | 1.00 | n/a | 0.65 | n/a | 0.82 | n/a | 1.00 | 0.86 | n/a |
| | 4 (102) | n/a | 0.83 | n/a | 1.00 | n/a | 0.67 | n/a | 1.00 | n/a | 1.00 | 0.92 | 0.82 |
| | 5 (127) | n/a | 0.92 | n/a | 1.00 | n/a | 0.71 | n/a | 1.00 | n/a | 1.00 | 1.00 | 0.91 |
| | 6 (152) | n/a | 1.00 | n/a | 1.00 | n/a | 0.75 | n/a | | n/a | 1.00 | | 1.00 |
| | 7 (178) | n/a | 1.00 | n/a | | n/a | 0.79 | n/a | | n/a | | | |
| | 8 (203) | 1.00 | | 1.00 | | 0.93 | 0.83 | 1.00 | | 1.00 | | | |
| | 9 (229) | | | | | 0.98 | 0.87 | | | | | | |
| | 10 (254) | | | | | 1.00 | 0.92 | | | | | | |
| | 11 (279) | | | | | | 0.96 | | | | | | |
| | 12 (305) | | | | | | 1.00 | | | | | | |
| | > 14 (356) | | | | | | | | | | | | |

1 Linear interpolation not permitted

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.

3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 8 — Load adjustment factors for 1/2-in. diameter Hilti KB1 in uncracked concrete [1,2]

| 1/2-in. KB1 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | Edge distance in shear ∥ To edge $f_{RV}$ | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ in (mm) | | | 2 (51) | 3-1/4 (83) | 2 (51) | 3-1/4 (83) | 2 (51) | 3-1/4 (83) | 2 (51) | 3-1/4 (83) | 2 (51) | 3-1/4 (83) | 2 (51) | 3-1/4 (83) |
| Embedment $h_{nom}$ in (mm) | | | 2-3/8 (60) | 3-5/8 (92) | 2-3/8 (60) | 3-5/8 (92) | 2-3/8 (60) | 3-5/8 (92) | 2-3/8 (60) | 3-5/8 (92) | 2-3/8 (60) | 3-5/8 (92) | 2-3/8 (60) | 3-5/8 (92) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2-3/4 | (70) | n/a | n/a | n/a | 0.33 | n/a | n/a | n/a | 0.14 | n/a | 0.29 | n/a | n/a |
| | 3 | (76) | n/a | n/a | n/a | 0.35 | n/a | n/a | n/a | 0.16 | n/a | 0.33 | n/a | n/a |
| | 3-1/2 | (89) | n/a | n/a | n/a | 0.38 | n/a | n/a | n/a | 0.21 | n/a | 0.38 | n/a | n/a |
| | 4 | (102) | n/a | 0.71 | 0.67 | 0.42 | n/a | 0.57 | 0.54 | 0.25 | 0.67 | 0.42 | 0.67 | n/a |
| | 5 | (127) | 0.92 | 0.76 | 0.83 | 0.50 | 0.64 | 0.58 | 0.76 | 0.35 | 0.83 | 0.50 | 0.75 | n/a |
| | 6 | (152) | 1.00 | 0.81 | 1.00 | 0.60 | 0.67 | 0.60 | 1.00 | 0.46 | 1.00 | 0.60 | 0.82 | 0.63 |
| | 7 | (178) | 1.00 | 0.86 | 1.00 | 0.70 | 0.69 | 0.62 | 1.00 | 0.59 | 1.00 | 0.70 | 0.88 | 0.68 |
| | 8 | (203) | | 0.91 | | 0.80 | 0.72 | 0.63 | | 0.72 | | 0.80 | 0.94 | 0.73 |
| | 8-1/2 | (216) | | 0.94 | | 0.85 | 0.74 | 0.64 | | 0.78 | | 0.85 | 0.97 | 0.75 |
| | 9 | (229) | | 0.96 | | 0.90 | 0.75 | 0.65 | | 0.85 | | 0.90 | 1.00 | 0.77 |
| | 10 | (254) | | 1.00 | | 1.00 | 0.78 | 0.67 | | 1.00 | | 1.00 | | 0.82 |
| | 11 | (279) | | | | | 0.81 | 0.68 | | | | | | 0.86 |
| | 12 | (305) | | | | | 0.83 | 0.70 | | | | | | 0.89 |
| | 14 | (356) | | | | | 0.89 | 0.73 | | | | | | 0.97 |
| | 16 | (406) | | | | | 0.94 | 0.77 | | | | | | 1.00 |
| | 18 | (457) | | | | | 1.00 | 0.80 | | | | | | |
| | 20 | (508) | | | | | | 0.83 | | | | | | |
| | > 24 | (610) | | | | | | 0.90 | | | | | | |

## Table 9 — Load adjustment factors for 1/2-in. diameter Hilti KB1 in cracked concrete [1,2]

| 1/2-in. KB1 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | Edge distance in shear ∥ To edge $f_{RV}$ | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ in (mm) | | | 2 (51) | 3-1/4 (83) | 2 (51) | 3-1/4 (83) | 2 (51) | 3-1/4 (83) | 2 (51) | 3-1/4 (83) | 2 (51) | 3-1/4 (83) | 2 (51) | 3-1/4 (83) |
| Embedment $h_{nom}$ in (mm) | | | 2-3/8 (60) | 3-5/8 (92) | 2-3/8 (60) | 3-5/8 (92) | 2-3/8 (60) | 3-5/8 (92) | 2-3/8 (60) | 3-5/8 (92) | 2-3/8 (60) | 3-5/8 (92) | 2-3/8 (60) | 3-5/8 (92) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 2-3/4 | (70) | n/a | n/a | n/a | 0.68 | n/a | n/a | n/a | 0.16 | n/a | 0.33 | n/a | n/a |
| | 3 | (76) | n/a | n/a | n/a | 0.71 | n/a | n/a | n/a | 0.19 | n/a | 0.38 | n/a | n/a |
| | 3-1/2 | (89) | n/a | n/a | n/a | 0.79 | n/a | n/a | n/a | 0.24 | n/a | 0.47 | n/a | n/a |
| | 4 | (102) | n/a | 0.71 | 1.00 | 0.86 | n/a | 0.57 | 1.00 | 0.29 | 1.00 | 0.58 | 0.84 | n/a |
| | 5 | (127) | 0.92 | 0.76 | 1.00 | 1.00 | 0.72 | 0.59 | 1.00 | 0.40 | 1.00 | 0.81 | 0.94 | n/a |
| | 6 | (152) | 1.00 | 0.81 | 1.00 | | 0.76 | 0.61 | 1.00 | 0.53 | 1.00 | 1.00 | 1.00 | 0.66 |
| | 7 | (178) | 1.00 | 0.86 | 1.00 | | 0.81 | 0.63 | 1.00 | 0.67 | 1.00 | | | 0.71 |
| | 8 | (203) | 1.00 | 0.91 | | | 0.85 | 0.65 | | 0.82 | | | | 0.76 |
| | 8-1/2 | (216) | 1.00 | 0.94 | | | 0.87 | 0.65 | | 0.90 | | | | 0.79 |
| | 9 | (229) | | 0.96 | | | 0.90 | 0.66 | | 0.98 | | | | 0.81 |
| | 10 | (254) | | 1.00 | | | 0.94 | 0.68 | | 1.00 | | | | 0.85 |
| | 11 | (279) | | | | | 0.98 | 0.70 | | | | | | 0.90 |
| | 12 | (305) | | | | | 1.00 | 0.72 | | | | | | 0.94 |
| | 14 | (356) | | | | | | 0.76 | | | | | | 1.00 |
| | 16 | (406) | | | | | | 0.79 | | | | | | |
| | 18 | (457) | | | | | | 0.83 | | | | | | |
| | 20 | (508) | | | | | | 0.86 | | | | | | |
| | > 24 | (610) | | | | | | 0.94 | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 10 — Load adjustment factors for 5/8-in. diameter Hilti KB1 in uncracked concrete [1,2]

| 5/8-in. KB1 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | Edge distance in shear ∥ To edge $f_{RV}$ | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ in (mm) | | | 2-3/4 (70) | 4 (102) | 2-3/4 (70) | 4 (102) | 2-3/4 (70) | 4 (102) | 2-3/4 (70) | 4 (102) | 2-3/4 (70) | 4 (102) | 2-3/4 (70) | 4 (102) |
| Embedment $h_{nom}$ in (mm) | | | 3-1/4 (83) | 4-1/2 (114) | 3-1/4 (83) | 4-1/2 (114) | 3-1/4 (83) | 4-1/2 (114) | 3-1/4 (83) | 4-1/2 (114) | 3-1/4 (83) | 4-1/2 (114) | 3-1/4 (83) | 4-1/2 (114) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 4-1/4 | (108) | n/a | 0.68 | n/a | 0.52 | n/a | 0.57 | n/a | 0.26 | n/a | 0.51 | n/a | n/a |
| | 5 | (127) | n/a | 0.71 | n/a | 0.58 | n/a | 0.58 | n/a | 0.33 | n/a | 0.58 | 0.55 | n/a |
| | 5-1/2 | (140) | 0.83 | 0.73 | 0.50 | 0.62 | 0.58 | 0.59 | 0.35 | 0.38 | 0.50 | 0.62 | 0.58 | n/a |
| | 6 | (152) | 0.86 | 0.75 | 0.55 | 0.67 | 0.59 | 0.59 | 0.40 | 0.43 | 0.55 | 0.67 | 0.60 | 0.62 |
| | 7 | (178) | 0.92 | 0.79 | 0.64 | 0.78 | 0.61 | 0.61 | 0.51 | 0.54 | 0.64 | 0.78 | 0.65 | 0.67 |
| | 8 | (203) | 0.98 | 0.83 | 0.73 | 0.89 | 0.62 | 0.63 | 0.62 | 0.66 | 0.73 | 0.89 | 0.70 | 0.71 |
| | 9 | (229) | 1.00 | 0.88 | 0.82 | 1.00 | 0.64 | 0.64 | 0.74 | 0.79 | 0.82 | 1.00 | 0.74 | 0.75 |
| | 10 | (254) | | 0.92 | 0.91 | | 0.65 | 0.66 | 0.87 | 0.92 | 0.91 | | 0.78 | 0.80 |
| | 12 | (305) | | 1.00 | 1.00 | | 0.68 | 0.69 | 1.00 | 1.00 | 1.00 | | 0.85 | 0.87 |
| | 14 | (356) | | | | | 0.71 | 0.72 | | | | | 0.92 | 0.94 |
| | 16 | (406) | | | | | 0.74 | 0.75 | | | | | 0.98 | 1.00 |
| | 18 | (457) | | | | | 0.77 | 0.78 | | | | | 1.00 | |
| | 20 | (508) | | | | | 0.80 | 0.82 | | | | | | |
| | 24 | (610) | | | | | 0.86 | 0.88 | | | | | | |
| | > 30 | (762) | | | | | 0.95 | 0.97 | | | | | | |

## Table 11 — Load adjustment factors for 5/8-in. diameter Hilti KB1 in cracked concrete [1,2]

| 5/8-in. KB1 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | Edge distance in shear ∥ To edge $f_{RV}$ | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ in (mm) | | | 2-3/4 (70) | 4 (102) | 2-3/4 (70) | 4 (102) | 2-3/4 (70) | 4 (102) | 2-3/4 (70) | 4 (102) | 2-3/4 (70) | 4 (102) | 2-3/4 (70) | 4 (102) |
| Embedment $h_{nom}$ in (mm) | | | 3-1/4 (83) | 4-1/2 (114) | 3-1/4 (83) | 4-1/2 (114) | 3-1/4 (83) | 4-1/2 (114) | 3-1/4 (83) | 4-1/2 (114) | 3-1/4 (83) | 4-1/2 (114) | 3-1/4 (83) | 4-1/2 (114) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 4-1/4 | (108) | n/a | 0.68 | n/a | 0.78 | n/a | 0.57 | n/a | 0.26 | n/a | 0.52 | n/a | n/a |
| | 5 | (127) | n/a | 0.71 | n/a | 0.87 | n/a | 0.58 | n/a | 0.33 | n/a | 0.66 | 0.66 | n/a |
| | 5-1/2 | (140) | 0.83 | 0.73 | 1.00 | 0.93 | 0.62 | 0.59 | 0.62 | 0.38 | 1.00 | 0.76 | 0.70 | n/a |
| | 6 | (152) | 0.86 | 0.75 | 1.00 | 1.00 | 0.63 | 0.60 | 0.71 | 0.43 | 1.00 | 0.87 | 0.73 | 0.62 |
| | 7 | (178) | 0.92 | 0.79 | 1.00 | | 0.65 | 0.61 | 0.89 | 0.55 | 1.00 | 1.00 | 0.79 | 0.67 |
| | 8 | (203) | 0.98 | 0.83 | 1.00 | | 0.68 | 0.63 | 1.00 | 0.67 | 1.00 | | 0.84 | 0.71 |
| | 9 | (229) | 1.00 | 0.88 | | | 0.70 | 0.64 | | 0.80 | | | 0.89 | 0.76 |
| | 10 | (254) | | 0.92 | | | 0.72 | 0.66 | | 0.93 | | | 0.94 | 0.80 |
| | 12 | (305) | | 1.00 | | | 0.76 | 0.69 | | 1.00 | | | 1.00 | 0.87 |
| | 14 | (356) | | | | | 0.81 | 0.72 | | | | | | 0.94 |
| | 16 | (406) | | | | | 0.85 | 0.75 | | | | | | 1.00 |
| | 18 | (457) | | | | | 0.90 | 0.79 | | | | | | |
| | 20 | (508) | | | | | 0.94 | 0.82 | | | | | | |
| | 24 | (610) | | | | | 1.00 | 0.88 | | | | | | |
| | > 30 | (762) | | | | | | 0.98 | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 12 — Load adjustment factors for 3/4-in. diameter Hilti KB1 in uncracked concrete [1,2]

| 3/4-in. KB1 uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | Edge distance in shear ∥ To edge $f_{RV}$ | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ in (mm) | | | 3-1/4 (83) | 4-3/4 (121) | 3-1/4 (83) | 4-3/4 (121) | 3-1/4 (83) | 4-3/4 (121) | 3-1/4 (83) | 4-3/4 (121) | 3-1/4 (83) | 4-3/4 (121) | 3-1/4 (83) | 4-3/4 (121) |
| Embedment $h_{nom}$ in (mm) | | | 4 (102) | 5-1/2 (140) | 4 (102) | 5-1/2 (140) | 4 (102) | 5-1/2 (140) | 4 (102) | 5-1/2 (140) | 4 (102) | 5-1/2 (140) | 4 (102) | 5-1/2 (140) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 4 | (102) | n/a | 0.64 | n/a | n/a | n/a | 0.56 | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4-1/2 | (114) | n/a | 0.66 | n/a | 0.47 | n/a | 0.56 | n/a | 0.24 | n/a | 0.47 | n/a | n/a |
| | 5 | (127) | 0.76 | 0.68 | n/a | 0.50 | 0.57 | 0.57 | n/a | 0.28 | n/a | 0.50 | n/a | n/a |
| | 5-1/2 | (140) | 0.78 | 0.69 | n/a | 0.53 | 0.58 | 0.58 | n/a | 0.32 | n/a | 0.53 | 0.55 | n/a |
| | 6-1/2 | (165) | 0.83 | 0.73 | n/a | 0.60 | 0.59 | 0.59 | n/a | 0.41 | n/a | 0.60 | 0.60 | n/a |
| | 7 | (178) | 0.86 | 0.75 | n/a | 0.64 | 0.60 | 0.60 | n/a | 0.46 | n/a | 0.64 | 0.62 | n/a |
| | 8 | (203) | 0.91 | 0.78 | n/a | 0.73 | 0.61 | 0.61 | n/a | 0.56 | n/a | 0.73 | 0.67 | 0.67 |
| | 9-1/2 | (241) | 0.99 | 0.83 | 0.79 | 0.86 | 0.63 | 0.63 | 0.70 | 0.72 | 0.79 | 0.86 | 0.73 | 0.73 |
| | 10 | (254) | 1.00 | 0.85 | 0.83 | 0.91 | 0.64 | 0.64 | 0.76 | 0.78 | 0.83 | 0.91 | 0.75 | 0.75 |
| | 12 | (305) | | 0.92 | 1.00 | 1.00 | 0.67 | 0.67 | 1.00 | 1.00 | 1.00 | 1.00 | 0.82 | 0.82 |
| | 16 | (406) | | 1.00 | | | 0.72 | 0.73 | | | | | 0.94 | 0.95 |
| | 20 | (508) | | | | | 0.78 | 0.78 | | | | | 1.00 | 1.00 |
| | 24 | (610) | | | | | 0.83 | 0.84 | | | | | | |
| | 30 | (762) | | | | | 0.92 | 0.92 | | | | | | |
| | > 36 | (914) | | | | | 1.00 | 1.00 | | | | | | |

## Table 13 — Load adjustment factors for 3/4-in. diameter Hilti KB1 in cracked concrete [1,2]

| 3/4-in. KB1 cracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear [3] $f_{AV}$ | | Edge distance in shear ⊥ Toward edge $f_{RV}$ | | Edge distance in shear ∥ To edge $f_{RV}$ | | Concrete thickness factor in shear [4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{ef}$ in (mm) | | | 3-1/4 (83) | 4-3/4 (121) | 3-1/4 (83) | 4-3/4 (121) | 3-1/4 (83) | 4-3/4 (121) | 3-1/4 (83) | 4-3/4 (121) | 3-1/4 (83) | 4-3/4 (121) | 3-1/4 (83) | 4-3/4 (121) |
| Embedment $h_{nom}$ in (mm) | | | 4 (102) | 5-1/2 (140) | 4 (102) | 5-1/2 (140) | 4 (102) | 5-1/2 (140) | 4 (102) | 5-1/2 (140) | 4 (102) | 5-1/2 (140) | 4 (102) | 5-1/2 (140) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 4 | (102) | n/a | 0.64 | n/a | n/a | n/a | 0.55 | n/a | n/a | n/a | n/a | n/a | n/a |
| | 4-1/2 | (114) | n/a | 0.66 | n/a | 0.73 | n/a | 0.56 | n/a | 0.19 | n/a | 0.39 | n/a | n/a |
| | 5 | (127) | 0.76 | 0.68 | n/a | 0.77 | 0.59 | 0.56 | n/a | 0.23 | n/a | 0.45 | n/a | n/a |
| | 5-1/2 | (140) | 0.78 | 0.69 | n/a | 0.83 | 0.59 | 0.57 | n/a | 0.26 | n/a | 0.52 | 0.61 | n/a |
| | 6-1/2 | (165) | 0.83 | 0.73 | n/a | 0.93 | 0.61 | 0.58 | n/a | 0.33 | n/a | 0.67 | 0.67 | n/a |
| | 7 | (178) | 0.86 | 0.75 | n/a | 0.99 | 0.62 | 0.59 | n/a | 0.37 | n/a | 0.75 | 0.69 | n/a |
| | 8 | (203) | 0.91 | 0.78 | n/a | 1.00 | 0.64 | 0.60 | n/a | 0.46 | n/a | 0.91 | 0.74 | 0.63 |
| | 9-1/2 | (241) | 0.99 | 0.83 | 1.00 | | 0.66 | 0.62 | 0.97 | 0.59 | 1.00 | 1.00 | 0.81 | 0.69 |
| | 10 | (254) | 1.00 | 0.85 | | | 0.67 | 0.62 | 1.00 | 0.64 | | | 0.83 | 0.70 |
| | 12 | (305) | | 0.92 | | | 0.71 | 0.65 | | 0.84 | | | 0.91 | 0.77 |
| | 16 | (406) | | 1.00 | | | 0.77 | 0.70 | | 1.00 | | | 1.00 | 0.89 |
| | 20 | (508) | | | | | 0.84 | 0.75 | | | | | | 0.99 |
| | 24 | (610) | | | | | 0.91 | 0.80 | | | | | | 1.00 |
| | 30 | (762) | | | | | 1.00 | 0.87 | | | | | | |
| | > 36 | (914) | | | | | | 0.94 | | | | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering Design software or perform anchor calculation using design equations from ACI 318 Ch. 17 or CSA A23.3 Annex D.
3 Spacing factor reduction in shear, $f_{AV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, is applicable when edge distance $c < 3h_{ef}$. If $c \geq 3h_{ef}$ then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with Figure 2 and Table 5 to calculate permissible edge distance, spacing and concrete thickness combinations.

## Table 14 — Hilti KB1 design strength in the soffit of uncracked lightweight concrete over metal deck [1,2,3,4,5,6]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Installation per Figure 3 | | | | Installation per Figure 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tension - $\Phi N_n$ | | Shear - $\Phi V_n$ | | Tension - $\Phi N_n$ | | Shear - $\Phi V_n$ |
| | | | Min. conc. thickness [10] in. (mm) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c \geq$ 3,000 psi (20.7 MPa) lb (kN) | Min. conc. thickness [10] in. (mm) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c \geq$ 3,000 psi (20.7 MPa) lb (kN) |
| 3/8 | 1-1/2 (38) | 1-7/8 (48) | 2-1/2 (64) | 1,025 (4.6) | 1,185 (5.3) | 645 (2.9) | n/a | n/a | n/a | n/a |
| | 2 (51) | 2-3/8 (60) | 2-1/2 (64) | 1,600 (7.1) | 1,850 (8.2) | 1,435 (6.4) | 2-1/2 (64) | 1,265 (5.6) | 1,460 (6.5) | 1,815 (8.1) |
| 1/2 | 2 (51) | 2-3/8 (60) | 2-1/2 (64) | 1,495 (6.7) | 1,725 (7.7) | 1,480 (6.6) | 2-1/2 (64) | 1,355 (6.0) | 1,565 (7.0) | 2,015 (9.0) |
| | 3-1/4 (83) | 3-5/8 (92) | 2-1/2 (64) | 2,725 (12.1) | 3,145 (14.0) | 2,355 (10.5) | 3-1/4 (83) | 1,920 (8.5) | 2,215 (9.9) | 3,105 (13.8) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 2-1/2 (64) | 2,410 (10.7) | 2,785 (12.4) | 2,275 (10.1) | 3-1/4 (83) | 1,505 (6.7) | 1,740 (7.7) | 2,595 (11.5) |
| | 4 (102) | 4-1/2 (114) | 2-1/2 (64) | 3,300 (14.7) | 3,810 (16.9) | 3,080 (13.7) | n/a | n/a | n/a | n/a |
| 3/4 | 3-1/4 (83) | 4 (102) | 2-1/2 (64) | 2,285 (10.2) | 2,640 (11.7) | 3,030 [9] (13.5) [9] | n/a | n/a | n/a | n/a |

## Table 15 — Hilti KB1 design strength in the soffit of cracked lightweight concrete over metal deck [1,2,3,4,5,6,7]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Installation per Figure 3 | | | | Installation per Figure 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tension - $\Phi N_n$ | | Shear - $\Phi V_n$ | | Tension - $\Phi N_n$ | | Shear - $\Phi V_n$ |
| | | | Min. conc. thickness [10] in. (mm) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c \geq$ 3,000 psi (20.7 MPa) lb (kN) | Min. conc. thickness [10] in. (mm) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c \geq$ 3,000 psi (20.7 MPa) lb (kN) |
| 3/8 | 1-1/2 (38) | 1-7/8 (48) | 2-1/2 (64) | 725 (3.2) | 835 (3.7) | 645 (2.9) | n/a | n/a | n/a | n/a |
| | 2 (51) | 2-3/8 (60) | 2-1/2 (64) | 1,210 (5.4) | 1,395 (6.2) | 1,435 (6.4) | 2-1/2 (64) | 955 (4.2) | 1,105 (4.9) | 1,815 (8.1) |
| 1/2 | 2 (51) | 2-3/8 (60) | 2-1/2 (64) | 1,060 (4.7) | 1,225 (5.4) | 1,480 (6.6) | 2-1/2 (64) | 960 (4.3) | 1,110 (4.9) | 2,015 (9.0) |
| | 3-1/4 (83) | 3-5/8 (92) | 2-1/2 (64) | 1,930 (8.6) | 2,230 (9.9) | 2,355 (10.5) | 3-1/4 (83) | 1,360 (6.0) | 1,570 (7.0) | 3,105 (13.8) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 2-1/2 (64) | 1,930 (8.6) | 2,230 (9.9) | 2,275 (10.1) | 3-1/4 (83) | 1,205 (5.4) | 1,390 (6.2) | 2,595 (11.5) |
| | 4 (102) | 4-1/2 (114) | 2-1/2 (64) | 2,480 (11.0) | 2,865 (12.7) | 3,080 (13.7) | n/a | n/a | n/a | n/a |
| 3/4 | 3-1/4 (83) | 4 (102) | 2-1/2 (64) | 2,000 (8.9) | 2,310 (10.3) | 3,030 [8,9] (13.5) [8,9] | n/a | n/a | n/a | n/a |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are lightweight concrete and no additional reduction factor for lightweight concrete is needed.
5 Minimum edge distance is 3 x $h_{ef}$ (effective embedment).
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 $h_{ef}$ where $\alpha_{N,seis}$ = 0.67. See PTG 19 Section 3.1.8 for additional information on seismic applications.
8 For the 3/4-inch diameter anchor, an additional factor for seismic shear, $\alpha_{N,seis}$ = 0.85, must be applied to the cracked concrete tabular values for seismic conditions. See Section 3.1.8 for additional information on seismic applications.
9 For the 3/4x12 KB1, multiply tabular value by 0.92.
10 Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 3 and 4.

**Figure 3 — Installation in the soffit of concrete over metal deck floor and roof assemblies – W deck**

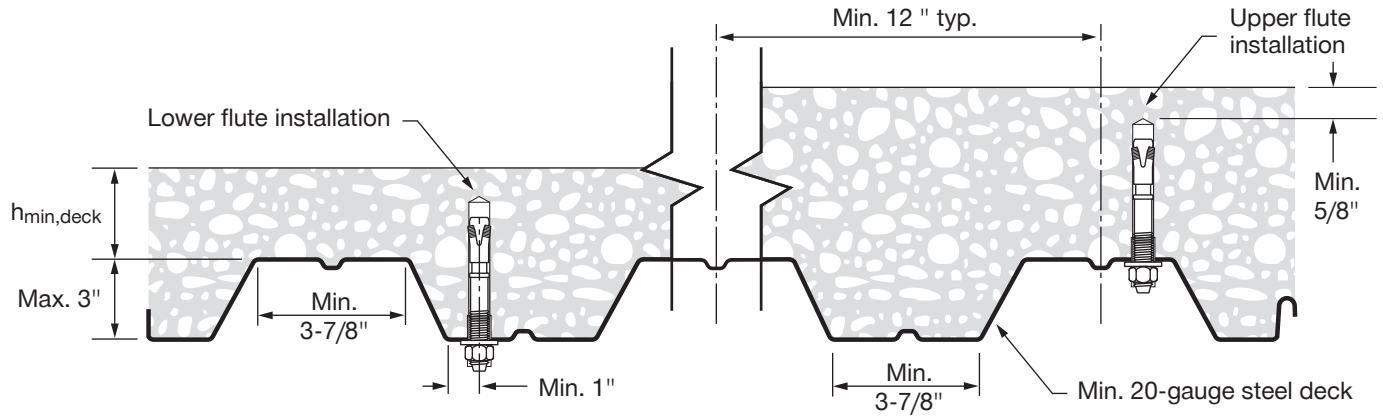
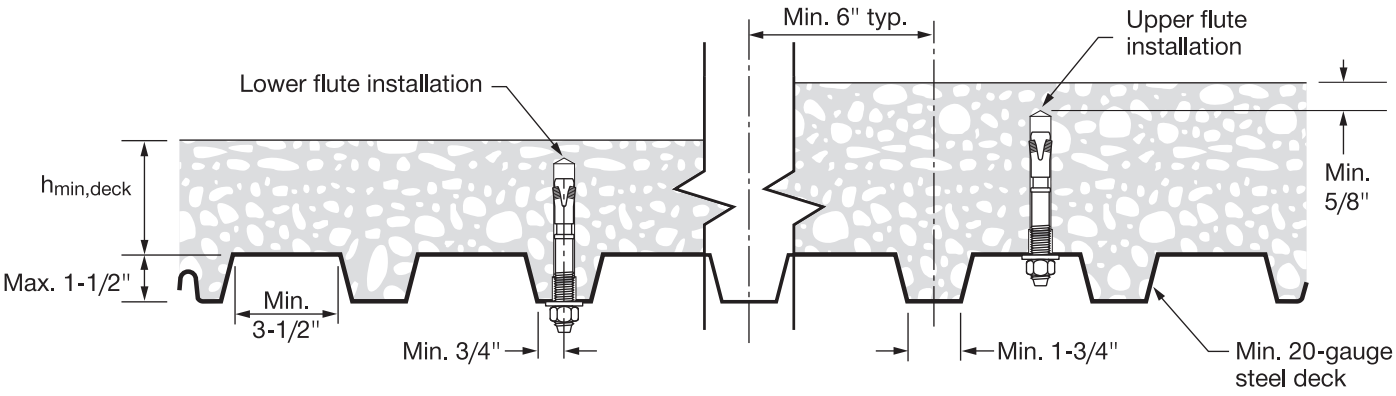



**Figure 4 — Installation in the soffit of concrete over metal deck floor and roof assemblies – B deck**



# DESIGN DATA IN CONCRETE PER CSA A23.3

### CSA A23.3 Annex D Design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. Table 19 in this section contains the Limit State Design tables that are based on the published loads in IAPMO Evaluation Report ER 678 and converted for use with CSA A23.3 Annex D. Tables 16 to 18 and Tables 21 and 22 below are Hilti Simplified Design Tables which are pre-factored resistance tables based on the design parameters and variables in Table 19. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363 4458 or at www.hilti.ca.

### Table 16 — Hilti KB1 factored resistance based on concrete failure modes in uncracked concrete [1,2,3,4]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 1-1/2 (38) | 1-7/8 (48) | 1,535 (6.8) | 1,720 (7.6) | 1,880 (8.4) | 2,175 (9.7) | 1,535 (6.8) | 1,720 (7.6) | 1,880 (8.4) | 2,175 (9.7) |
| | 2 (51) | 2-1/2 (64) | 2,125 (9.5) | 2,200 (9.8) | 2,265 (10.1) | 2,375 (10.6) | 2,365 (10.5) | 2,645 (11.8) | 2,900 (12.9) | 3,345 (14.9) |
| 1/2 | 2 (51) | 2-1/2 (64) | 2,380 (10.6) | 2,660 (11.8) | 2,915 (13.0) | 3,365 (15.0) | 2,380 (10.6) | 2,660 (11.8) | 2,915 (13.0) | 3,365 (15.0) |
| | 3-1/4 (83) | 3-5/8 (92) | 4,940 (22.0) | 5,525 (24.6) | 6,050 (26.9) | 6,990 (31.1) | 9,885 (44.0) | 11,050 (49.2) | 12,105 (53.8) | 13,975 (62.2) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 3,385 (15.1) | 3,785 (16.8) | 4,145 (18.4) | 4,785 (21.3) | 7,655 (34.0) | 8,560 (38.1) | 9,375 (41.7) | 10,825 (48.2) |
| | 4 (102) | 4-1/2 (114) | 6,330 (28.2) | 7,075 (31.5) | 7,750 (34.5) | 8,950 (39.8) | 13,465 (59.9) | 15,055 (67.0) | 16,490 (73.4) | 19,040 (84.7) |
| 3/4 | 3-1/4 (83) | 4 (102) | 4,940 (22.0) | 5,525 (24.6) | 6,050 (26.9) | 6,990 (31.1) | 9,885 (44.0) | 11,050 (49.2) | 12,105 (53.8) | 13,975 (62.2) |
| | 4-3/4 (121) | 5-1/2 (140) | 8,700 (38.7) | 9,725 (43.3) | 10,655 (47.4) | 12,300 (54.7) | 17,395 (77.4) | 19,450 (86.5) | 21,305 (94.8) | 24,600 (109.4) |

### Table 17 — Hilti KB1 factored resistance based on concrete failure modes in cracked concrete [1,2,3,4,5]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 1-1/2 (38) | 1-7/8 (48) | 1,090 (4.9) | 1,220 (5.4) | 1,335 (5.9) | 1,545 (6.9) | 1,090 (4.9) | 1,220 (5.4) | 1,335 (5.9) | 1,545 (6.9) |
| | 2 (51) | 2-1/2 (64) | 1,680 (7.5) | 1,880 (8.4) | 2,060 (9.2) | 2,375 (10.6) | 1,680 (7.5) | 1,880 (8.4) | 2,060 (9.2) | 2,375 (10.6) |
| 1/2 | 2 (51) | 2-1/2 (64) | 1,690 (7.5) | 1,890 (8.4) | 2,070 (9.2) | 2,390 (10.6) | 1,690 (7.5) | 1,890 (8.4) | 2,070 (9.2) | 2,390 (10.6) |
| | 3-1/4 (83) | 3-5/8 (92) | 3,510 (15.6) | 3,925 (17.4) | 4,295 (19.1) | 4,960 (22.1) | 7,015 (31.2) | 7,845 (34.9) | 8,595 (38.2) | 9,925 (44.1) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 2,715 (12.1) | 3,040 (13.5) | 3,330 (14.8) | 3,845 (17.1) | 5,435 (24.2) | 6,075 (27.0) | 6,655 (29.6) | 7,685 (34.2) |
| | 4 (102) | 4-1/2 (114) | 4,780 (21.3) | 5,345 (23.8) | 5,855 (26.0) | 6,760 (30.1) | 9,560 (42.5) | 10,690 (47.5) | 11,710 (52.1) | 13,520 (60.1) |
| 3/4 | 3-1/4 (83) | 4 (102) | 3,495 (15.5) | 3,905 (17.4) | 4,280 (19.0) | 4,945 (22.0) | 8,695 (38.7) | 9,725 (43.3) | 10,650 (47.4) | 12,300 (54.7) |
| | 4-3/4 (121) | 5-1/2 (140) | 6,235 (27.7) | 6,970 (31.0) | 7,635 (34.0) | 8,815 (39.2) | 15,310 (68.1) | 17,115 (76.1) | 18,750 (83.4) | 21,650 (96.3) |

1 See PTG 19 Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 6 to 13 as necessary. Compare to the steel values in table 18. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 $h_{ef}$ where $\alpha_{N,seis}$ = 0.67. No reduction needed for seismic shear. See PTG 19 Section 3.1.8 for additional information on seismic applications

## Table 18 — Steel resistance for Hilti KB1 carbon steel anchors[1,2]

| Anchor diameter in. | Tensile [3] $N_{sar}$ lb (kN) | Shear [4] $V_{sar}$ lb (kN) | Seismic Shear [5] $V_{sar,eq}$ lb (kN) |
|---|---|---|---|
| 3/8 | 4,315 (19.2) | 1,620 (7.2) | 1,620 (7.2) |
| 1/2 | 7,385 (32.8) | 3,330 (14.8) | 3,330 (14.8) |
| 5/8 | 11,670 (51.9) | 5,675 (25.2) | 5,675 (25.2) |
| 3/4 | 16,520 (73.5) | 6,865 (30.5) | 5,835 (26.0) |
| 3/4x12 | 14,455 (64.3) | 5,950 (26.5) | 5,055 (22.5) |

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Hilti KB1 anchors are to be considered ductile steel elements, with the exception of the 3/4x12 KB1 which is a brittle steel element.
3 Tensile $N_{sar}$ = Ase,N $\phi_s$ $f_{uta}$ R as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with $V_{sar} < 0.6\ _{Ase,V}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
5 Seismic shear values determined by seismic shear tests with $V_{sar,eq} \leq 0.60\ A_{se,V}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
See Section 3.1.8 for additional information on seismic applications.

## Table 19 — Hilti KB1 carbon steel design information in concrete in accordance with CSA A23.3 Annex D [1]

| Design parameter | Symbol | Units | 3/8 | | 1/2 | | 5/8 | | 3/4 | | Ref A23.3-04 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Anchor O.D. | $d_a$ | in. (mm) | 0.375 (9.5) | | 0.5 (12.7) | | 0.625 (15.9) | | 0.75 (19.1) | | |
| Effective min. embedment [2] | $h_{ef}$ | in. (mm) | 1-1/2 (38) | 2 (51) | 2 (51) | 3-1/4 (83) | 2-3/4 (70) | 4 (102) | 3-1/4 (83) | 4-3/4 (121) | |
| Min. concrete thickness | $h_{min}$ | in. (mm) | See Table 5 | | | | | | | | |
| Minimum edge distance | $c_{min}$ | in. (mm) | See Table 5 | | | | | | | | |
| Minimum anchor spacing | $s_{min}$ | in. (mm) | See Table 5 | | | | | | | | |
| Min. specified yield strength | $f_{ya}$ | psi ($N/mm^2$) | 95,100 (656) | | 84,700 (584) | | 83,500 (576) | | 81,200 (560) | | |
| Min. specified ult. strength | $f_{ut}$ | psi ($N/mm^2$) | 118,900 (820) | | 105,900 (730) | | 104,400 (720) | | 101,500 (700) | | |
| Effective tensile stress area | $A_{se,N}$ | $in^2$ ($mm^2$) | 0.053 (34) | | 0.103 (66) | | 0.164 (106) | | 0.239 (154) | | |
| Steel embed. material resistance factor for reinforcement | $\Phi_s$ | - | 0.85 | | 0.85 | | 0.85 | | 0.85 | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes [3] | R | - | 0.80 | | 0.80 | | 0.80 | | 0.80 [4] | | D.5.3 |
| Resistance modification factor for shear, steel failure modes [3] | R | - | 0.75 | | 0.75 | | 0.75 | | 0.75 [4] | | D.5.3 |
| Factored steel resistance in tension | $N_{sar}$ | lb (kN) | 4,315 (19.2) | | 7,385 (32.8) | | 11,670 (51.9) | | 16,520 [4] (73.5) | | D.6.1.2 |
| Factored steel resistance in shear | $V_{sar}$ | lb (kN) | 1,620 (7.2) | | 3,330 (14.8) | | 5,675 (25.2) | | 6,865 [4] (30.5) | | D.7.1.2 |
| Factored steel resistance in shear, seismic | $V_{sar,eq}$ | lb (kN) | 1,620 (7.2) | | 3,330 (14.8) | | 5,675 (25.2) | | 5,835 [4] (26.0) | | |
| Critical edge distance | $c_{ac}$ | in. (mm) | 8 (203) | 5 (127) | 6 (152) | 10 (254) | 11 (279) | 9 (229) | 12 (305) | 11 (279) | |
| Coeff. for factored conc. breakout resistance, uncracked concrete | $k_{c,uncr}$ | - | 10.0 | | 10.0 | | 10.0 | | 10.0 | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete | $k_{c,cr}$ | - | 7.1 | | 7.1 | | 7.1 | | 8.8 | | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked conc. [5] | $y_{c,N}$ | - | 1.0 | | 1.0 | | 1.0 | | 1.0 | | D.6.2.6 |
| Anchor category | - | - | 1 | | 1 | | 1 | | 1 | | D.5.3 (c ) |
| Concrete material resistance factor | $\Phi_c$ | - | 0.65 | | 0.65 | | 0.65 | | 0.65 | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B [6] | R | - | 1.00 | | 1.00 | | 1.00 | | 1.00 | | D.5.3 (c ) |
| Factored pullout resistance in 20 MPa uncracked concrete [7] | $N_{pr,uncr}$ | lb (kN) | n/a | 2,190 (9.7) | n/a | n/a | 3,390 (15.1) | 6,335 (28.2) | n/a | n/a | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete [7] | $N_{pr,cr}$ | lb (kN) | n/a | n/a | n/a | n/a | n/a | n/a | 3,500 (15.6) | 6,235 (27.7) | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete, seismic [7] | $N_{pr,eq}$ | lb (kN) | n/a | n/a | n/a | 3,335 (14.8) | n/a | n/a | 3,500 (15.6) | 5,605 (24.9) | D.6.3.2 |

1 Design information in this table is taken from IAPMO ER-678, dated December 1, 2020,Tables 4 and 5, and converted for use with CSA A23.3 Annex D.
2 See Figure 1 of this document.
3 The KB1 is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2, with the exception of the 3/4x12 KB1 which is considered a brittle steel element with R = 0.70 for steel failure in tension and R = 0.65 for steel failure in shear.
4 For the 3/4x12 KB1, R = 0.70 for steel failure in tension and R = 0.65 for steel failure in shear. Multiply factored steel resistance in tension, $N_{sar}$, by 0.875, and multiply factored steel resistance in shear, $V_{sar}$, and seismic shear, $V_{sar,eq}$, by 0.87.
5 For all design cases, $\Psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
6 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
7 For all design cases, $\Psi_{c,P}$ = 1.0. Tabular value for pullout strength is for a concrete compressive strength of 2,900 psi (20.0 MPa). Pullout strength for concrete compressive strength greater than 2,900 psi (20.2 MPa) may be increased by multiplying the tabular pullout strength by $(f'_c / 2{,}900)^n$ for psi, or $(f'_c / 20.2)^n$ for MPa, where n is as follows:
3/8-in. diameter: n = 0.16
1/2-in. diameter: n = 0.23
5/8-in and 3/4-in diameter: n = 0.50
NA (not applicable) denotes that pullout strength does not need to be considered for design.

## Table 20 — Hilti KB1 factored resistance in the soffit of uncracked lightweight concrete over metal deck [1,2,3,4,5,6]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Installation per Figure 3 | | | | Installation per Figure 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tension - $N_r$ | | Shear - $V_r$ | | Tension - $N_r$ | | Shear - $V_r$ |
| | | | Min. conc. thickness [10] in. (mm) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN)" | $f'_c \geq$ 20 MPa (2,900 psi) lb (kN) | Min. conc. thickness [10] in. (mm) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN)" | $f'_c \geq$ 20 MPa (2,900 psi) lb (kN) |
| 3/8 | 1-1/2 (38) | 1-7/8 (48) | 2-1/2 (64) | 860 (3.8) | 1,000 (4.4) | 635 (2.8) | n/a | n/a | n/a | n/a |
| | 2 (51) | 2-3/8 (60) | 2-1/2 (64) | 1,580 (7.0) | 1,845 (8.2) | 1,405 (6.2) | 2-1/2 (64) | 1,250 (5.6) | 2,130 (9.5) | 1,815 (8.1) |
| 1/2 | 2 (51) | 2-3/8 (60) | 2-1/2 (64) | 1,485 (6.6) | 1,630 (7.3) | 1,455 (6.5) | 2-1/2 (64) | 1,345 (6.0) | 1,830 (8.1) | 1,650 (7.3) |
| | 3-1/4 (83) | 3-5/8 (92) | 2-1/2 (64) | 2,705 (12.0) | 2,970 (13.2) | 2,310 (10.3) | 3-1/4 (83) | 1,905 (8.5) | 2,795 (12.4) | 2,515 (11.2) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 2-1/2 (64) | 2,370 (10.5) | 2,905 (12.9) | 2,230 (9.9) | 3-1/4 (83) | 1,480 (6.6) | 3,685 (16.4) | 3,000 (13.3) |
| | 4 (102) | 4-1/2 (114) | 2-1/2 (64) | 3,245 (14.4) | 3,970 (17.7) | 3,020 (13.4) | n/a | n/a | n/a | n/a |
| 3/4 | 3-1/4 (83) | 4 (102) | 2-1/2 (64) | 2,245 (10.0) | 2,750 (12.2) | 2,970 [9] (13.2) [9] | n/a | n/a | n/a | n/a |

## Table 21 — Hilti KB1 carbon steel factored resistance in the soffit of cracked lightweight concrete over metal deck [1,2,3,4,5,6,7]

| Nominal anchor diameter in. | Effective embedment in. (mm) | Nominal embedment in. (mm) | Installation per Figure 3 | | | | Installation per Figure 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tension - $N_r$ | | Shear - $V_r$ | | Tension - $N_r$ | | Shear - $V_r$ |
| | | | Min. conc. thickness [10] in. (mm) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN)" | $f'_c \geq$ 20 MPa (2,900 psi) lb (kN) | Min. conc. thickness [10] in. (mm) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN)" | $f'_c \geq$ 20 MPa (2,900 psi) lb (kN) |
| 3/8 | 1-1/2 (38) | 1-7/8 (48) | 2-1/2 (64) | 610 (2.7) | 710 (3.2) | 635 (2.8) | n/a | n/a | n/a | n/a |
| | 2 (51) | 2-3/8 (60) | 2-1/2 (64) | 1,195 (5.3) | 1,390 (6.2) | 1,405 (6.2) | 2-1/2 (64) | 945 (4.2) | 1,100 (4.9) | 1,780 (7.9) |
| 1/2 | 2 (51) | 2-3/8 (60) | 2-1/2 (64) | 1,050 (4.7) | 1,155 (5.1) | 1,455 (6.5) | 2-1/2 (64) | 950 (4.2) | 1,045 (4.6) | 1,975 (8.8) |
| | 3-1/4 (83) | 3-5/8 (92) | 2-1/2 (64) | 1,915 (8.5) | 2,105 (9.4) | 2,310 (10.3) | 3-1/4 (83) | 1,350 (6.0) | 1,480 (6.6) | 3,045 (13.5) |
| 5/8 | 2-3/4 (70) | 3-1/4 (83) | 2-1/2 (64) | 1,900 (8.5) | 2,325 (10.3) | 2,230 (9.9) | 3-1/4 (83) | 1,185 (5.3) | 1,450 (6.4) | 2,545 (11.3) |
| | 4 (102) | 4-1/2 (114) | 2-1/2 (64) | 2,440 (10.9) | 2,985 (13.3) | 3,020 (13.4) | n/a | n/a | n/a | n/a |
| 3/4 | 3-1/4 (83) | 4 (102) | 2-1/2 (64) | 1,965 (8.7) | 2,405 (10.7) | 2,970 [8,9] (13.2) [8,9] | n/a | n/a | n/a | n/a |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are lightweight concrete and no additional reduction factor for lightweight concrete is needed.
5 Minimum edge distance is 3 x $h_{ef}$ (effective embedment).
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75, except for 3/4 x 4-3/4 $h_{ef}$ where $\alpha_{N,seis}$ = 0.67. See Section 3.1.8 for additional information on seismic applications.
8 For the 3/4-inch diameter anchor, an additional factor for seismic shear, $\alpha_{V,seis}$ = 0.85, must be applied to the cracked concrete tabular values for seismic conditions. See Section 3.1.8 for additional information on seismic applications.
9 For the 3/4x12 KB1, multiply tabular value by 0.92.
10 Minimum concrete thickness over the upper flute when anchor is installed in the lower flute. See Figure 3 and 4.

## DESIGN DATA IN GROUT-FILLED CMU

The following design information is the allowable load tables for use in grout-filled CMU block walls that are based on the published loads in IAPMO Evaluation Report ER 677. This data is applicable for both the US and Canada.

### Table 22 — Allowable tensile loads for Hilti KB1 in the face of grout-filled concrete masonry unit (CMU) walls [1,3,4,5,6]

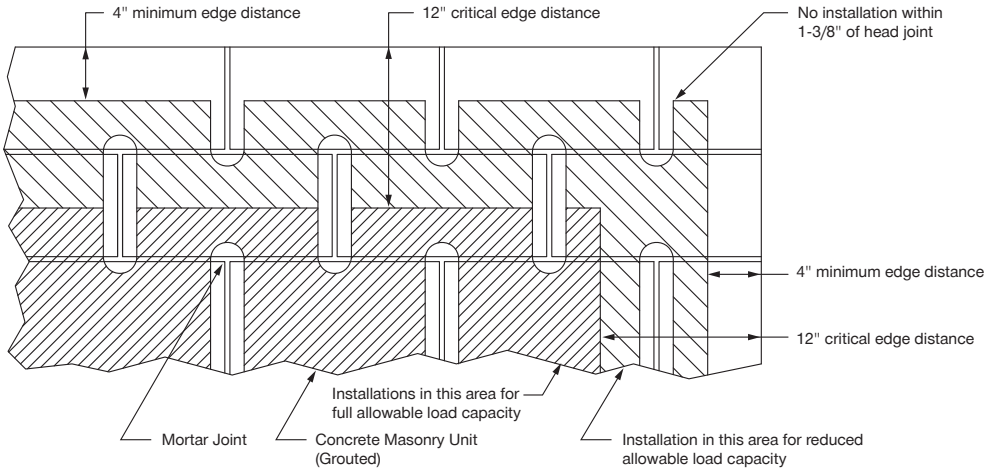
| Nominal anchor diameter | Nominal embedment | | Allowable tension capacity at $s_{cr}$ and $c_{cr}$ | | Spacing | | | Edge Distance | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Critical spacing, $s_{cr}$ | | Minimum spacing, $s_{min}$ [2] | | Load reduction factor at $s_{min}$ | Critical edge distance, $c_{cr}$ | Minimum edge distance, $c_{min}$ | Load reduction factor at $c_{min}$ |
| in. | in. | (mm) | lb | (kN) | in | (mm) | in | (mm) | | in (mm) | in (mm) | |
| 3/8 | 2-3/8 | (60) | 350 | (1.6) | 8 | (203) | 3 | (76) | 0.56 | 12 (305) | 4 (102) | 0.87 |
| 1/2 | 2-3/8 | (60) | 615 | (2.7) | 8 | (203) | 4 | (102) | 0.54 | | | 0.88 |
| | 3-5/8 | (92) | 1,055 | (4.7) | 13 | (330) | | | 0.48 | | | 0.94 |
| 5/8 | 3-1/4 | (83) | 965 | (4.3) | 11 | (279) | 5 | (127) | 0.62 | | | 0.86 |
| | 4-1/2 | (114) | 1,140 | (5.1) | 16 | (406) | | | 0.76 | | | 1.00 |
| 3/4 | 4 | (102) | 1,085 | (4.8) | 13 | (330) | 6 | (152) | 0.55 | | | 0.84 |
| | 5-1/2 | (140) | 1,130 | (5.0) | 19 | (483) | | | 0.69 | | | 0.75 |

### Table 23 — Allowable shear loads for Hilti KB1 in the face of grout-filled concrete masonry unit (CMU) walls [1,3,4,5,6]

| Nominal anchor diameter | Nominal embedment | | Allowable shear capacity at $s_{cr}$ and $c_{cr}$ | | Spacing | | | Edge Distance | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Critical spacing, $s_{cr}$ | | Minimum spacing, $s_{min}$ [2] | | Load reduction factor at $s_{min}$ | Critical edge distance, $c_{cr}$ | Minimum edge distance, $c_{min}$ | Perpendicular load reduction factor at $c_{min}$ | Parallel load reduction factor at $c_{min}$ |
| in. | in. | (mm) | lb | (kN) | in | (mm) | in | (mm) | | in (mm) | in (mm) | | |
| 3/8 | 2-3/8 | (60) | 575 | (2.6) | 8 | (203) | 3 | (76) | 0.84 | 12 (305) | 4 (102) | 0.94 | 0.94 |
| 1/2 | 2-3/8 | (60) | 960 | (4.3) | 8 | (203) | 4 | (102) | | | | 0.72 | 1.00 |
| | 3-5/8 | (92) | | | | | | | | | | | |
| 5/8 | 3-1/4 | (83) | 1,370 | (6.1) | 11 | (279) | 5 | (127) | | | | 0.64 | 0.83 |
| | 4-1/2 | (114) | | | | | | | | | | | |
| 3/4 | 4 | (102) | 1,370 | (6.1) | 13 | (330) | 6 | (152) | | | | 0.64 | 0.83 |
| | 5-1/2 | (140) | | | | | | | | | | | |

1 Values valid for anchors installed in face shells of Type 1, Grade N, lightweight, medium-weight, or normal-weight concrete masonry units conforming to ASTM C90. The masonry units must be fully grouted with coarse grout conforming to the 2018 and 2015 IBC Section 2103.3, or 2012 IBC Section 2103.13. Mortar must comply with 2018 and 2015 IBC Section 2103.2, or 2012 IBC Section 2103.9. Masonry compressive strength must be at least 1,500 psi at the time of anchor installation.
2 Loads tabulated are applicable to anchors spaced a critical distance of 4 times the embedment depth. The anchors may be placed at a minimum spacing, $s_{min}$, provided that reductions are applied to the tabulated values.
3 Anchors must be installed a minimum of 1-3/8 inches from any vertical mortar joint (head joint) in accordance with Figure 5.
4 Embedment depth must be measured from the outside face of the concrete masonry unit.
5 For intermediate edge distances and spacings, allowable loads may be determined by linearly interpolating between the allowable loads at the two tabulated edge distances.
6 The tabulated allowable loads have calculated based on a safety factor of 5.0

### Figure 5 — Acceptable locations (shaded areas) for Hilti KB1 anchors in the face of grout-filled concrete masonry unit (CMU) walls




Anchor installation is restricted to shaded areas

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

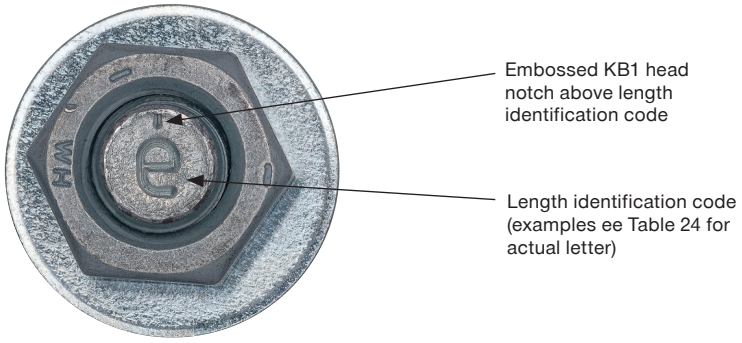
## ORDERING INFORMATION

**Table 24 — Hilti KB1 product portfolio**

| Description | Length (in) | Length ident. letter | Thread length (in) | Nominal embed. 1 (in) | Min. fixture thickness 1 (in) | Max. fixture thickness 1 (in) | Nominal embed. 2 (in) | Min. fixture thickness 2 (in) | Max. fixture thickness 2 (in) | Packaging quantity |
|---|---|---|---|---|---|---|---|---|---|---|
| KB1 3/8x2 1/2 | 2-1/2 | c | 1 | 1-7/8 | 0 | 1/4 | - | - | - | 50 |
| KB1 3/8x3 | 3 | d | 1-5/8 | 1-7/8 | 0 | 3/4 | 2-3/8 | 0 | 1/4 | 50 |
| KB1 3/8x3 3/4 | 3-3/4 | e | 2-3/8 | 1-7/8 | 0 | 1-1/2 | 2-3/8 | 0 | 1 | 50 |
| KB1 3/8x5 | 5 | h | 3-5/8 | 1-7/8 | 0 | 2-3/4 | 2-3/8 | 0 | 2-1/4 | 50 |
| KB1 1/2x3 | 3 | d | 1-1/8 | 2-3/8 | 0 | 1/16 | - | - | - | 20 |
| KB1 1/2x3 3/4 | 3-3/4 | e | 2 | 2-3/8 | 0 | 3/4 | - | - | - | 20 |
| KB1 1/2x4 1/2 | 4-1/2 | g | 2-5/8 | 2-3/8 | 0 | 1-1/2 | 3-5/8 | 0 | 1/4 | 20 |
| KB1 1/2x5 1/2 | 5-1/2 | i | 3-5/8 | 2-3/8 | 0 | 2-1/2 | 3-5/8 | 0 | 1-1/4 | 20 |
| KB1 1/2x7 | 7 | l | 4-1/2 | 2-3/8 | 1/2 | 4 | 3-5/8 | 0 | 2-3/4 | 20 |
| KB1 5/8x4 1/4 | 4-1/4 | f | 2-1/4 | 3-1/4 | 0 | 3/8 | - | - | - | 15 |
| KB1 5/8x4 3/4 | 4-3/4 | g | 2-3/4 | 3-1/4 | 0 | 7/8 | - | - | - | 15 |
| KB1 5/8x6 | 6 | j | 4 | 3-1/4 | 0 | 2-1/8 | 4-1/2 | 0 | 7/8 | 15 |
| KB1 5/8x7 | 7 | l | 5 | 3-1/4 | 0 | 3-1/8 | 4-1/2 | 0 | 1-7/8 | 15 |
| KB1 5/8x8 1/2 | 8-1/2 | o | 6-1/2 | 3-1/4 | 0 | 4-5/8 | 4-1/2 | 0 | 3-3/8 | 15 |
| KB1 3/4x4 3/4 | 4-3/4 | g | 2-1/2 | 4 | 0 | 1/8 | - | - | - | 10 |
| KB1 3/4x5 1/2 | 5-1/2 | i | 3-1/4 | 4 | 0 | 7/8 | - | - | - | 10 |
| KB1 3/4x7 | 7 | l | 4 | 4 | 0 | 2-3/8 | 5-1/2 | 0 | 7/8 | 10 |
| KB1 3/4x8 | 8 | n | 5 | 4 | 0 | 3-3/8 | 5-1/2 | 0 | 1-7/8 | 10 |
| KB1 3/4x10 | 10 | r | 7 | 4 | 0 | 5-3/8 | 5-1/2 | 0 | 3-7/8 | 10 |
| KB1 3/4x12 | 12 | t | 6 | 4 | 2-5/8 | 7-3/8 | 5-1/2 | 1-1/8 | 5-7/8 | 10 |



**Figure 6 — Bolt head with length identification mark and KB1 head notch embossment**

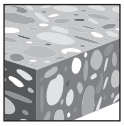


# 3.3.10 KWIK HUS CARBON STEEL SCREW ANCHOR

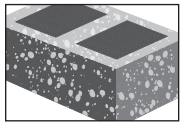
## PRODUCT DESCRIPTION

**KWIK HUS (KH) Carbon Steel Screw Anchor**

| Anchor System | Features and Benefits |
|---|---|
| Carbon Steel KH  | • Quick and easy to install.<br>• Length and diameter identification clearly stamped on head facilitates quality control and inspection after installation.<br>• Through fixture installation improves productivity and accurate installation.<br>• Thread design enables quality setting and exceptional load values in wide variety of base material strengths.<br>• Anchor is fully removable<br>• Anchor size is same as drill bit size and uses standard diameter drill bits.<br>• Suitable for reduced edge distances and spacing.<br>• Suitable for uncracked normal-weight concrete, lightweight concrete |



Uncracked concrete



Grout-filled concrete masonry

## MATERIAL SPECIFICATIONS

Hilti KWIK HUS anchors are manufactured from carbon steel. The anchors are dull zinc plated to a minimum thickness of 8 µm.

# INSTALLATION PARAMETERS

**Figure 1 — Hilti KWIK HUS anchor installation details**

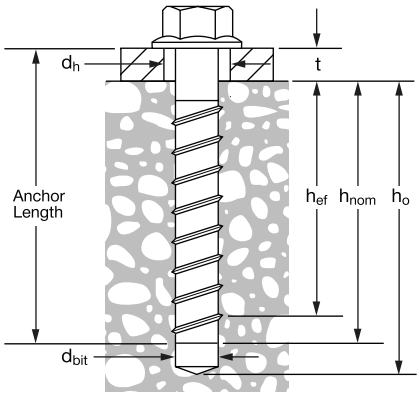



**Table 1 — Hilti KWIK HUS specifications**

| Setting information | Symbol | Units | Nominal anchor diameter | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3/8 | | | 1/2 | | | 5/8 | | 3/4 | |
| Nominal bit diameter | $d_{bit}$ | in. | 3/8 | | | 1/2 | | | 5/8 | | 3/4 | |
| Fixture hole diameter | $d_h$ | in. | 1/2 | | | 5/8 | | | 3/4 | | 7/8 | |
| Installation torque[1] | $T_{inst}$ | ft-lb | 40 | | | 45 | | | 85 | | 95 | |
| Maximum impact wrench torque rating[2] | $T_{impact,max}$ | ft-lb | 114 | 450 | | 137 | 450 | | 450 | | 450 | |
| Nominal embedment | $h_{nom}$ | in. | 1-5/8 | 2-1/2 | 3-1/4 | 2-1/4 | 3 | 4-1/4 | 3-1/4 | 5 | 4 | 6-1/4 |
| Effective embedment | $h_{ef}$ | in. | 1.11 | 1.86 | 2.20 | 1.52 | 2.16 | 3.22 | 2.39 | 3.88 | 2.92 | 4.84 |
| Minimum hole depth | $h_o$ | in. | 1-7/8 | 2-3/4 | 3-1/2 | 2-5/8 | 3-3/8 | 4-5/8 | 3-5/8 | 5-3/8 | 4-3/8 | 6-5/8 |
| Critical edge distance | $c_{ac}$ | in. | 2.50 | 3.12 | 3.74 | 2.75 | 3.70 | 5.25 | 3.63 | 5.81 | 4.41 | 7.28 |
| Minimum spacing at critical edge distance | $s_{min,cac}$ | in. | 2.25 | | | 3 | | | | | 4 | |
| Minimum edge distance | $c_{min}$ | in. | 1.50 | | | 1.75 | | | | | | |
| Minimum spacing at minimum edge distance | $s_{min}$ | in. | 3 | | | | | | | | 4 | |
| Minimum concrete thickness | $h_{min}$ | in. | 3-1/4 | 4 | 4-7/8 | 3-3/4 | 4-3/4 | 6-3/4 | 5 | 7 | 6 | 8-1/8 |
| Wrench size | - | in. | 9/16 | | | 3/4 | | | 15/16 | | 1-1/8 | |
| Effective tensile stress area | $A_{se}$ | $in^2$ | 0.086 | | | 0.161 | | | 0.268 | | 0.392 | |
| Minimum specified ultimate strength | $f_{uta}$ | psi | 107,120 | | | 97,140 | | | 90,180 | | 81,600 | |

1 $T_{inst}$ applies to installations using a calibrated torque wrench.

2 Because of variability in measurement procedures, the published torque of an impact tool may not correlate properly with the above setting torques. Over-torquing can damage the anchor and/or reduce its holding capacity.

# DESIGN INFORMATION IN CONCRETE PER ACI 318

### ACI 318 Chapter 17 design

The technical data contained in this section are Hilti Simplified Design Tables. The load values were developed using the Strength Design equations of ACI 318 Chapter 17. KWIK HUS anchor were tested and the test results were evaluated in accordance with ACI 355.2 and AC193. An ICC-ES evaluation report was not published with this information. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8.

**Table 2 — Hilti KWIK HUS design strength with concrete / pullout failure in uncracked concrete[1,2,3,4,5]**

| Nominal anchor diameter | Nominal embed. in. (mm) | Tension - $\phi N_n$ | | | | Shear - $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) |
| 3/8 | 1-5/8 | 910 | 1,000 | 1,155 | 1,415 | 980 | 1,075 | 1,245 | 1,520 |
| | (41) | (4.0) | (4.4) | (5.1) | (6.3) | (4.4) | (4.8) | (5.5) | (6.8) |
| | 2-1/2 | 1,980 | 2,165 | 2,505 | 3,065 | 2,130 | 2,335 | 2,695 | 3,300 |
| | (64) | (8.8) | (9.6) | (11.1) | (13.6) | (9.5) | (10.4) | (12.0) | (14.7) |
| | 3-1/4 | 2,545 | 2,790 | 3,220 | 3,945 | 2,740 | 3,005 | 3,465 | 4,245 |
| | (83) | (11.3) | (12.4) | (14.3) | (17.5) | (12.2) | (13.4) | (15.4) | (18.9) |
| 1/2 | 2-1/4 | 1,460 | 1,600 | 1,850 | 2,265 | 1,575 | 1,725 | 1,990 | 2,440 |
| | (57) | (6.5) | (7.1) | (8.2) | (10.1) | (7.0) | (7.7) | (8.9) | (10.9) |
| | 3 | 2,475 | 2,710 | 3,130 | 3,835 | 2,665 | 2,920 | 3,375 | 4,130 |
| | (76) | (11.0) | (12.1) | (13.9) | (17.1) | (11.9) | (13.0) | (15.0) | (18.4) |
| | 4-1/4 | 4,505 | 4,935 | 5,700 | 6,980 | 9,705 | 10,635 | 12,280 | 15,040 |
| | (108) | (20.0) | (22.0) | (25.4) | (31.0) | (43.2) | (47.3) | (54.6) | (66.9) |
| 5/8 | 3-1/4 | 3,240 | 3,550 | 4,100 | 5,025 | 3,490 | 3,825 | 4,415 | 5,410 |
| | (83) | (14.4) | (15.8) | (18.2) | (22.4) | (15.5) | (17.0) | (19.6) | (24.1) |
| | 5 | 6,705 | 7,345 | 8,485 | 10,390 | 14,445 | 15,825 | 18,270 | 22,380 |
| | (127) | (29.8) | (32.7) | (37.7) | (46.2) | (64.3) | (70.4) | (81.3) | (99.6) |
| 3/4 | 4 | 4,380 | 4,795 | 5,540 | 6,785 | 9,430 | 10,330 | 11,930 | 14,610 |
| | (102) | (19.5) | (21.3) | (24.6) | (30.2) | (41.9) | (45.9) | (53.1) | (65.0) |
| | 6-1/4 | 9,345 | 10,235 | 11,820 | 14,475 | 20,125 | 22,045 | 25,455 | 31,175 |
| | (159) | (41.6) | (45.5) | (52.6) | (64.4) | (89.5) | (98.1) | (113.2) | (138.7) |

1 See section 3.1.8 to convert design strength value to ASD value.

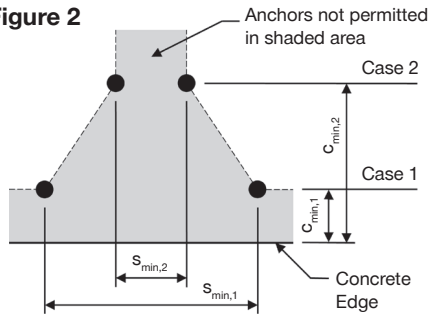
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 4 to 7 as necessary. Compare to steel values in table 3. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60

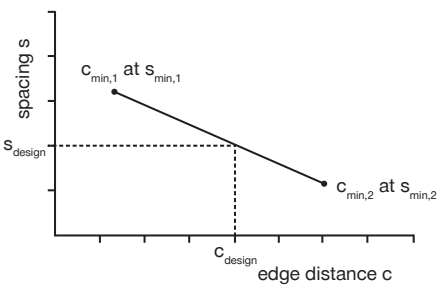
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

**Figure 2**




For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$



### Table 3 — Steel design strength for Hilti KWIK HUS anchors[1,2]

| Nominal anchor diameter | Hilti KWIK HUS anchors | |
|---|---|---|
| | Tensile[1,3] $\phi N_{sa}$ lb (kN) | Shear[2,4] $\phi V_{sa}$ lb (kN) |
| 3/8 | 5,990 (26.6) | 3,095 (13.8) |
| 1/2 | 10,165 (45.2) | 4,910 (21.8) |
| 5/8 | 15,735 (70.0) | 6,735 (30.0) |
| 3/4 | 20,810 (92.6) | 9,995 (44.5) |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Hilti KWIK HUS anchors are to be considered brittle steel elements.

3 Tensile = $\phi N_{sa} = \phi_s A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17

4 Shear values determined by static shear tests with $\phi V_{sa} \leq \phi\ 0.60\ A_{se,V}\ f_{uta}$ as noted in ACI 318 Chapter 17.

### Table 4 — Load adjustment factors for 3/8-in. diameter Hilti KWIK HUS in uncracked concrete[1,2]

| 3/8-in. KH uncracked concrete | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | | Edge distance in shear: II to and away from edge $f_{RV}$ | | | Conc. thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | in. (mm) | 1-5/8 (41) | 2-1/2 (64) | 3-1/4 (83) | 1-5/8 (41) | 2-1/2 (64) | 3-1/4 (83) | 1-5/8 (41) | 2-1/2 (64) | 3-1/4 (83) | 1-5/8 (41) | 2-1/2 (64) | 3-1/4 (83) | 1-5/8 (41) | 2-1/2 (64) | 3-1/4 (83) | 1-5/8 (41) | 2-1/2 (64) | 3-1/4 (83) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 1-1/2 (38) | n/a | n/a | n/a | 0.61 | 0.59 | 0.54 | n/a | n/a | n/a | 0.49 | 0.25 | 0.20 | 0.61 | 0.50 | 0.40 | n/a | n/a | n/a |
| | 2 (51) | n/a | n/a | n/a | 0.80 | 0.70 | 0.62 | n/a | n/a | n/a | 0.75 | 0.38 | 0.31 | 0.80 | 0.70 | 0.62 | n/a | n/a | n/a |
| | 2-1/4 (57) | 0.84 | 0.70 | 0.67 | 0.90 | 0.76 | 0.67 | 0.65 | 0.60 | 0.59 | 0.90 | 0.46 | 0.37 | 0.90 | 0.76 | 0.67 | n/a | n/a | n/a |
| | 2-1/2 (64) | 0.88 | 0.72 | 0.69 | 1.00 | 0.82 | 0.72 | 0.67 | 0.61 | 0.60 | 1.00 | 0.54 | 0.43 | 1.00 | 0.82 | 0.72 | n/a | n/a | n/a |
| | 3 (76) | 0.95 | 0.77 | 0.73 | | 0.96 | 0.82 | 0.71 | 0.63 | 0.61 | | 0.71 | 0.57 | | 0.96 | 0.82 | n/a | n/a | n/a |
| | 3-1/4 (83) | 0.99 | 0.79 | 0.75 | | 1.00 | 0.87 | 0.72 | 0.64 | 0.62 | | 0.80 | 0.64 | | 1.00 | 0.87 | 0.95 | n/a | n/a |
| | 3-1/2 (89) | 1.00 | 0.81 | 0.77 | | | 0.94 | 0.74 | 0.65 | 0.63 | | 0.89 | 0.71 | | | 0.94 | 0.98 | n/a | n/a |
| | 4 (102) | | 0.86 | 0.80 | | | 1.00 | 0.78 | 0.68 | 0.65 | | 1.00 | 0.87 | | | 1.00 | 1.00 | 0.84 | n/a |
| | 4-1/2 (114) | | 0.90 | 0.84 | | | | 0.81 | 0.70 | 0.67 | | | 1.00 | | | | | 0.89 | n/a |
| | 4-7/8 (124) | | 0.94 | 0.87 | | | | 0.84 | 0.71 | 0.69 | | | | | | | | 0.93 | 0.86 |
| | 5 (127) | | 0.95 | 0.88 | | | | 0.84 | 0.72 | 0.69 | | | | | | | | 0.94 | 0.87 |
| | 6 (152) | | 1.00 | 0.95 | | | | 0.91 | 0.76 | 0.73 | | | | | | | | 1.00 | 0.96 |
| | 7 (178) | | | 1.00 | | | | 0.98 | 0.81 | 0.77 | | | | | | | | | 1.00 |
| | 8 (203) | | | | | | | 1.00 | 0.85 | 0.80 | | | | | | | | | |
| | 9 (229) | | | | | | | | 0.90 | 0.84 | | | | | | | | | |
| | 10 (254) | | | | | | | | 0.94 | 0.88 | | | | | | | | | |
| | 11 (279) | | | | | | | | 0.98 | 0.92 | | | | | | | | | |
| | 12 (305) | | | | | | | | 1.00 | 0.96 | | | | | | | | | |
| | 14 (356) | | | | | | | | | 1.00 | | | | | | | | | |
| | 16 (406) | | | | | | | | | | | | | | | | | | |
| | 18 (457) | | | | | | | | | | | | | | | | | | |
| | 20 (508) | | | | | | | | | | | | | | | | | | |
| | 24 (610) | | | | | | | | | | | | | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 1 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

## Table 5 — Load adjustment factors for 1/2-in. diameter Hilti KWIK HUS in uncracked concrete[1,2]

| 1/2-in. KH uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | | Edge distance factor in tension $f_{RN}$ | | | Spacing factor in shear[3] $f_{AV}$ | | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | | Edge distance in shear: II to and away from edge $f_{RV}$ | | | Conc. thickness factor in shear[4] $f_{HV}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | | in. (mm) | 2-1/4 (57) | 3 (76) | 4-1/4 (108) | 2-1/4 (57) | 3 (76) | 4-1/4 (108) | 2-1/4 (57) | 3 (76) | 4-1/4 (108) | 2-1/4 (57) | 3 (76) | 4-1/4 (108) | 2-1/4 (57) | 3 (76) | 4-1/4 (108) | 2-1/4 (57) | 3 (76) | 4-1/4 (108) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | n/a | 0.68 | 0.58 | 0.51 | n/a | n/a | n/a | 0.45 | 0.28 | 0.08 | 0.68 | 0.56 | 0.17 | n/a | n/a | n/a |
| | 2 | (51) | n/a | n/a | n/a | 0.75 | 0.63 | 0.54 | n/a | n/a | n/a | 0.54 | 0.34 | 0.10 | 0.75 | 0.63 | 0.21 | n/a | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | n/a | 0.91 | 0.72 | 0.60 | n/a | n/a | n/a | 0.76 | 0.48 | 0.14 | 0.91 | 0.72 | 0.29 | n/a | n/a | n/a |
| | 3 | (76) | 0.83 | 0.73 | 0.66 | 1.00 | 0.82 | 0.66 | 0.67 | 0.62 | 0.55 | 1.00 | 0.63 | 0.19 | 1.00 | 0.82 | 0.38 | n/a | n/a | n/a |
| | 3-1/2 | (89) | 0.88 | 0.77 | 0.68 | | 0.95 | 0.73 | 0.69 | 0.64 | 0.56 | | 0.80 | 0.24 | | 0.95 | 0.47 | n/a | n/a | n/a |
| | 3-3/4 | (95) | 0.91 | 0.79 | 0.69 | | 1.00 | 0.76 | 0.71 | 0.65 | 0.57 | | 0.89 | 0.26 | | 1.00 | 0.53 | 0.91 | n/a | n/a |
| | 4 | (102) | 0.94 | 0.81 | 0.71 | | | 0.80 | 0.72 | 0.66 | 0.57 | | 0.98 | 0.29 | | | 0.58 | 0.94 | n/a | n/a |
| | 4-1/2 | (114) | 0.99 | 0.85 | 0.73 | | | 0.87 | 0.75 | 0.68 | 0.58 | | 1.00 | 0.35 | | | 0.69 | 1.00 | n/a | n/a |
| | 4-3/4 | (121) | 1.00 | 0.87 | 0.75 | | | 0.91 | 0.76 | 0.69 | 0.59 | | | 0.38 | | | 0.75 | | 0.88 | n/a |
| | 5 | (127) | | 0.89 | 0.76 | | | 0.95 | 0.78 | 0.70 | 0.59 | | | 0.41 | | | 0.81 | | 0.91 | n/a |
| | 6 | (152) | | 0.96 | 0.81 | | | 1.00 | 0.83 | 0.75 | 0.61 | | | 0.53 | | | 1.00 | | 0.99 | n/a |
| | 6-3/4 | (171) | | 1.00 | 0.85 | | | | 0.87 | 0.78 | 0.62 | | | 0.64 | | | | | 1.00 | 0.70 |
| | 7 | (178) | | | 0.86 | | | | 0.89 | 0.79 | 0.63 | | | 0.67 | | | | | | 0.72 |
| | 8 | (203) | | | 0.91 | | | | 0.94 | 0.83 | 0.65 | | | 0.82 | | | | | | 0.76 |
| | 9 | (229) | | | 0.97 | | | | 1.00 | 0.87 | 0.66 | | | 0.98 | | | | | | 0.81 |
| | 10 | (254) | | | 1.00 | | | | | 0.91 | 0.68 | | | 1.00 | | | | | | 0.85 |
| | 11 | (279) | | | | | | | | 0.95 | 0.70 | | | | | | | | | 0.90 |
| | 12 | (305) | | | | | | | | 0.99 | 0.72 | | | | | | | | | 0.94 |
| | 14 | (356) | | | | | | | | 1.00 | 0.76 | | | | | | | | | 1.00 |
| | 16 | (406) | | | | | | | | | 0.79 | | | | | | | | | |
| | 18 | (457) | | | | | | | | | 0.83 | | | | | | | | | |
| | 20 | (508) | | | | | | | | | 0.87 | | | | | | | | | |
| | > 24 | (610) | | | | | | | | | 0.94 | | | | | | | | | |

## Table 6 — Load Adjustment Factors for 5/8-in. Diameter Hilti KWIK HUS in uncracked concrete[1,2]

| 5/8-in. KH uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | Edge distance in shear: II to and away from edge $f_{RV}$ | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | | in. (mm) | 3-1/4 (83) | 5 (127) | 3-1/4 (83) | 5 (127) | 3-1/4 (83) | 5 (127) | 3-1/4 (83) | 5 (127) | 3-1/4 (83) | 5 (127) | 3-1/4 (83) | 5 (127) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | 0.62 | 0.51 | n/a | n/a | 0.24 | 0.06 | 0.47 | 0.13 | n/a | n/a |
| | 2 | (51) | n/a | n/a | 0.67 | 0.54 | n/a | n/a | 0.29 | 0.08 | 0.57 | 0.15 | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | 0.76 | 0.59 | n/a | n/a | 0.40 | 0.11 | 0.76 | 0.21 | n/a | n/a |
| | 3 | (76) | 0.71 | 0.63 | 0.86 | 0.65 | 0.61 | 0.55 | 0.53 | 0.14 | 0.86 | 0.28 | n/a | n/a |
| | 3-1/2 | (89) | 0.74 | 0.65 | 0.97 | 0.70 | 0.63 | 0.55 | 0.66 | 0.18 | 0.97 | 0.35 | n/a | n/a |
| | 4 | (102) | 0.78 | 0.67 | 1.00 | 0.76 | 0.65 | 0.56 | 0.81 | 0.22 | 1.00 | 0.43 | n/a | n/a |
| | 4-1/2 | (114) | 0.81 | 0.69 | | 0.83 | 0.66 | 0.57 | 0.97 | 0.26 | | 0.52 | n/a | n/a |
| | 5 | (127) | 0.85 | 0.71 | | 0.89 | 0.68 | 0.58 | 1.00 | 0.30 | | 0.60 | 0.85 | n/a |
| | 5-1/2 | (140) | 0.88 | 0.74 | | 0.96 | 0.70 | 0.58 | | 0.35 | | 0.70 | 0.89 | n/a |
| | 6 | (152) | 0.92 | 0.76 | | 1.00 | 0.72 | 0.59 | | 0.40 | | 0.80 | 0.93 | n/a |
| | 7 | (178) | 0.99 | 0.80 | | | 0.75 | 0.61 | | 0.50 | | 1.00 | 1.00 | 0.65 |
| | 8 | (203) | 1.00 | 0.84 | | | 0.79 | 0.62 | | 0.61 | | | | 0.69 |
| | 9 | (229) | | 0.89 | | | 0.83 | 0.64 | | 0.73 | | | | 0.74 |
| | 10 | (254) | | 0.93 | | | 0.86 | 0.65 | | 0.86 | | | | 0.78 |
| | 11 | (279) | | 0.97 | | | 0.90 | 0.67 | | 0.99 | | | | 0.81 |
| | 12 | (305) | | 1.00 | | | 0.94 | 0.68 | | 1.00 | | | | 0.85 |
| | 14 | (356) | | | | | 1.00 | 0.71 | | | | | | 0.92 |
| | 16 | (406) | | | | | | 0.74 | | | | | | 0.98 |
| | 18 | (457) | | | | | | 0.77 | | | | | | 1.00 |
| | 20 | (508) | | | | | | 0.80 | | | | | | |
| | 24 | (610) | | | | | | 0.86 | | | | | | |
| | > 30 | (762) | | | | | | 0.95 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 1 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

**Table 7 — Load adjustment factors for 3/4-in. diameter Hilti KWIK HUS in uncracked concrete[1,2]**

| 3/4-in. KH uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | Edge distance in shear: II to and away from edge $f_{RV}$ | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | | in. | 4 | 6-1/4 | 4 | 6-1/4 | 4 | 6-1/4 | 4 | 6-1/4 | 4 | 6-1/4 | 4 | 6-1/4 |
| | | (mm) | (102) | (159) | (102) | (159) | (102) | (159) | (102) | (159) | (102) | (159) | (102) | (159) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 1-3/4 | (44) | n/a | n/a | 0.57 | 0.48 | n/a | n/a | 0.10 | 0.05 | 0.19 | 0.10 | n/a | n/a |
| | 2 | (51) | n/a | n/a | 0.61 | 0.50 | n/a | n/a | 0.12 | 0.06 | 0.23 | 0.12 | n/a | n/a |
| | 2-1/2 | (64) | n/a | n/a | 0.68 | 0.54 | n/a | n/a | 0.16 | 0.08 | 0.33 | 0.17 | n/a | n/a |
| | 3 | (76) | n/a | n/a | 0.76 | 0.58 | n/a | n/a | 0.21 | 0.11 | 0.43 | 0.22 | n/a | n/a |
| | 3-1/2 | (89) | n/a | n/a | 0.84 | 0.62 | n/a | n/a | 0.27 | 0.14 | 0.54 | 0.28 | n/a | n/a |
| | 4 | (102) | 0.73 | 0.64 | 0.93 | 0.67 | 0.58 | 0.55 | 0.33 | 0.17 | 0.66 | 0.34 | n/a | n/a |
| | 4-1/2 | (114) | 0.76 | 0.65 | 1.00 | 0.72 | 0.59 | 0.56 | 0.39 | 0.20 | 0.79 | 0.41 | n/a | n/a |
| | 5 | (127) | 0.79 | 0.67 | | 0.76 | 0.60 | 0.56 | 0.46 | 0.24 | 0.92 | 0.48 | n/a | n/a |
| | 5-1/2 | (140) | 0.81 | 0.69 | | 0.81 | 0.61 | 0.57 | 0.53 | 0.28 | 1.00 | 0.55 | n/a | n/a |
| | 6 | (152) | 0.84 | 0.71 | | 0.86 | 0.62 | 0.58 | 0.61 | 0.31 | | 0.63 | 0.69 | n/a |
| | 7 | (178) | 0.90 | 0.74 | | 0.97 | 0.64 | 0.59 | 0.77 | 0.40 | | 0.79 | 0.75 | n/a |
| | 8 | (203) | 0.96 | 0.78 | | 1.00 | 0.66 | 0.60 | 0.94 | 0.48 | | 0.97 | 0.80 | n/a |
| | 8-1/8 | (206) | 0.96 | 0.78 | | | 0.66 | 0.60 | 0.96 | 0.50 | | 0.99 | 0.80 | 0.65 |
| | 9 | (229) | 1.00 | 0.81 | | | 0.68 | 0.62 | 1.00 | 0.58 | | 1.00 | 0.85 | 0.68 |
| | 10 | (254) | | 0.84 | | | 0.70 | 0.63 | | 0.68 | | | 0.89 | 0.72 |
| | 11 | (279) | | 0.88 | | | 0.72 | 0.64 | | 0.78 | | | 0.94 | 0.75 |
| | 12 | (305) | | 0.91 | | | 0.74 | 0.65 | | 0.89 | | | 0.98 | 0.79 |
| | 14 | (356) | | 0.98 | | | 0.78 | 0.68 | | 1.00 | | | 1.00 | 0.85 |
| | 16 | (406) | | 1.00 | | | 0.82 | 0.71 | | | | | | 0.91 |
| | 18 | (457) | | | | | 0.86 | 0.73 | | | | | | 0.96 |
| | 20 | (508) | | | | | 0.90 | 0.76 | | | | | | 1.00 |
| | 24 | (610) | | | | | 0.98 | 0.81 | | | | | | |
| | 30 | (762) | | | | | 1.00 | 0.89 | | | | | | |
| | > 36 | (914) | | | | | | 0.96 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use Hilti PROFIS Engineering software or perform anchor calculation using design equations from ACI 318 Chapter 17.

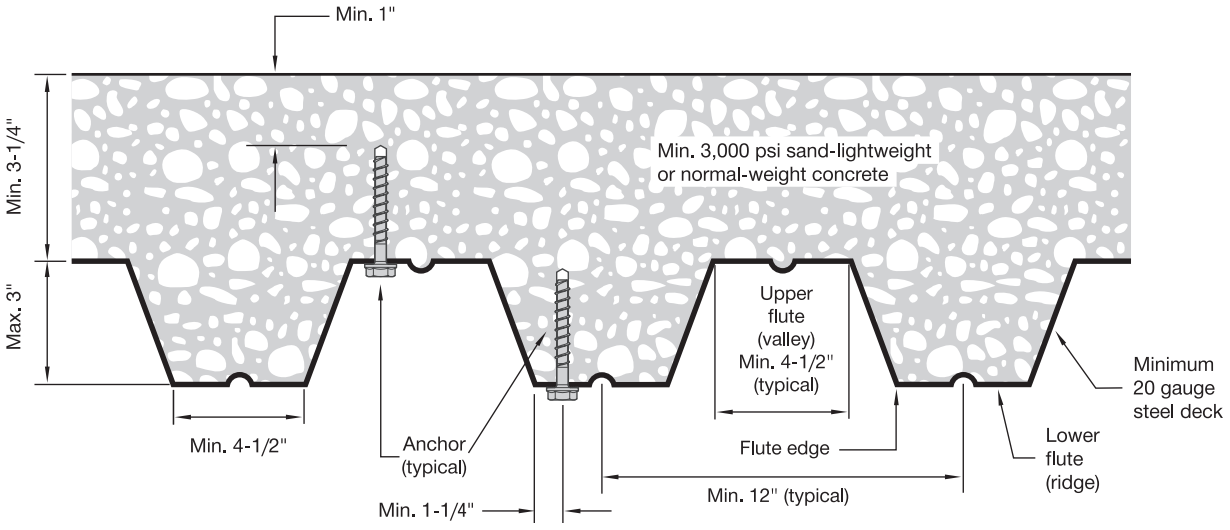
3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 1 and figure 2 of this section to calculate permissable edge distance, spacing and concrete thickness combinations.

3.3.10

**Figure 3 — Installation of Hilti KWIK HUS in soffit of concrete over steel deck floor and roof assemblies[1]**




1 Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum concrete cover above the drilled hole is satisfied. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

**Table 8 — Hilti KWIK HUS in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6,7]**

| Nominal anchor diameter | Nominal embed. in. (mm) | Installation in lower flute | | | | Installation in upper flute | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Tension - $\phi N_n$ | | Shear - $\phi V_n$ | | Tension - $\phi N_n$ | | Shear - $\phi V_n$ | |
| | | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) |
| 3/8 | 1-5/8 (41) | 835 (3.7) | 965 (4.3) | 1,000 (4.4) | 1,000 (4.4) | 660 (2.9) | 760 (3.4) | 2,360 (10.5) | 2,360 (10.5) |
| | 2-1/2 (64) | 1,455 (6.5) | 1,680 (7.5) | 905 (4.0) | 905 (4.0) | 1,900 (8.5) | 2,195 (9.8) | 3,655 (16.3) | 3,655 (16.3) |
| | 3-1/4 (83) | 2,550 (11.3) | 2,945 (13.1) | 2,165 (9.6) | 2,165 (9.6) | n/a | n/a | n/a | n/a |
| 1/2 | 2-1/4 (57) | 850 (3.8) | 980 (4.4) | 965 (4.3) | 965 (4.3) | 905 (4.0) | 1,045 (4.6) | 4,710 (21.0) | 4,710 (21.0) |
| | 3 (76) | 1,990 (8.9) | 2,300 (10.2) | 1,750 (7.8) | 1,750 (7.8) | n/a | n/a | n/a | n/a |
| | 4-1/4 (108) | 3,485 (15.5) | 4,025 (17.9) | 2,155 (9.6) | 2,155 (9.6) | n/a | n/a | n/a | n/a |
| 5/8 | 3-1/4 (83) | 2,715 (12.1) | 3,135 (13.9) | 2,080 (9.3) | 2,080 (9.3) | n/a | n/a | n/a | n/a |
| | 5 (127) | 6,170 (27.4) | 7,125 (31.7) | 2,515 (11.2) | 2,515 (11.2) | n/a | n/a | n/a | n/a |
| 3/4 | 4 (102) | 2,715 (12.1) | 3,135 (13.9) | 2,255 (10.0) | 2,255 (10.0) | n/a | n/a | n/a | n/a |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{nom}$ (nominal embedment).

4 Tabular values are lightweight concrete and no additional reduction factor is needed.

5 No additional reduction factors for spacing or edge distance need to be applied.

6 Comparison to steel values in table 3 is not required. Values in tables 8 control.

7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in table 2 of this section. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

**Table 9 — Steel resistance for Hilti KWIK HUS screw anchor[1,2]**

| Anchor diameter in. | Nominal embedment in. (mm) | Tensile $N_{sar}$[3] lb (kN) | Shear $V_{sar}$[4] lb (kN) |
|---|---|---|---|
| 3/8 | 1-5/8 (41) | 5,480 (24.4) | 2,850 (12.7) |
| | 2-1/2 (64) | | |
| | 3-1/4 (83) | | |
| 1/2 | 2-1/4 (57) | 9,280 (41.3) | 4,525 (20.1) |
| | 3 (76) | | |
| | 4-1/4 (108) | | |
| 5/8 | 3-1/4 (83) | 14,405 (64.1) | 6,200 (27.6) |
| | 5 (127) | | |
| 3/4 | 4 (102) | 19,050 (84.7) | 9,205 (40.9) |
| | 6-1/4 (159) | | |

1 See Section 3.1.8 to convert factored resistance value to ASD value.
2 Hilti KWIK HUS screw anchors are to be considered brittle steel elements.
3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
4 Shear determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3 Annex D.

## Table 10 — Hilti KWIK HUS screw anchor design information in accordance with CSA A23.3 Annex D[1]

| Design parameter | Symbol | Units | Nominal anchor diameter | | | | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3/8 | | | 1/2 | | | 5/8 | | 3/4 | | A23.3 |
| Anchor O.D. | $d_a$ | in. (mm) | 0.375 (9.5) | | | 0.5 (12.7) | | | 0.625 (15.9) | | 0.75 (19.1) | | |
| Effective minimum embedment[2] | $h_{ef}$ | in. (mm) | 1.11 (28) | 1.86 (47) | 2.20 (56) | 1.52 (39) | 2.16 (55) | 3.22 (82) | 2.39 (61) | 3.88 (99) | 2.92 (74) | 4.84 (123) | |
| Minimum concrete thickness | $h_{min}$ | in. (mm) | 3-1/4 (83) | 4 (102) | 4-7/8 (124) | 3-3/4 (95) | 4-3/4 (121) | 6-3/4 (171) | 5 (127) | 7 (178) | 6 (152) | 8-1/8 (206) | |
| Critical edge distance | $c_{ac}$ | in. (mm) | 2.10 (53) | 2.92 (74) | 3.30 (84) | 2.75 (70) | 3.88 (99) | 5.25 (133) | 3.63 (92) | 5.82 (148) | 4.41 (112) | 7.28 (185) | |
| Minimum anchor spacing at critical edge distance | $s_{min,cac}$ | in. (mm) | 2.25 (57) | | | 3 (76) | | | | | 4 (102) | | |
| Minimum edge distance | $c_{min}$ | in. (mm) | 1.50 (38) | | | 1.75 (44) | | | | | | | |
| Anchor spacing at minimum edge distance | $s_{min}$ | in. (mm) | 3 (76) | | | | | | | | 4 (102) | | |
| Minimum hole depth in concrete | $h_o$ | in. (mm) | 1-7/8 (48) | 2-3/4 (70) | 3 1/2 (86) | 2-5/8 (67) | 3-3/8 (86) | 4-5/8 (117) | 3-5/8 (92) | 5-3/8 (137) | 4-3/8 (111) | 6-5/8 (168) | |
| Minimum specified ultimate strength | $f_{uta}$ | in. (mm) | 107,120 (739) | | | 97,140 (670) | | | 90,180 (622) | | 81,600 (563) | | |
| Effective tensile stress area | $A_{se,N}$ | in. (mm) | 0.086 (55.5) | | | 0.161 (103.9) | | | 0.268 (172.9) | | 0.392 (252.9) | | |
| Steel embedment material resistance factor for reinforcement | $\phi_s$ | - | 0.85 | | | | | | | | | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes[4] | R | - | 0.70 | | | | | | | | | | D.5.3 |
| Resistance modification factor for shear, steel failure modes[4] | R | - | 0.65 | | | | | | | | | | D.5.3 |
| Factored steel resistance in tension | $N_{sar}$ | lb (kN) | 5,840 (26.0) | | | 9,200 (40.9) | | | 14,405 (64.1) | | 19,050 (84.7) | | D.6.1.2 |
| Factored steel resistance in shear | $V_{sar}$ | lb (kN) | 2,850 (12.7) | | | 4,525 (20.1) | | | 6,200 (27.6) | | 9,205 (40.9) | | D.7.1.2 |
| Coefficient for factored concrete breakout resistance, uncracked concrete | $k_{c,uncr}$ | - | 10 | | | | | | 11.2 | | | | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked concrete[5] | $\psi_{c,N}$ | - | 10 | | | | | | | | | | D.6.2.6 |
| Anchor category | - | - | 1 | | | | | | | | | | D.5.3 (c ) |
| Concrete material resistance factor | $\phi_c$ | - | 0.65 | | | | | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[6] | R | - | 1.00 | | | | | | | | | | D.5.3 (c ) |
| Factored pullout resistance in 20 MPa uncracked concrete[7] | $N_{pr,uncr}$ | lb (kN) | NA | | | | | | | | | | D.6.3.2 |

1 Design information in this table is taken from tables 2 of this section and converted with use of CSA A23.3 Annex D.
2 See figure 1 of this section.
3 For concrete over metal deck applications where the concrete thickness over the top flute is less than $h_{min}$ in this table, see figure 3 and table 3 of this section.
4 The KWIK HUS is considered a brittle steel element as defined by CSA A23.3 Annex D section D.2.
5 For all design cases, $\psi_{c,N}$ = 1.0.
6 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
7 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design.

### Table 11 — Hilti KWIK HUS screw anchor factored resistance with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 1-1/8 (28) | 1-5/8 (41) | 970 (4.3) | 1,085 (4.8) | 1,185 (5.3) | 1,370 (6.1) | 970 (4.3) | 1,085 (4.8) | 1,185 (5.3) | 1,370 (6.1) |
| | 1-7/8 (47) | 2-1/2 (64) | 2,105 (9.4) | 2,355 (10.5) | 2,580 (11.5) | 2,980 (13.2) | 2,105 (9.4) | 2,355 (10.5) | 2,580 (11.5) | 2,980 (13.2) |
| | 2-3/16 (56) | 3-1/4 (83) | 2,740 (12.2) | 3,060 (13.6) | 3,355 (14.9) | 3,875 (17.2) | 2,740 (12.2) | 3,060 (13.6) | 3,355 (14.9) | 3,875 (17.2) |
| 1/2 | 1-1/2 (39) | 2-1/4 (57) | 1,590 (7.1) | 1,780 (7.9) | 1,950 (8.7) | 2,250 (10.0) | 1,590 (7.1) | 1,780 (7.9) | 1,950 (8.7) | 2,250 (10.0) |
| | 2 (55) | 3 (76) | 2,665 (11.9) | 2,980 (13.3) | 3,265 (14.5) | 3,770 (16.8) | 2,665 (11.9) | 2,980 (13.3) | 3,265 (14.5) | 3,770 (16.8) |
| | 3-1/4 (82) | 4-1/4 (108) | 4,850 (21.6) | 5,425 (24.1) | 5,945 (26.4) | 6,860 (30.5) | 9,705 (43.2) | 10,850 (48.3) | 11,885 (52.9) | 13,725 (61.1) |
| 5/8 | 2-3/8 (61) | 3-1/4 (83) | 3,485 (15.5) | 3,900 (17.3) | 4,270 (19.0) | 4,930 (21.9) | 3,485 (15.5) | 3,900 (17.3) | 4,270 (19.0) | 4,930 (21.9) |
| | 4 (99) | 5 (127) | 7,210 (32.1) | 8,060 (35.9) | 8,830 (39.3) | 10,195 (45.4) | 14,420 (64.1) | 16,120 (71.7) | 17,660 (78.6) | 20,390 (90.7) |
| 3/4 | 2-15/16 (74) | 4 (102) | 4,660 (20.7) | 5,210 (23.2) | 5,705 (25.4) | 6,590 (29.3) | 9,320 (41.4) | 10,420 (46.3) | 11,415 (50.8) | 13,180 (58.6) |
| | 4-13/16 (123) | 6-1/4 (159) | 9,985 (44.4) | 11,165 (49.7) | 12,230 (54.4) | 14,120 (62.8) | 19,970 (88.8) | 22,325 (99.3) | 24,455 (108.8) | 28,240 (125.6) |

1 See section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 4 to 7 as necessary. Compare to the steel values in table 9. The lesser of the values is to be used for the design.
4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

### Table 12 — Hilti KWIK HUS in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6,7]

| Nominal anchor diameter in. | Nominal embedment depth in. (mm) | Installation in lower flute | | | | Installation in upper flute | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Tension - $\phi N_r$ | | Shear - $\phi V_r$ | | Tension - $\phi N_r$ | | Shear - $\phi V_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa ((4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| 3/8 | 1-5/8 (41) | 820 (3.6) | 1,005 (4.5) | 925 (4.1) | 925 (4.1) | 650 (2.9) | 795 (3.5) | 2,175 (9.7) | 2,175 (9.7) |
| | 2-1/2 (64) | 1,430 (6.4) | 1,755 (7.8) | 835 (3.7) | 835 (3.7) | 1,865 (8.3) | 2,285 (10.2) | 3,365 (15.0) | 3,365 (15.0) |
| | 3-1/4 (83) | 2,505 (11.1) | 3,070 (13.7) | 1,990 (8.9) | 1,990 (8.9) | n/a | n/a | n/a | n/a |
| 1/2 | 2-1/4 (57) | 835 (3.7) | 1,020 (4.5) | 885 (3.9) | 885 (3.9) | 890 (4.0) | 1,090 (4.8) | 4,335 (19.3) | 4,335 (19.3) |
| | 3 (76) | 1,955 (8.7) | 2,395 (10.7) | 1,615 (7.2) | 1,615 (7.2) | n/a | n/a | n/a | n/a |
| | 4-1/4 (108) | 3,425 (15.2) | 4,195 (18.7) | 1,985 (8.8) | 1,985 (8.8) | n/a | n/a | n/a | n/a |
| 5/8 | 3-1/4 (83) | 2,670 (11.9) | 3,270 (14.5) | 1,915 (8.5) | 1,915 (8.5) | n/a | n/a | n/a | n/a |
| | 5 (127) | 6,070 (27.0) | 7,430 (33.1) | 2,315 (10.3) | 2,315 (10.3) | n/a | n/a | n/a | n/a |
| 3/4 | 4 (102) | 2,670 (11.9) | 3,270 (14.5) | 2,080 (9.3) | 2,080 (9.3) | n/a | n/a | n/a | n/a |

1 See section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{nom}$ (nominal embedment).
4 Tabular values are lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.
7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

# DESIGN INFORMATION IN MASONRY

**Table 13 — Allowable tension loads for Hilti KWIK HUS installed in grout-filled masonry walls (lb)[1,2,3,4,5]**

| Nominal anchor diameter | Nominal embedment [3] in. | Loads at $c_{cr}$ and $s_{cr}$ | Spacing | | | Edge distance | | |
|---|---|---|---|---|---|---|---|---|
| | | | Critical - $s_{cr}$ [6] in. | Minimum - $s_{min}$ [6] in. | Load reduction factor at $s_{min}$ [6] | Critical - $c_{cr}$ [7] in. | Minimum $c_{min}$ [8] in. | Load reduction factor [7] |
| 3/8 | 1-5/8 | 535 | 4 | 2 | 0.70 | 4 | 4 | 1.00 |
| | 2-1/2 | 895 | 6 | 4 | 0.80 | | | |
| | 3-1/4 | 1,210 | | | | | | |
| 1/2 | 2-1/4 | 710 | 4 | 2 | 0.60 | 4 | 4 | 1.00 |
| | 3 | 1,110 | 8 | 4 | | | | |
| | 4-1/4 | 1,515 | | | | | | |
| 5/8 | 3-1/4 | 1,155 | 10 | 4 | 0.60 | 10 | 4 | 1.00 |
| | 5 | 1,735 | | | | | | |
| 3/4 | 4 | 1,680 | 12 | 4 | 0.60 | 12 | 4 | 1.00 |
| | 6-1/4 | 2,035 | | | | | | |

**Table 14 — Allowable shear loads for Hilti KWIK HUS installed in grout-filled masonry walls (lb)[1,2,3,4,5]**

| Nominal anchor diameter | Nominal embedment [3] in. | Loads at $c_{cr}$ and $s_{cr}$ | Spacing | | | Edge distance | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Critical - $s_{cr}$ [6] in. | Minimum - $s_{min}$ [6] in. | Load reduction factor at $s_{min}$ [7] | Critical - $c_{cr}$ [8] in. | Minimum $c_{min}$ [8] in. | Load reduction factor at $c_{min}$ | |
| | | | | | | | | Load direction perpendicular to edge | Load direction parallel to edge |
| 3/8 | 1-5/8 | 1,140 | 6 | 4 | 0.94 | 6 | 4 | 0.61 | 1.00 |
| | 2-1/2 | 1,165 | | | | | | 0.70 | 1.00 |
| | 3-1/4 | 1,190 | | | | | | 0.70 | 1.00 |
| 1/2 | 2-1/4 | 1,845 | 8 | 4 | 0.88 | 8 | 4 | 0.50 | 1.00 |
| | 3 | 2,055 | | | | | | 0.45 | 0.94 |
| | 4-1/4 | 2,745 | | | | | | 0.40 | 0.89 |
| 5/8 | 3-1/4 | 3,040 | 10 | 4 | 0.36 | 10 | 4 | 0.36 | 0.82 |
| | 5 | 3,485 | | | | | | 0.34 | 0.92 |
| 3/4 | 4 | 3,040 | 10 | 4 | 0.36 | 12 | 4 | 0.36 | 0.82 |
| | 6-1/4 | 3,485 | | | | | | 0.34 | 0.92 |

1 All values are for anchors installed in fully-grouted masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight or normal-weight.

2 Anchors may not be installed within 1 inch in any direction of a vertical joint.

3 Embedment depth is measured from the outside face of the concrete masonry embedment.

4 Linear interpolation of load values between minimum spacing ($s_{min}$) and critical spacing ($s_{cr}$) and between minimum edge distance ($c_{min}$) and critical edge distance ($c_{cr}$) is permitted.

5 For combined loading: $\left(\frac{T_{applied}}{T_{allowable}}\right)^{5/3} + \left(\frac{V_{applied}}{V_{allowable}}\right)^{5/3} \leq 1$

6 Anchor spacing $s_{cr}$ is where full load values in the table may be used. Anchor-to-anchor spacing of less than $s_{min}$ is not recommended. Spacing is measured from the center of one anchor to the center of an adjacent anchor.

7 Load reduction factors are multiplicative, both spacing and edge distance load reduction factors must be considered. Load values for anchors installed at less than $c_{cr}$ or $s_{cr}$ must be multiplied by the appropriate load reduction factor based on actual edge distance or anchor spacing.

8 Critical edge distance $c_{cr}$ is where full load values in the table may be used. Edge distance spacing of less than $c_{min}$ is not recommended. Edge distance is measured from the center of the anchor to the closest edge.

**Table 15 — Hilti KWIK HUS allowable loads installed in top of grout-filled concrete masonry construction (lb)[1,2]**

| Nominal anchor diameter | Nominal embedment in. | Minimum edge distance in. | Minimum spacing in. | Minimum end distance in. | Tension | Shear | |
|---|---|---|---|---|---|---|---|
| | | | | | | Perpendicular to edge of masonry wall | Parallel to edge of masonry wall |
| 1/2 | 4-1/4 | 1-3/4 | 8 | 4 | 680 | 305 | 1,110 |
| 5/8 | 5 | 1-3/4 | 10 | 5 | 1,310 | 305 | 1,165 |

1 All values are for anchors installed in fully-grouted masonry with minimum masonry prism strength of 1,500 psi. Concrete masonry units may be lightweight or normal-weight.

2 For combined loading: $\left(\frac{T_{applied}}{T_{allowable}}\right)^{5/3} + \left(\frac{V_{applied}}{V_{allowable}}\right)^{5/3} \leq 1$

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## ORDERING INFORMATION[1]







| Description | Hole diameter | Anchor length See figure 1 | Minimum embedment depth | Qty / Box |
|---|---|---|---|---|
| **KH 3/8 x 2-1/8** | 3/8 | 2-1/8 | 1-5/8 | 50 |
| **KH 3/8 x 3** | 3/8 | 3 | 2-1/2 | 50 |
| **KH 3/8 x 3-1/2** | 3/8 | 3-1/2 | 2-1/2 | 50 |
| **KH 3/8 x 4** | 3/8 | 4 | 3-1/4 | 50 |
| **KH 3/8 x 5** | 3/8 | 5 | 3-1/4 | 30 |
| **KH 1/2 x 3** | 1/2 | 3 | 2-1/4 | 30 |
| **KH 1/2 x 3-1/2** | 1/2 | 3-1/2 | 3 | 25 |
| **KH 1/2 x 4** | 1/2 | 4 | 3 | 25 |
| **KH 1/2 x 4-1/2** | 1/2 | 4-1/2 | 4- 1/4 | 25 |
| **KH 1/2 x 5** | 1/2 | 5 | 4-1/4 | 25 |
| **KH 1/2 x 6** | 1/2 | 6 | 4-1/4 | 25 |
| **KH 5/8 x 4** | 5/8 | 4 | 3-1/4 | 15 |
| **KH 5/8 x 5-1/2** | 5/8 | 5-1/2 | 3-1/4 | 15 |
| **KH 5/8 x 6-1/2** | 5/8 | 6-1/2 | 3-1/4 | 15 |
| **KH 3/4 x 4-1/2** | 3/4 | 4-1/2 | 4 | 10 |
| **KH 3/4 x 5-1/2** | 3/4 | 5-1/2 | 4 | 10 |
| **KH 3/4 x 7** | 3/4 | 7 | 4 | 10 |
| **KH 3/4 x 9** | 3/4 | 9 | 4 | 10 |

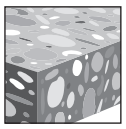
1 All dimensions in inches.

# 3.3.11 KWIK BOLT 3 STAINLESS STEEL AND HOT-DIPPED GALVANIZED EXPANSION ANCHOR

## PRODUCT DESCRIPTION

**KWIK Bolt 3 stainless steel anchors and hot-dipped galvanized plating**

| Anchor System | Features and Benefits |
|---|---|
|  Hot Dipped Galvanized KB3  Stainless Steel KB3  A-18/A22 impact tool | • Used with Hilti Dust Removal System (DRS) for dustless drilling and installation (compliant with Table 1 of OSHA 1926.1153 regulations for silica dust exposure).<br>• Accurate SafeSet™ installation when using the Hilti SIW-6AT-A22 impact wrench and the SI-AT-A22 Adaptive Torque Module<br>• Length identification code facilitates quality control and inspection after installation.<br>• Through fixture installation and variable thread lengths improve productivity and accommodate various base plate thicknesses.<br>• Raised impact section (Dog Point) prevents thread damage during installation.<br>• Anchor size is same as drill bit size for easy installation. For temporary applications anchors may be driven into drilled holes after usage.<br>• Mechanical expansion allows immediate load application. |


Uncracked concrete



Hollow drill bit adaptive torque tool (AT)



Profis Anchor design software

| Approvals/Listings | |
|---|---|
| **ICC-ES (International Code Council) 2018 International Building Code / International Residential Code (IBC/IRC)** | ESR-2302 in concrete per ACI 318 Ch. 17 / ACI 355.2/ ICC-ES AC193 |
| **City of Los Angeles** | City of Los Angeles 2020 LABC Supplement (within ESR-2302) |
| **Florida Building Code** | 2020 FBC with HVHZ |
| **Nuclear Quality Assurance** | Qualified under NQA-1 Nuclear Quality Program |

## MATERIAL SPECIFICATIONS

**Carbon steel with hot-dip galvanized plating**

Anchor bodies manufactured from carbon steel have the tensile bolt fracture loads shown in table 1.

Carbon steel anchor components have an average zinc plating thickness greater than 43 µm according to ASTM A153, Class C.

Nuts conform to the requirements of ASTM A563, Grade A, Hex.

Washers meet the requirements of ASTM F844.

Stainless steel expansion wedges are manufactured from either AISI Type 304 or Type 316.

**Stainless steel**

Anchor bodies smaller than 3/4-inch, excluding all KWIK Bolt 3 Countersunk, are produced from AISI Type 304 or Type 316 stainless steel having the bolt fracture loads shown in table 1.

Anchor bodies 3/4-inch and larger, and all stainless steel KWIK Bolt 3 Countersunk anchor bodies, are produced from AISI Type 304 or Type 316 stainless steel having the mechanical properties shown in table 1.

Nuts meet the dimensional requirements of ASTM F594.

Washers meet the dimensional requirements of ANSI B18.22.1, Type A, plain.

Stainless steel expansion wedges for AISI Type 304 are made from either AISI Type 304 or Type 316. Stainless steel expansion wedges for AISI Type 316 anchors are made from type 316. All stainless steel nuts and washers for AISI Type 304 or Type 316 anchors are manufactured from AISI Type 304 or 316, respectively.

**Table 1 — Hilti KWIK Bolt 3 Bolt fracture load (lb)[1]**

| Nominal anchor diameter in. | Hot-dip galvanized | Stainless steel |
|---|---|---|
| 1/4 | no offering | 2,900 |
| 3/8 | no offering | 7,200 |
| 1/2 | 12,400 | 12,400 |
| 5/8 | 19,600 | 21,900 |
| 3/4 | 28,700 | $f_{uta} \geq 76$, $f_{ya} \geq 64$[2] |
| 1 | no offering | $f_{uta} \geq 76$, $f_{ya} \geq 64$[2] |

1 Bolt fracture loads are determined by testing in a universal tensile machine for quality control at the manufacturing facility. These loads are not intended for design use. See table 12 for the steel design strengths of stainless steel.

2 All 3/4-in. stainless steel, and all 1-in. stainless steel material strengths specified by the tensile and yield strengths expressed in (ksi). Bolt fracture loads not applicable for these models.

## INSTALLATION PARAMETERS

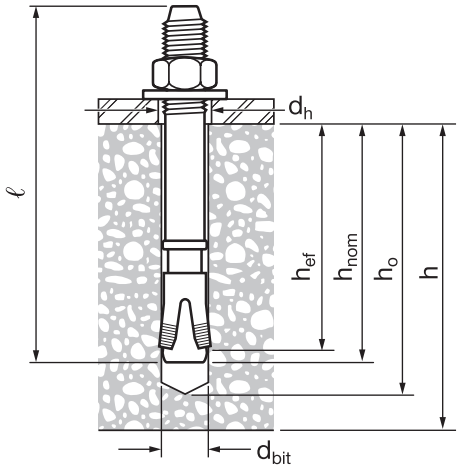



**Figure 1 — KWIK Bolt 3 installation**

**Table 2 — Hilti KWIK Bolt 3 specifications**

| Setting information | Symbol | Units | Nominal anchor diameter | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | 3/8 | 1/2 | | 5/8 | | 3/4 | | 1 | |
| Drill bit dia. | $d_{bit}$ | in. | 1/4 | 3/8 | 1/2 | | 5/8 | | 3/4 | | 1 | |
| Minimum nominal embedment | $h_{nom}$ | in. | 1-3/4 | 2-3/8 | 2-1/4 | 3-5/8 | 3-1/2 | 4-3/8 | 4-1/4 | 5-5/8 | 4-5/8 | 6-3/8 |
| | | (mm) | (44) | (60) | (57) | (92) | (89) | (111) | (108) | (143) | 117 | 162 |
| Minimum effective embedment | $h_{ef}$ | in. | 1-1/2 | 2 | 2 | 3-1/4 | 3-1/8 | 4 | 3-3/4 | 5 | 4 | 5-3/4 |
| | | (mm) | (38) | (51) | (51) | (83) | (79) | (102) | (95) | (127) | (102) | (146) |
| Minimum hole depth | $h_o$ | in. | 2 | 2-5/8 | 2-5/8 | 4 | 3-7/8 | 4-3/4 | 4-1/2 | 5-3/4 | 5 | 6-3/4 |
| | | (mm) | (51) | (67) | (67) | (102) | (98) | (121) | (114) | (146) | (127) | (171) |
| Fixture hole dia. | $d_h$ | in. | 5/16 | 7/16 | 9/16 | | 11/16 | | 13/16 | | 1-1/8 | |
| Anchor length | ℓ | | See ordering information | | | | | | | | | |
| Installation torque concrete | $T_{inst}$ | ft-lb | 4 | 20 | 40 | | 60 | | 110 | | 150 | |
| | | (Nm) | (5) | (27) | (54) | | (81) | | (149) | | (203) | |
| Installation torque masonry | $T_{inst}$ | ft-lb | 4 | 15 | 25 | | 65 | | 120 | | not recommended | |
| | | (Nm) | (5) | (20) | (34) | | (88) | | (163) | | | |
| Wrench size | | in. | 7/16 | 9/16 | 3/4 | | 15/16 | | 1-1/8 | | 1-1/2 | |

## DESIGN INFORMATION IN CONCRETE PER ACI 318

**ACI 318 Chapter 17 design**

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-2302 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.7. Data tables from ESR-2302 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Allowable Stress Design or ASD technical information and data tables can be found at www.hilti.com.

**Table 3 — Hilti KWIK Bolt 3 stainless steel design strength with concrete / pullout failure in uncracked concrete[1,2,3,4,5]**

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $\phi N_n$ | | | | Shear - $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) |
| 1/4 | 1-1/2 (38) | 1-3/4 (44) | 730 (3.2) | 770 (3.4) | 840 (3.7) | 950 (4.2) | 1,545 (6.9) | 1,690 (7.5) | 1,950 (8.7) | 2,390 (10.6) |
| 3/8 | 2 (51) | 2-3/8 (60) | 1,925 (8.6) | 2,110 (9.4) | 2,440 (10.9) | 2,985 (13.3) | 2,375 (10.6) | 2,605 (11.6) | 3,005 (13.4) | 3,680 (16.4) |
| 1/2 | 2 (51) | 2-1/4 (57) | 2,150 (9.6) | 2,355 (10.5) | 2,720 (12.1) | 3,335 (14.8) | 2,375 (10.6) | 2,605 (11.6) | 3,005 (13.4) | 3,680 (16.4) |
| | 3-1/4 (83) | 3-1/2 (89) | 3,920 (17.4) | 4,295 (19.1) | 4,960 (22.1) | 6,070 (27.0) | 9,845 (43.8) | 10,785 (48.0) | 12,450 (55.4) | 15,250 (67.8) |
| 5/8 | 3-1/8 (79) | 3-1/2 (89) | 4,050 (18.0) | 4,435 (19.7) | 5,120 (22.8) | 6,275 (27.9) | 9,280 (41.3) | 10,165 (45.2) | 11,740 (52.2) | 14,380 (64.0) |
| | 4 (102) | 4-3/8 (111) | 5,090 (22.6) | 5,575 (24.8) | 6,440 (28.6) | 7,885 (35.1) | 13,440 (59.8) | 14,725 (65.5) | 17,000 (75.6) | 20,820 (92.6) |
| 3/4 | 3-3/4 (95) | 4-1/4 (108) | 5,560 (24.7) | 6,090 (27.1) | 7,035 (31.3) | 8,615 (38.3) | 12,200 (54.3) | 13,365 (59.5) | 15,430 (68.6) | 18,900 (84.1) |
| | 5 (127) | 5-1/2 (140) | 7,040 (31.3) | 7,710 (34.3) | 8,905 (39.6) | 10,905 (48.5) | 18,785 (83.6) | 20,575 (91.5) | 23,760 (105.7) | 29,100 (129.4) |
| 1 | 4 (102) | 4-1/2 (114) | 6,240 (27.8) | 6,835 (30.4) | 7,895 (35.1) | 9,665 (43.0) | 13,440 (59.8) | 14,725 (65.5) | 17,000 (75.6) | 20,820 (92.6) |
| | 5-3/4 (146) | 6-1/4 (159) | 10,110 (45.0) | 11,070 (49.2) | 12,785 (56.9) | 15,660 (69.7) | 23,165 (103.0) | 25,375 (112.9) | 29,300 (130.3) | 35,885 (159.6) |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 14 to 19 as necessary. Compare to steel values in table 12. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

**Table 4 — Steel design strength for Hilti KWIK Bolt 3 stainless steel anchors[1,2]**

| Nominal anchor diameter in. | Nominal embedment in. (mm) | Tensile[3] $\phi N_{sa}$ lb (kN) | Shear[4] $\phi V_{sa}$ lb (kN) |
|---|---|---|---|
| 1/4 | 1-3/4 (44) | 1,725 (7.7) | 1,090 (4.8) |
| 3/8 | 2-3/8 (60) | 5,175 (23.0) | 3,235 (14.4) |
| 1/2 | 2-1/4 (57) | 9,490 (42.2) | 2,725 (12.1) |
| | 3-1/2 (89) | | 4,510 (20.1) |
| 5/8 | 3-1/2 (89) | 14,665 (65.2) | 5,820 (25.9) |
| | 4-3/8 (111) | | 9,295 (41.3) |
| 3/4 | 4-1/4 (108) | 16,200 (72.1) | 7,735 (34.4) |
| | 5-1/2 (140) | | 15,305 (68.1) |
| 1 | 4-1/2 (114) | 31,735 (141.2) | 8,130 (36.2) |
| | 6-1/4 (159) | | 17,775 (79.1) |

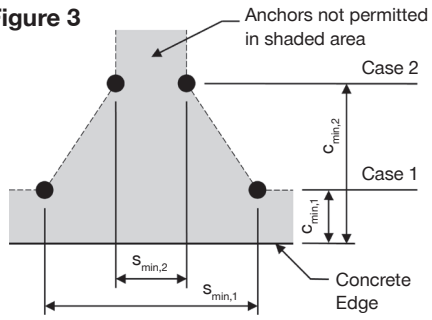
1 See section 3.1.8 to convert design strength value to ASD value.

2 KWIK Bolt 3 stainless steel anchors are to be considered ductile steel elements.

3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.

**Figure 3**




For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$

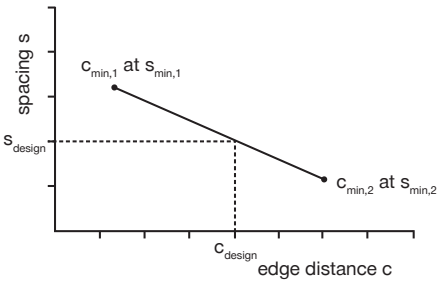



**Table 5 — Stainless steel Hilti KWIK Bolt 3 installation parameters[1]**

| Setting information | Symbol | Units | Nominal anchor diameter $d_o$ | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | 3/8 | | 1/2 | | | | 5/8 | | | 3/4 | | | 1 | |
| Effective minimum embedment | $h_{ef}$ | in. | 1-1/2 | 2 | | 2 | | 3-1/4 | | 3-1/8 | 4 | | 3-3/4 | | 5 | 4 | 5-3/4 |
| | | (mm) | (38) | (51) | | (51) | | (83) | | (79) | (102) | | (95) | | (127) | (102) | (146) |
| Minimum member thickness | $h_{min}$ | in. | 4 | 4 | 5 | 4 | 6 | 6 | 8 | 5 | 6 | 8 | 6 | 8 | 8 | 8 | 10 |
| | | (mm) | (102) | (102) | (127) | (102) | (152) | (152) | (203) | (127) | (152) | (203) | (152) | (203) | (203) | (203) | (254) |
| Case 1 | $c_{min,1}$ | in. | 1-3/8 | 2 | 1-5/8 | 2-1/2 | 1-7/8 | 1-5/8 | 1-5/8 | 3-1/4 | 2-1/2 | 2-1/2 | 3-1/4 | 3 | 2-7/8 | 3-1/2 | 3 |
| | | (mm) | (35) | (51) | (41) | (68) | (48) | (41) | (41) | (83) | (64) | (64) | (83) | (76) | (73) | (89) | (76) |
| | for $s_{min,1} \geq$ | in. | 1-3/4 | 4 | 3-5/8 | 5 | 4-5/8 | 4-1/2 | 4-1/4 | 5-5/8 | 5-1/4 | 5 | 7 | 6-7/8 | 6-5/8 | 6-3/4 | 6-3/4 |
| | | (mm) | (44) | (102) | (92) | (127) | (117) | (114) | (108) | (143) | (133) | (127) | (178) | (175) | (168) | (172) | (172) |
| Case 2 | $c_{min,2}$ | in. | 1-5/8 | 3-1/4 | 2-1/2 | 2-7/8 | 2-3/8 | 2-3/8 | 2-1/8 | 3-7/8 | 3 | 2-3/4 | 4-1/8 | 3-3/4 | 3-3/4 | 4-1/4 | 3-3/4 |
| | | (mm) | (41) | (83) | (64) | (73) | (60) | (60) | (54) | (98) | (76) | (70) | (105) | (95) | (95) | (108) | (95) |
| | for $s_{min,2} \geq$ | in. | 1-1/4 | 2 | 1-3/4 | 2-1/2 | 2-1/4 | 2-1/8 | 1-7/8 | 3-1/8 | 2-1/8 | 2-1/8 | 4 | 3-1/2 | 3-1/2 | 5 | 4-3/4 |
| | | (mm) | (32) | (51) | (44) | (64) | (57) | (54) | (48) | (79) | (54) | (54) | (102) | (89) | (89) | (127) | (121) |

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge .distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacings.

**Table 6 — Load adjustment factors for 1/4-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]**

| 1/4-in. KB3 stainless steel uncracked uoncrete | | | Spacing factor in tension $f_{AN}$ | Edge distance factor in tension $f_{RN}$ | Spacing factor in shear[3] $f_{AV}$ | Edge distance in shear | | Concrete thickness factor in shear[4] $f_{HV}$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | ⊥ toward edge $f_{RV}$ | II to and away from edge $f_{RV}$ | |
| Embedment $h_{nom}$ | | in. | 1-3/4 | 1-3/4 | 1-3/4 | 1-3/4 | 1-3/4 | 1-3/4 |
| | | (mm) | (44) | (44) | (44) | (44) | (44) | (44) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 1-1/4 | (32) | 0.64 | n/a | 0.56 | n/a | n/a | n/a |
| | 1-3/8 | (35) | 0.65 | 0.53 | 0.57 | 0.26 | 0.51 | n/a |
| | 1-1/2 | (38) | 0.67 | 0.56 | 0.57 | 0.29 | 0.56 | n/a |
| | 2 | (51) | 0.72 | 0.68 | 0.60 | 0.45 | 0.68 | n/a |
| | 3 | (76) | 0.83 | 1.00 | 0.65 | 0.83 | 1.00 | n/a |
| | 3-1/2 | (89) | 0.89 | | 0.67 | 1.00 | | n/a |
| | 4 | (102) | 0.94 | | 0.70 | | | 0.88 |
| | 4-1/2 | (114) | 1.00 | | 0.72 | | | 0.94 |
| | 5 | (127) | | | 0.74 | | | 0.99 |
| | 5-1/2 | (140) | | | 0.77 | | | 1.00 |
| | 6 | (152) | | | 0.79 | | | |
| | 7 | (178) | | | 0.84 | | | |
| | 8 | (203) | | | 0.89 | | | |
| | 9 | (229) | | | 0.94 | | | |
| | 10 | (254) | | | 0.99 | | | |
| | 11 | (279) | | | 1.00 | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

**Table 7 — Load adjustment factors for 3/8-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]**

| 3/8-in. KB3 stainless steel uncracked concrete | | | Spacing factor in tension $f_{AN}$ | Edge distance factor in tension $f_{RN}$ | Spacing factor in shear[3] $f_{AV}$ | Edge distance in shear | | Concrete thickness factor in shear[4] $f_{HV}$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | ⊥ toward edge $f_{RV}$ | II to and away from edge $f_{RV}$ | |
| Embedment $h_{nom}$ | | in. (mm) | 2-3/8 (60) | 2-3/8 (60) | 2-3/8 (60) | 2-3/8 (60) | 2-3/8 (60) | 2-3/8 (60) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 2 | (51) | 0.67 | 0.51 | 0.58 | 0.35 | 0.51 | n/a |
| | 2-1/2 | (64) | 0.71 | 0.60 | 0.60 | 0.49 | 0.60 | n/a |
| | 3 | (76) | 0.75 | 0.69 | 0.62 | 0.64 | 0.69 | n/a |
| | 3-1/2 | (89) | 0.79 | 0.80 | 0.64 | 0.81 | 0.81 | n/a |
| | 4 | (102) | 0.83 | 0.91 | 0.67 | 0.99 | 0.99 | 0.81 |
| | 4-1/2 | (114) | 0.88 | 1.00 | 0.69 | 1.00 | 1.00 | 0.86 |
| | 5 | (127) | 0.92 | | 0.71 | | | 0.91 |
| | 6 | (152) | 1.00 | | 0.75 | | | 1.00 |
| | 7 | (178) | | | 0.79 | | | |
| | 8 | (203) | | | 0.83 | | | |
| | 9 | (229) | | | 0.87 | | | |
| | 10 | (254) | | | 0.91 | | | |
| | 11 | (279) | | | 0.95 | | | |
| | 12 | (305) | | | 1.00 | | | |
| | 14 | (356) | | | | | | |

**Table 8 — Load adjustment factors for 1/2-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]**

| 1/2-in. KB3 stainless steel uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Concrete thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. (mm) | 2-1/4 (57) | 3-1/2 (89) | 2-1/4 (57) | 3-1/2 (89) | 2-1/4 (57) | 3-1/2 (89) | 2-1/4 (57) | 3-1/2 (89) | 2-1/4 (57) | 3-1/2 (89) | 2-1/4 (57) | 3-1/2 (89) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 1-5/8 | (41) | n/a | n/a | n/a | 0.39 | n/a | n/a | n/a | 0.07 | n/a | 0.15 | n/a | n/a |
| | 2 | (51) | n/a | n/a | n/a | 0.42 | n/a | n/a | n/a | 0.10 | n/a | 0.20 | n/a | n/a |
| | 2-1/8 | (54) | n/a | 0.61 | n/a | 0.43 | n/a | 0.54 | n/a | 0.11 | n/a | 0.22 | n/a | n/a |
| | 2-1/2 | (64) | 0.71 | 0.63 | 0.54 | 0.47 | 0.61 | 0.55 | 0.53 | 0.14 | 0.54 | 0.28 | n/a | n/a |
| | 3 | (76) | 0.75 | 0.65 | 0.62 | 0.52 | 0.63 | 0.55 | 0.70 | 0.19 | 0.70 | 0.37 | n/a | n/a |
| | 3-1/2 | (89) | 0.79 | 0.68 | 0.72 | 0.57 | 0.65 | 0.56 | 0.88 | 0.23 | 0.88 | 0.47 | n/a | n/a |
| | 4 | (102) | 0.83 | 0.71 | 0.82 | 0.62 | 0.68 | 0.57 | 1.00 | 0.29 | 1.00 | 0.57 | 0.84 | n/a |
| | 4-1/2 | (114) | 0.88 | 0.73 | 0.92 | 0.68 | 0.70 | 0.58 | | 0.34 | | 0.68 | 0.89 | n/a |
| | 5 | (127) | 0.92 | 0.76 | 1.00 | 0.74 | 0.72 | 0.59 | | 0.40 | | 0.74 | 0.94 | n/a |
| | 6 | (152) | 1.00 | 0.81 | | 0.89 | 0.76 | 0.61 | | 0.53 | | 0.89 | 1.00 | 0.66 |
| | 7 | (178) | | 0.86 | | 1.00 | 0.81 | 0.63 | | 0.66 | | 1.00 | | 0.71 |
| | 8 | (203) | | 0.91 | | | 0.85 | 0.64 | | 0.81 | | | | 0.76 |
| | 9 | (229) | | 0.96 | | | 0.89 | 0.66 | | 0.97 | | | | 0.81 |
| | 10 | (254) | | 1.00 | | | 0.94 | 0.68 | | 1.00 | | | | 0.85 |
| | 11 | (279) | | | | | 0.98 | 0.70 | | | | | | 0.89 |
| | 12 | (305) | | | | | 1.00 | 0.72 | | | | | | 0.93 |
| | 14 | (356) | | | | | | 0.75 | | | | | | 1.00 |
| | 16 | (406) | | | | | | 0.79 | | | | | | |
| | 18 | (457) | | | | | | 0.83 | | | | | | |
| | 20 | (508) | | | | | | 0.86 | | | | | | |
| | > 24 | (610) | | | | | | 0.93 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

**Table 9 — Load adjustment factors for 5/8-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]**

| 5/8-in. KB3 stainless steel uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Concrete thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. (mm) | 3-1/2 (89) | 4-3/8 (111) | 3-1/2 (89) | 4-3/8 (111) | 3-1/2 (89) | 4-3/8 (111) | 3-1/2 (89) | 4-3/8 (111) | 3-1/2 (89) | 4-3/8 (111) | 3-1/2 (89) | 4-3/8 (111) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 2-1/8 | (54) | n/a | 0.59 | n/a | n/a | n/a | 0.53 | n/a | n/a | n/a | n/a | n/a | n/a |
| | 2-1/2 | (64) | n/a | 0.60 | n/a | 0.37 | n/a | 0.54 | n/a | 0.12 | n/a | 0.23 | n/a | n/a |
| | 3 | (76) | n/a | 0.63 | n/a | 0.40 | n/a | 0.55 | n/a | 0.15 | n/a | 0.30 | n/a | n/a |
| | 3-1/8 | (79) | 0.67 | 0.63 | n/a | 0.41 | 0.56 | 0.55 | n/a | 0.16 | n/a | 0.32 | n/a | n/a |
| | 3-1/4 | (83) | 0.67 | 0.64 | 0.49 | 0.42 | 0.56 | 0.55 | 0.24 | 0.17 | 0.47 | 0.34 | n/a | n/a |
| | 3-1/2 | (89) | 0.69 | 0.65 | 0.51 | 0.44 | 0.57 | 0.56 | 0.26 | 0.19 | 0.51 | 0.38 | n/a | n/a |
| | 4 | (102) | 0.71 | 0.67 | 0.56 | 0.47 | 0.58 | 0.56 | 0.32 | 0.23 | 0.56 | 0.47 | n/a | n/a |
| | 5 | (127) | 0.77 | 0.71 | 0.68 | 0.55 | 0.60 | 0.58 | 0.45 | 0.33 | 0.68 | 0.55 | 0.63 | n/a |
| | 6 | (152) | 0.82 | 0.75 | 0.81 | 0.63 | 0.62 | 0.59 | 0.59 | 0.43 | 0.81 | 0.63 | 0.69 | 0.62 |
| | 7 | (178) | 0.87 | 0.79 | 0.95 | 0.74 | 0.64 | 0.61 | 0.75 | 0.54 | 0.95 | 0.74 | 0.74 | 0.67 |
| | 8 | (203) | 0.93 | 0.83 | 1.00 | 0.84 | 0.66 | 0.63 | 0.91 | 0.66 | 1.00 | 0.84 | 0.79 | 0.71 |
| | 9 | (229) | 0.98 | 0.88 | | 0.95 | 0.68 | 0.64 | 1.00 | 0.79 | | 0.95 | 0.84 | 0.75 |
| | 10 | (254) | 1.00 | 0.92 | | 1.00 | 0.70 | 0.66 | | 0.92 | | 1.00 | 0.89 | 0.80 |
| | 11 | (279) | | 0.96 | | | 0.72 | 0.67 | | 1.00 | | | 0.93 | 0.83 |
| | 12 | (305) | | 1.00 | | | 0.74 | 0.69 | | | | | 0.97 | 0.87 |
| | 14 | (356) | | | | | 0.77 | 0.72 | | | | | 1.00 | 0.94 |
| | 16 | (406) | | | | | 0.81 | 0.75 | | | | | | 1.00 |
| | 18 | (457) | | | | | 0.85 | 0.78 | | | | | | |
| | 20 | (508) | | | | | 0.89 | 0.82 | | | | | | |
| | 24 | (610) | | | | | 0.97 | 0.88 | | | | | | |
| | > 30 | (762) | | | | | 1.00 | 0.97 | | | | | | |

**Table 10 — Load adjustment factors for 3/4-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]**

| 3/4-in. KB3 stainless steel uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Concrete thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. (mm) | 4-1/4 (108) | 5-1/2 (140) | 4-1/4 (108) | 5-1/2 (140) | 4-1/4 (108) | 5-1/2 (140) | 4-1/4 (108) | 5-1/2 (140) | 4-1/4 (108) | 5-1/2 (140) | 4-1/4 (108) | 5-1/2 (140) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 2-7/8 | (73) | n/a | n/a | n/a | 0.43 | n/a | n/a | n/a | 0.11 | n/a | 0.23 | n/a | n/a |
| | 3 | (76) | n/a | n/a | n/a | 0.44 | n/a | n/a | n/a | 0.12 | n/a | 0.24 | n/a | n/a |
| | 3-1/4 | (83) | n/a | n/a | 0.37 | 0.46 | n/a | n/a | 0.20 | 0.14 | 0.37 | 0.27 | n/a | n/a |
| | 3-1/2 | (89) | n/a | 0.62 | 0.39 | 0.47 | n/a | 0.55 | 0.22 | 0.15 | 0.39 | 0.30 | n/a | n/a |
| | 4 | (102) | 0.68 | 0.63 | 0.42 | 0.51 | 0.57 | 0.55 | 0.27 | 0.18 | 0.42 | 0.37 | n/a | n/a |
| | 4-1/2 | (114) | 0.70 | 0.65 | 0.45 | 0.54 | 0.58 | 0.56 | 0.32 | 0.22 | 0.45 | 0.44 | n/a | n/a |
| | 5 | (127) | 0.72 | 0.67 | 0.49 | 0.58 | 0.59 | 0.57 | 0.38 | 0.26 | 0.49 | 0.52 | n/a | n/a |
| | 6 | (152) | 0.77 | 0.70 | 0.57 | 0.65 | 0.60 | 0.58 | 0.49 | 0.34 | 0.57 | 0.65 | 0.65 | n/a |
| | 7 | (178) | 0.81 | 0.73 | 0.67 | 0.73 | 0.62 | 0.59 | 0.62 | 0.43 | 0.67 | 0.73 | 0.70 | n/a |
| | 8 | (203) | 0.86 | 0.77 | 0.76 | 0.82 | 0.64 | 0.61 | 0.76 | 0.52 | 0.76 | 0.82 | 0.75 | 0.66 |
| | 9 | (229) | 0.90 | 0.80 | 0.86 | 0.92 | 0.66 | 0.62 | 0.91 | 0.62 | 0.91 | 0.92 | 0.79 | 0.70 |
| | 10 | (254) | 0.94 | 0.83 | 0.95 | 1.00 | 0.67 | 0.64 | 1.00 | 0.73 | 1.00 | 1.00 | 0.83 | 0.74 |
| | 11 | (279) | 0.99 | 0.87 | 1.00 | | 0.69 | 0.65 | | 0.84 | | | 0.87 | 0.77 |
| | 12 | (305) | 1.00 | 0.90 | | | 0.71 | 0.66 | | 0.96 | | | 0.91 | 0.81 |
| | 14 | (356) | | 0.97 | | | 0.74 | 0.69 | | 1.00 | | | 0.99 | 0.87 |
| | 16 | (406) | | 1.00 | | | 0.78 | 0.72 | | | | | 1.00 | 0.93 |
| | 18 | (457) | | | | | 0.81 | 0.74 | | | | | | 0.99 |
| | 20 | (508) | | | | | 0.85 | 0.77 | | | | | | 1.00 |
| | 24 | (610) | | | | | 0.92 | 0.82 | | | | | | |
| | 30 | (762) | | | | | 1.00 | 0.91 | | | | | | |
| | > 36 | (914) | | | | | | 0.99 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

**Table 11 — Load adjustment factors for 1-in. diameter Hilti KWIK Bolt 3 stainless steel anchor in uncracked concrete[1,2]**

| 1-in. KB3 stainless steel uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Concrete thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. (mm) | 4-1/2 (114) | 6-1/4 (159) | 4-1/2 (114) | 6-1/4 (159) | 4-1/2 (114) | 6-1/4 (159) | 4-1/2 (114) | 6-1/4 (159) | 4-1/2 (114) | 6-1/4 (159) | 4-1/2 (114) | 6-1/4 (159) |
| Spacing (s) / edge distance ($c_{ai}$) / concrete thickness (h) - in. (mm) | 3 | (76) | n/a | n/a | n/a | 0.43 | n/a | n/a | n/a | 0.10 | n/a | 0.20 | n/a | n/a |
| | 3-1/2 | (89) | n/a | n/a | 0.42 | 0.45 | n/a | n/a | 0.21 | 0.12 | 0.42 | 0.25 | n/a | n/a |
| | 4 | (102) | n/a | n/a | 0.45 | 0.48 | n/a | n/a | 0.26 | 0.15 | 0.45 | 0.30 | n/a | n/a |
| | 4-1/2 | (114) | n/a | n/a | 0.49 | 0.51 | n/a | n/a | 0.31 | 0.18 | 0.49 | 0.36 | n/a | n/a |
| | 4-3/4 | (121) | n/a | 0.64 | 0.50 | 0.53 | n/a | 0.56 | 0.34 | 0.20 | 0.50 | 0.39 | n/a | n/a |
| | 5 | (127) | 0.71 | 0.64 | 0.52 | 0.54 | 0.59 | 0.56 | 0.37 | 0.21 | 0.52 | 0.43 | n/a | n/a |
| | 6 | (152) | 0.75 | 0.67 | 0.60 | 0.60 | 0.60 | 0.57 | 0.48 | 0.28 | 0.60 | 0.56 | n/a | n/a |
| | 7 | (178) | 0.79 | 0.70 | 0.70 | 0.67 | 0.62 | 0.58 | 0.61 | 0.35 | 0.70 | 0.67 | n/a | n/a |
| | 8 | (203) | 0.83 | 0.73 | 0.80 | 0.74 | 0.64 | 0.60 | 0.74 | 0.43 | 0.80 | 0.74 | 0.74 | n/a |
| | 9 | (229) | 0.88 | 0.76 | 0.90 | 0.82 | 0.65 | 0.61 | 0.89 | 0.51 | 0.90 | 0.82 | 0.78 | n/a |
| | 10 | (254) | 0.92 | 0.79 | 1.00 | 0.91 | 0.67 | 0.62 | 1.00 | 0.60 | 1.00 | 0.91 | 0.83 | 0.69 |
| | 11 | (279) | 0.96 | 0.82 | | 1.00 | 0.69 | 0.63 | | 0.69 | | 1.00 | 0.87 | 0.72 |
| | 12 | (305) | 1.00 | 0.85 | | | 0.70 | 0.64 | | 0.79 | | | 0.91 | 0.76 |
| | 14 | (356) | | 0.91 | | | 0.74 | 0.67 | | 1.00 | | | 0.98 | 0.82 |
| | 16 | (406) | | 0.96 | | | 0.77 | 0.69 | | | | | 1.00 | 0.87 |
| | 18 | (457) | | 1.00 | | | 0.81 | 0.71 | | | | | | 0.92 |
| | 20 | (508) | | | | | 0.84 | 0.74 | | | | | | 0.98 |
| | 24 | (610) | | | | | 0.91 | 0.79 | | | | | | 1.00 |
| | 30 | (762) | | | | | 1.00 | 0.86 | | | | | | |
| | > 36 | (914) | | | | | | 0.93 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 13 and figure 3 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

**Table 12 — Hilti KWIK Bolt 3 hot-dip galvanized design strength with concrete/pullout failure in uncracked concrete[1,2,3,4,5]**

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $\phi N_n$ | | | | Shear - $\phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) | $f'_c$ = 2,500 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 6,000 psi lb (kN) |
| 1/2 | 2 | 2-1/4 | 2,205 | 2,415 | 2,790 | 3,420 | 2,375 | 2,605 | 3,005 | 3,680 |
| | (51) | (57) | (9.8) | (10.7) | (12.4) | (15.2) | (10.6) | (11.6) | (13.4) | (16.4) |
| | 3-1/4 | 3-1/2 | 4,250 | 4,655 | 5,375 | 6,585 | 9,845 | 10,785 | 12,450 | 15,250 |
| | (83) | (89) | (18.9) | (20.7) | (23.9) | (29.3) | (43.8) | (48.0) | (55.4) | (67.8) |
| 5/8 | 3-1/8 | 3-1/2 | 4,200 | 4,605 | 5,315 | 6,510 | 9,280 | 10,165 | 11,740 | 14,380 |
| | (79) | (89) | (18.7) | (20.5) | (23.6) | (29.0) | (41.3) | (45.2) | (52.2) | (64.0) |
| | 4 | 4-3/8 | 5,860 | 6,420 | 7,415 | 9,080 | 13,440 | 14,725 | 17,000 | 20,820 |
| | (102) | (111) | (26.1) | (28.6) | (33.0) | (40.4) | (59.8) | (65.5) | (75.6) | (92.6) |
| 3/4 | 3-3/4 | 4-1/4 | 5,665 | 6,205 | 7,165 | 8,775 | 12,200 | 13,365 | 15,430 | 18,900 |
| | (95) | (108) | (25.2) | (27.6) | (31.9) | (39.0) | (54.3) | (59.5) | (68.6) | (84.1) |
| | 5 | 5-1/2 | 6,615 | 7,245 | 8,365 | 10,245 | 18,785 | 20,575 | 23,760 | 29,100 |
| | (127) | (140) | (29.4) | (32.2) | (37.2) | (45.6) | (83.6) | (91.5) | (105.7) | (129.4) |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 23 to 25 as necessary. Compare to steel values in table 21. The lesser of the values is to be used for the design.

4 Tabular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda$ = 0.68; for all-lightweight, $\lambda$ = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

**Table 13 — Steel design strength for Hilti KWIK Bolt 3 hot-dip galvanized anchors[1,2]**

| Nominal anchor diameter in. | Nominal embedment in. (mm) | Tensile $\phi N_{sa}$[3] lb (kN) | Shear $\phi V_{sa}$[4] lb (kN) |
|---|---|---|---|
| 1/2 | 2-1/4 (57) | 8,745 (38.9) | 2,925 (13.0) |
| | 3-1/2 (89) | | 3,815 (17.0) |
| 5/8 | 3-1/2 (89) | 13,515 (60.1) | 7,565 (33.7) |
| | 4-3/8 (111) | | |
| 3/4 | 4-1/4 (108) | 19,080 (84.9) | 11,050 (49.2) |
| | 5-1/2 (140) | | |

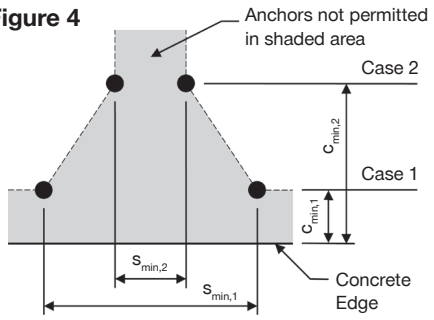
1 See section 3.1.8 to convert design strength value to ASD value.

2 KWIK Bolt 3 carbon steel anchors are to be considered ductile steel elements.

3 Tensile $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.

4 Shear values determined by static shear tests with $\phi V_{sa} < \phi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.

**Figure 4**




For a specific edge distance, the permitted spacing is calculated as follows:

$$s \geq s_{min,2} + \frac{(s_{min,1} - s_{min,2})}{(c_{min,1} - c_{min,2})} (c - c_{min,2})$$

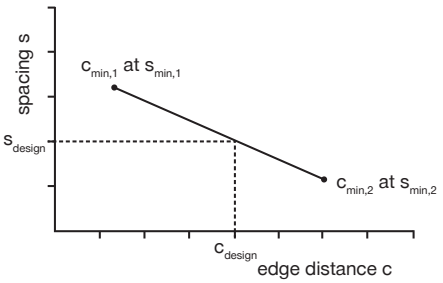



**Table 14 — Hot-dip galvanized KWIK Bolt 3 installation parameters[1]**

| Setting information | Symbol | Units | Nominal anchor diameter $d_o$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/2 | | | | 5/8 | | | 3/4 | | |
| Effective minimum embedment | $h_{ef}$ | in. | 2 | | 3-1/4 | | 3-1/8 | 4 | | 3-3/4 | | 5 |
| | | (mm) | (51) | | (83) | | (79) | (102) | | (95) | | (127) |
| Minimum member thickness | $h_{min}$ | in. | 4 | 6 | 6 | 8 | 5 | 6 | 8 | 6 | 8 | 8 |
| | | (mm) | (102) | (152) | (152) | (203) | (127) | (152) | (203) | (152) | (203) | (203) |
| Case 1 | $c_{min,1}$ | in. | 3-1/4 | 2-5/8 | 2 | | 2-1/4 | 2 | 1-78 | 3-1/2 | | 3-5/8 |
| | | (mm) | (83) | (67) | (51) | | (57) | (51) | (48) | (89) | | (92) |
| | for $s_{min,1}$ ≥ | in. | 6-1/4 | 5-1/2 | 4-7/8 | | 5-1/4 | 5 | 4-3/4 | 7-1/2 | | 7-3/8 |
| | | (mm) | (158) | (140) | (124) | | (133) | (127) | (121) | (191) | | (187) |
| Case 2 | $c_{min,2}$ | in. | 3-3/4 | 2-3/4 | 2-5/8 | 2-1/4 | 3-1/2 | 2-1/2 | 2-1/4 | 6-1/2 | | 4-3/4 |
| | | (mm) | (95) | (70) | (67) | (57) | (89) | (64) | (57) | (165) | | (121) |
| | for $s_{min,2}$ ≥ | in. | 3-1/8 | 2-3/4 | 2-3/8 | 2-1/8 | 2-1/2 | 2-1/8 | 2-1/8 | 4 | | 3-7/8 |
| | | (mm) | (79) | (70) | (60) | (54) | (64) | (54) | (54) | (102) | | (98) |

1 Linear interpolation is permitted to establish an edge distance and spacing combination between Case 1 and Case 2. Linear interpolation for a specific edge .distance c, where $c_{min,1} < c < c_{min,2}$ will determine the permissible spacings.

**Table 15 — Load adjustment factors for 1/2-in. diameter Hilti KWIK Bolt 3 hot-dip galvanized anchor in uncracked concrete[1,2]**

| 1/2-in. KB3 hot-dip galvanized uncracked concrete | | | spacing factor in tension $f_{AN}$ | | edge distance factor in tension $f_{RN}$ | | spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear | | | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ⊥ toward edge $f_{RV}$ | | II to and away from edge $f_{RV}$ | | | |
| Embedment $h_{nom}$ | | in. (mm) | 2-1/4 (57) | 3-1/2 (89) | 2-1/4 (57) | 3-1/2 (89) | 2-1/4 (57) | 3-1/2 (89) | 2-1/4 (57) | 3-1/2 (89) | 2-1/4 (57) | 3-1/2 (89) | 2-1/4 (57) | 3-1/2 (89) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 2 | (51) | n/a | n/a | n/a | 0.38 | n/a | n/a | n/a | 0.10 | n/a | 0.20 | n/a | n/a |
| | 2-3/8 | (60) | n/a | 0.62 | n/a | 0.41 | n/a | 0.54 | n/a | 0.13 | n/a | 0.26 | n/a | n/a |
| | 2-1/2 | (64) | n/a | 0.63 | n/a | 0.42 | n/a | 0.55 | n/a | 0.14 | n/a | 0.28 | n/a | n/a |
| | 3 | (76) | n/a | 0.65 | n/a | 0.46 | n/a | 0.55 | n/a | 0.19 | n/a | 0.37 | n/a | n/a |
| | 3-1/8 | (79) | 0.76 | 0.66 | n/a | 0.48 | 0.64 | 0.56 | n/a | 0.20 | n/a | 0.40 | n/a | n/a |
| | 3-1/4 | (83) | 0.77 | 0.67 | 0.67 | 0.49 | 0.64 | 0.56 | 0.79 | 0.21 | 0.79 | 0.42 | n/a | n/a |
| | 3-1/2 | (89) | 0.79 | 0.68 | 0.72 | 0.51 | 0.65 | 0.56 | 0.88 | 0.23 | 0.88 | 0.47 | n/a | n/a |
| | 4 | (102) | 0.83 | 0.71 | 0.82 | 0.56 | 0.68 | 0.57 | 1.00 | 0.29 | 1.00 | 0.56 | 0.84 | n/a |
| | 4-1/2 | (114) | 0.88 | 0.73 | 0.92 | 0.61 | 0.70 | 0.58 | | 0.34 | | 0.61 | 0.89 | n/a |
| | 5 | (127) | 0.92 | 0.76 | 1.00 | 0.67 | 0.72 | 0.59 | | 0.40 | | 0.67 | 0.94 | n/a |
| | 6 | (152) | 1.00 | 0.81 | | 0.80 | 0.76 | 0.61 | | 0.53 | | 0.80 | 1.00 | 0.66 |
| | 7 | (178) | 1.00 | 0.86 | | 0.93 | 0.81 | 0.63 | | 0.66 | | 0.93 | | 0.71 |
| | 8 | (203) | | 0.91 | | 1.00 | 0.85 | 0.64 | | 0.81 | | 1.00 | | 0.76 |
| | 9 | (229) | | 0.96 | | | 0.89 | 0.66 | | 0.97 | | | | 0.81 |
| | 10 | (254) | | 1.00 | | | 0.94 | 0.68 | | 1.00 | | | | 0.85 |
| | 11 | (279) | | | | | 0.98 | 0.70 | | | | | | 0.89 |
| | 12 | (305) | | | | | 1.00 | 0.72 | | | | | | 0.93 |
| | 14 | (356) | | | | | | 0.75 | | | | | | 1.00 |
| | 16 | (406) | | | | | | 0.79 | | | | | | |
| | 18 | (457) | | | | | | 0.83 | | | | | | |
| | 20 | (508) | | | | | | 0.86 | | | | | | |
| | > 24 | (610) | | | | | | 0.93 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 22 and figure 4 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

**Table 16 — Load adjustment factors for 5/8-in. diameter Hilti KWIK Bolt 3 hot-dip galvanized anchor in uncracked concrete[1,2]**

| 5/8-in. KB3 hot-dip galvanized uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | Edge distance in shear: II to and away from edge $f_{RV}$ | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | | in. (mm) | 3-1/2 (89) | 4-3/8 (111) | 3-1/2 (89) | 4-3/8 (111) | 3-1/2 (89) | 4-3/8 (111) | 3-1/2 (89) | 4-3/8 (111) | 3-1/2 (89) | 4-3/8 (111) | 3-1/2 (89) | 4-3/8 (111) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 2 | (51) | n/a | n/a | n/a | 0.34 | n/a | n/a | n/a | 0.08 | n/a | 0.17 | n/a | n/a |
| | 2-1/8 | (54) | n/a | 0.59 | n/a | 0.34 | n/a | 0.53 | n/a | 0.09 | n/a | 0.18 | n/a | n/a |
| | 2-1/4 | (57) | n/a | 0.59 | 0.38 | 0.35 | n/a | 0.54 | 0.14 | 0.10 | 0.27 | 0.20 | n/a | n/a |
| | 2-1/2 | (64) | 0.63 | 0.60 | 0.41 | 0.37 | 0.55 | 0.54 | 0.16 | 0.12 | 0.32 | 0.23 | n/a | n/a |
| | 3 | (76) | 0.66 | 0.63 | 0.45 | 0.40 | 0.56 | 0.55 | 0.21 | 0.15 | 0.42 | 0.30 | n/a | n/a |
| | 3-1/2 | (89) | 0.69 | 0.65 | 0.50 | 0.44 | 0.57 | 0.56 | 0.26 | 0.19 | 0.50 | 0.38 | n/a | n/a |
| | 4 | (102) | 0.71 | 0.67 | 0.54 | 0.47 | 0.58 | 0.56 | 0.32 | 0.23 | 0.54 | 0.47 | n/a | n/a |
| | 4-1/2 | (114) | 0.74 | 0.69 | 0.60 | 0.51 | 0.59 | 0.57 | 0.38 | 0.28 | 0.60 | 0.51 | n/a | n/a |
| | 5 | (127) | 0.77 | 0.71 | 0.66 | 0.55 | 0.60 | 0.58 | 0.45 | 0.33 | 0.66 | 0.55 | 0.63 | n/a |
| | 6 | (152) | 0.82 | 0.75 | 0.79 | 0.63 | 0.62 | 0.59 | 0.59 | 0.43 | 0.79 | 0.63 | 0.69 | 0.62 |
| | 7 | (178) | 0.87 | 0.79 | 0.92 | 0.74 | 0.64 | 0.61 | 0.75 | 0.54 | 0.92 | 0.74 | 0.74 | 0.67 |
| | 8 | (203) | 0.93 | 0.83 | 1.00 | 0.84 | 0.66 | 0.63 | 0.91 | 0.66 | 1.00 | 0.84 | 0.79 | 0.71 |
| | 9 | (229) | 0.98 | 0.88 | | 0.95 | 0.68 | 0.64 | 1.00 | 0.79 | | 0.95 | 0.84 | 0.75 |
| | 10 | (254) | 1.00 | 0.92 | | 1.00 | 0.70 | 0.66 | | 0.92 | | 1.00 | 0.89 | 0.80 |
| | 11 | (279) | | 0.96 | | | 0.72 | 0.67 | | 1.00 | | | 0.93 | 0.83 |
| | 12 | (305) | | 1.00 | | | 0.74 | 0.69 | | | | | 0.97 | 0.87 |
| | 14 | (356) | | | | | 0.77 | 0.72 | | | | | 1.00 | 0.94 |
| | 16 | (406) | | | | | 0.81 | 0.75 | | | | | | 1.00 |
| | 18 | (457) | | | | | 0.85 | 0.78 | | | | | | |
| | 20 | (508) | | | | | 0.89 | 0.82 | | | | | | |
| | 24 | (610) | | | | | 0.97 | 0.88 | | | | | | |
| | > 30 | (762) | | | | | 1.00 | 0.97 | | | | | | |

**Table 17 — Load adjustment factors for 3/4-in. diameter Hilti KWIK Bolt 3 hot-dip galvanized anchor in uncracked concrete[1,2]**

| 3/4-in. KB3 hot-dip galvanized uncracked concrete | | | Spacing factor in tension $f_{AN}$ | | Edge distance factor in tension $f_{RN}$ | | Spacing factor in shear[3] $f_{AV}$ | | Edge distance in shear: ⊥ toward edge $f_{RV}$ | | Edge distance in shear: II to and away from edge $f_{RV}$ | | Conc. thickness factor in shear[4] $f_{HV}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embedment $h_{nom}$ | | in. (mm) | 4-1/4 (108) | 5-1/2 (140) | 4-1/4 (108) | 5-1/2 (140) | 4-1/4 (108) | 5-1/2 (140) | 4-1/4 (108) | 5-1/2 (140) | 4-1/4 (108) | 5-1/2 (140) | 4-1/4 (108) | 5-1/2 (140) |
| Spacing (s) / edge distance ($c_a$) / concrete thickness (h) - in. (mm) | 3-1/2 | (89) | n/a | n/a | 0.41 | n/a | n/a | n/a | 0.22 | n/a | 0.41 | n/a | n/a | n/a |
| | 3-5/8 | (92) | n/a | n/a | 0.42 | 0.49 | n/a | n/a | 0.23 | 0.16 | 0.42 | 0.32 | n/a | n/a |
| | 3-7/8 | (98) | n/a | 0.63 | 0.44 | 0.51 | n/a | 0.55 | 0.26 | 0.18 | 0.44 | 0.35 | n/a | n/a |
| | 4 | (102) | 0.68 | 0.63 | 0.45 | 0.52 | 0.57 | 0.55 | 0.27 | 0.18 | 0.45 | 0.37 | n/a | n/a |
| | 4-1/2 | (114) | 0.70 | 0.65 | 0.49 | 0.56 | 0.58 | 0.56 | 0.32 | 0.22 | 0.49 | 0.44 | n/a | n/a |
| | 5 | (127) | 0.72 | 0.67 | 0.53 | 0.59 | 0.59 | 0.57 | 0.38 | 0.26 | 0.53 | 0.52 | n/a | n/a |
| | 5-1/2 | (140) | 0.74 | 0.68 | 0.57 | 0.63 | 0.60 | 0.57 | 0.43 | 0.30 | 0.57 | 0.60 | n/a | n/a |
| | 6 | (152) | 0.77 | 0.70 | 0.62 | 0.67 | 0.60 | 0.58 | 0.49 | 0.34 | 0.62 | 0.67 | 0.65 | n/a |
| | 7 | (178) | 0.81 | 0.73 | 0.72 | 0.75 | 0.62 | 0.59 | 0.62 | 0.43 | 0.72 | 0.75 | 0.70 | n/a |
| | 8 | (203) | 0.86 | 0.77 | 0.82 | 0.84 | 0.64 | 0.61 | 0.76 | 0.52 | 0.82 | 0.84 | 0.75 | 0.66 |
| | 9 | (229) | 0.90 | 0.80 | 0.92 | 0.95 | 0.66 | 0.62 | 0.91 | 0.62 | 0.92 | 0.95 | 0.79 | 0.70 |
| | 10 | (254) | 0.94 | 0.83 | 1.00 | 1.00 | 0.67 | 0.64 | 1.00 | 0.73 | 1.00 | 1.00 | 0.83 | 0.74 |
| | 11 | (279) | 0.99 | 0.87 | | | 0.69 | 0.65 | | 0.84 | | | 0.87 | 0.77 |
| | 12 | (305) | 1.00 | 0.90 | | | 0.71 | 0.66 | | 0.96 | | | 0.91 | 0.81 |
| | 14 | (356) | | 0.97 | | | 0.74 | 0.69 | | 1.00 | | | 0.99 | 0.87 |
| | 16 | (406) | | 1.00 | | | 0.78 | 0.72 | | | | | 1.00 | 0.93 |
| | 18 | (457) | | | | | 0.81 | 0.74 | | | | | | 0.99 |
| | 20 | (508) | | | | | 0.85 | 0.77 | | | | | | 1.00 |
| | 24 | (610) | | | | | 0.92 | 0.82 | | | | | | |
| | 30 | (762) | | | | | 1.00 | 0.91 | | | | | | |
| | > 36 | (914) | | | | | | 0.99 | | | | | | |

1 Linear interpolation not permitted.

2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17.

3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.

4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

If a reduction factor value is in a shaded cell, this indicates that this specific edge distance may not be permitted with a certain spacing (or vice versa). Check with table 22 and figure 4 of this section to calculate permissable edge distance, spacing and concrete thickness combinations. Use of Hilti KWIK Bolt 3 anchors with edge distance and spacing dimensions smaller than what is noted in this table is permitted.

**Table 18 — Hilti KWIK Bolt 3 stainless steel design strength in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,7,8]**

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Loads according to figure 5 | | | |
|---|---|---|---|---|---|---|
| | | | Tension - $\phi N_n$ | | Shear - $\phi V_n$ | |
| | | | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) | $f'_c$ = 3,000 psi lb (kN) | $f'_c$ = 4,000 psi lb (kN) |
| 1/4 | 1-1/2 (38) | 1-3/4 (44) | 1,175 (5.2) | 1,355 (6.0) | 1,315 (5.8) | 1,315 (5.8) |
| 3/8 | 2 (51) | 2-3/8 (60) | 1,675 (7.5) | 1,935 (8.6) | 1,675 (7.5) | 1,675 (7.5) |
| 1/2 | 2 (51) | 2-1/4 (57) | 1,265 (5.6) | 1,460 (6.5) | 1,135 (5.0) | 1,135 (5.0) |
| | 3-1/4 (83) | 3-1/2 (89) | | | | |
| 5/8 | 3-1/8 (79) | 3-1/2 (89) | 2,880 (12.8) | 3,325 (14.8) | 3,700 (16.5) | 3,700 (16.5) |
| | 4 (102) | 4-3/8 (111) | | | | |

1 See section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are lightweight concrete and no additional reduction factor is needed.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Comparison to steel values in table 4 is not required. Values in tables 26 control.
7 Comparison to steel values in table 12 is not required. Values in tables 27 control.
8 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

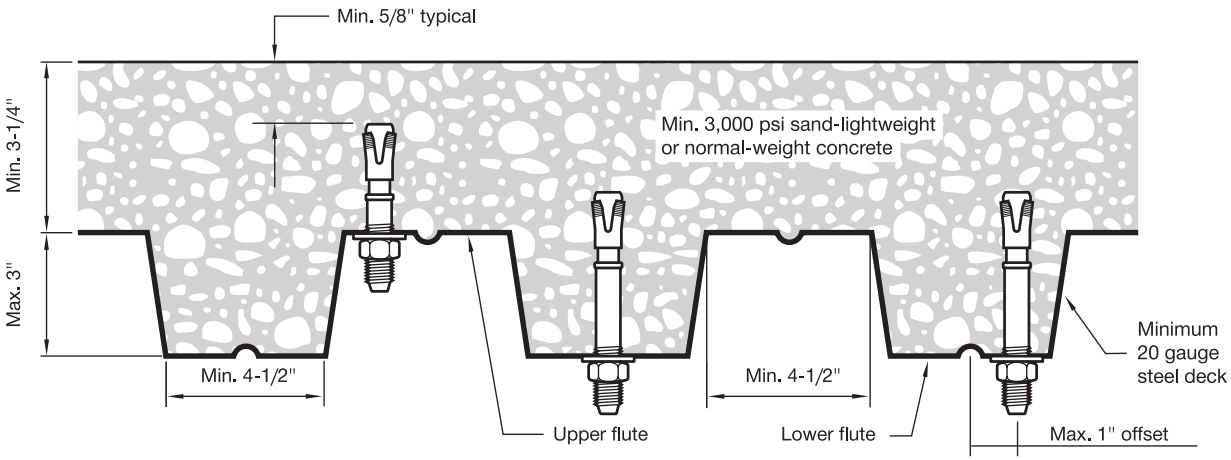



**Figure 5 — Installation in concrete over metal deck**

## DESIGN INFORMATION IN CONCRETE PER CSA A23.3

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-2302. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.com.

**Table 19 — Steel resistance for Hilti KWIK Bolt 3 stainless steel anchors[1,2]**

| Nominal anchor diameter in. | Nominal embedment in. (mm) | Tensile $N_{sar}$ [3] lb (kN) | Shear $V_{sar}$ [4] lb (kN) |
|---|---|---|---|
| 1/4 | 1-11/16 (42.9) | 1,565 (7.0) | 1,070 (4.8) |
| 3/8 | 2-3/8 (60.3) | 4,690 (20.9) | 3,175 (14.1) |
| 1/2 | 2-1/4 (57.2) | 8,600 (38.3) | 2,675 (11.9) |
| | 3-1/2 (88.9) | | 4,425 (19.7) |
| 5/8 | 3-1/2 (88.9) | 13,295 (59.1) | 5,710 (25.4) |
| | 4-3/8 (111.1) | | 9,115 (40.5) |
| 3/4 | 4-1/4 (108.0) | 14,690 (65.3) | 7,585 (33.7) |
| | 5-1/2 (139.7) | | 15,010 (66.8) |
| 1 | 4-5/8 (117.5) | 28,770 (128.0) | 7,975 (35.5) |
| | 5-7/8 (149.2) | | 17,430 (77.5) |

1 See Section 3.1.8 to convert factored resistance value to ASD value.

2 Hilti KWIK Bolt 3 stainless steel anchors are to be considered ductile steel elements.

3 Tensile $N_{sar} = A_{se,N}\ \phi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.

4 Shear determined by static shear tests with $V_{sar} < A_{se,V}\ \phi_s\ 0.6\ f_{uta}$ R as noted in CSA A23.3 Annex D.

## Table 20 — Hilti KWIK Bolt 3 stainless steel design information in accordance with CSA A23.3 Annex D[1]

| Design parameter | Symbol | Units | Nominal anchor diameter | | | | | | | | | | | | | | | | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | 3/8 | | 1/2 | | | | 5/8 | | | 3/4 | | | 1 | | | A23.3-14 |
| Anchor O.D. | $d_a$ | in. | 0.25 | 0.375 | | 0.5 | | | | 0.625 | | | 0.75 | | | 1 | | | |
| | | (mm) | (6.4) | (9.5) | | (12.7) | | | | (15.9) | | | (19.1) | | | (25.4) | | | |
| Effective minimum embedment[2] | $h_{ef}$ | in. | 1-1/2 | 2 | | 2 | | 3-1/4 | | 3-1/8 | 4 | | 3-3/4 | | 5 | 4 | 5-1/4 | | |
| | | (mm) | (38) | (51) | | (51) | | (83) | | (79) | (102) | | (95) | | (127) | (102) | (133) | | |
| Minimum concrete thickness[2] | $h_{min}$ | in. | 4 | 4 | 5 | 4 | 6 | 6 | 8 | 5 | 6 | 8 | 6 | 8 | 8 | 8 | 10 | | |
| | | (mm) | (102) | (102) | (127) | (102) | (152) | (152) | (203) | (127) | (152) | (203) | (152) | (203) | (203) | (203) | (254) | | |
| Critical edge distance | $c_{ac}$ | in. | 3 | 4-3/8 | 3-7/8 | 4-7/8 | 4 | 6-3/4 | 5-3/4 | 7-3/8 | 9-1/2 | 7-1/2 | 10-1/2 | 9-1/4 | 9-3/4 | 10 | 11 | | |
| | | (mm) | (76) | (111) | (98) | (124) | (102) | (171) | (146) | (187) | (241) | (191) | (267) | (235) | (248) | (254) | (279) | | |
| Minimum edge distance | $c_{min}$ | in. | 1-3/8 | 2 | 1-5/8 | 2-1/2 | 1.875 | 1-5/8 | 1-5/8 | 3-1/4 | 2-1/2 | 2-1/2 | 3-1/4 | 3 | 2-7/8 | 3-1/2 | 3 | | |
| | | (mm) | (35) | (51) | (41) | (64) | (48) | (41) | (41) | (83) | (64) | (64) | (83) | (76) | (73) | (89) | (76) | | |
| | for s > | in. | 1-3/4 | 4 | 3-3/8 | 5 | 4-5/8 | 4-1/2 | 4.25 | 5-5/8 | 5-1/4 | 5 | 7 | 6-7/8 | 6-5/8 | 6-3/4 | 6-3/4 | | |
| | | (mm) | (44) | (102) | (86) | (127) | (117) | (114) | (108) | (143) | (133) | (127) | (178) | (175) | (168) | (171) | (171) | | |
| Minimum anchor spacing | $s_{min}$ | in. | 1-1/4 | 2 | 1-3/4 | 2-1/2 | 2-1/4 | 2 | 1-7/8 | 3-1/8 | 2-1/8 | 2-1/8 | 4 | 3-1/2 | 3-1/2 | 5 | 4-3/4 | | |
| | | (mm) | (32) | (51) | (44) | (64) | (57) | (2) | (48) | (79) | (54) | (54) | (102) | (89) | (89) | (127) | (121) | | |
| | for c > | in. | 1-5/8 | 3-1/4 | 2-1/2 | 2-7/8 | 2-3/8 | 2-3/8 | 2-1/8 | 3-7/8 | 3 | 2-3/4 | 4-1/8 | 3-3/4 | 3-3/4 | 4-1/4 | 3-3/4 | | |
| | | (mm) | (41) | (83) | (64) | (73) | (60) | (60) | (54) | (98) | (76) | (70) | (105) | (95) | (95) | (108) | (95) | | |
| Minimum hole depth in concrete | $h_o$ | in. | 2 | 2-5/8 | | 2-5/8 | | 4 | | 3-7/8 | 4-3/4 | | 4-1/2 | | 5-3/4 | 5 | 6-3/4 | | |
| | | (mm) | (50.8) | (67) | | (67) | | (102) | | (98) | (121) | | (117) | | (146) | | | | |
| Minimum specified yield strength | $f_{ya}$ | psi | 84,800 | 92,000 | | 92,000 | | | | 92,000 | | | 76,000 | | | 76,000 | | | |
| | | ($N/mm^2$) | (585) | (634) | | (634) | | | | (634) | | | (524) | | | (524) | | | |
| Minimum specified ultimate strength | $f_{uta}$ | psi | 115,000 | 115,000 | | 115,000 | | | | 115,000 | | | 90,000 | | | 90000 | | | |
| | | ($N/mm^2$) | (793) | (793) | | (793) | | | | (793) | | | (621) | | | (621) | | | |
| Effective tensile stress area | $A_{se,N}$ | $in^2$ | 0.02 | 0.06 | | 0.11 | | | | 0.17 | | | 0.24 | | | 0.47 | | | |
| | | ($mm^2$) | (12.9) | (38.7) | | (71.0) | | | | (109.7) | | | (154.8) | | | (154.8) | | | |
| Steel embedment material resistance factor for reinforcement | $\phi_s$ | - | 0.85 | | | | | | | | | | | | | | | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes[3] | R | - | 0.80 | | | | | | | | | | | | | | | | D.5.3 |
| Resistance modification factor for shear, steel failure modes[3] | R | - | 0.75 | | | | | | | | | | | | | | | | D.5.3 |
| Factored steel resistance in tension | $N_{sar}$ | lb | 1,565 | 4,690 | | 8,600 | | | | 13,295 | | | 14,690 | | | 28,770 | | | D.6.1.2 |
| | | (kN) | (7.0) | (20.9) | | (38.3) | | | | (59.1) | | | (65.3) | | | (128.0) | | | |
| Factored steel resistance in shear | $V_{sar}$ | lb | 1,070 | 3,175 | | 2,675 | | 4,425 | | 5,710 | 9,115 | | 7,585 | | 15,010 | 7,975 | 17,430 | | D.7.1.2 |
| | | (kN) | (4.8) | (14.1) | | (11.9) | | (19.7) | | (25.4) | (66.8) | | (33.7) | | (66.8) | (35.5) | (77.5) | | |
| Coeff. for factored concrete breakout resistance, uncracked concrete | $k_{c,uncr}$ | - | 10 | | | | | | | | | | | | | | | | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked concrete[4] | $\psi_{c,N}$ | - | 1.0 | | | | | | | | | | | | | | | | D.6.2.6 |
| Anchor category | - | - | 2 | 1 | | | | | | | | | | | | | | | D.5.3 (c ) |
| Concrete material resistance factor | $\phi_c$ | - | 0.65 | | | | | | | | | | | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | R | - | 0.85 | 1.00 | | | | | | | | | | | | | | | D.5.3 (c ) |
| Factored pullout resistance in 20 MPa uncracked concrete[6] | $N_{pr,uncr}$ | lb | 1,100 | 2,070 | | 2,315 | | 4,225 | | 4,360 | 5,485 | | 6,000 | | 7,600 | NA | 10,905 | | D.6.3.2 |
| | | (kN) | (4.9) | (9.2) | | (10.3) | | (18.8) | | (19.4) | (24.4) | | (26.7) | | (33.8) | | (48.5) | | |

1 Design information in this table is taken from ICC-ES ESR-2302, dated December 1, 2020 table 4, and converted for use with CSA A23.3 Annex D.
2 See figure 1 of this section.
3 The stainless steel KWIK Bolt 3 is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-2302 for additional information.

## Table 21 — Hilti KWIK Bolt 3 stainless steel factored resistance with concrete/pullout failure in uncracked concrete[1,2,3,4,5]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4 | 1 1/2 (38) | 1-11/16 43 | 930 (4.1) | 1,040 (4.6) | 1,140 (5.1) | 1,315 (5.8) | 1,300 (5.8) | 1,455 (6.5) | 1,595 (7.1) | 1,840 (8.2) |
| 3/8 | 2 (51) | 2-5/16 (59) | 2,080 (9.2) | 2,325 (10.3) | 2,545 (11.3) | 2,940 (13.1) | 2,380 (10.6) | 2,660 (11.8) | 2,915 (13.0) | 3,365 (15.0) |
| 1/2 | 2 (51) | 2 3/8 (60) | 2,315 (10.3) | 2,585 (11.5) | 2,835 (12.6) | 3,275 (14.6) | 2,380 (10.6) | 2,660 (11.8) | 2,915 (13.0) | 3,365 (15.0) |
| | 3-1/4 (83) | 3 5/8 (92) | 4,220 (18.8) | 4,715 (21.0) | 5,165 (23.0) | 5,965 (26.5) | 9,885 (44.0) | 11,050 (49.2) | 12,105 (53.8) | 13,975 (62.2) |
| 5/8 | 3-1/8 (79) | 3-9/16 (90) | 4,360 (19.4) | 4,875 (21.7) | 5,340 (23.8) | 6,165 (27.4) | 9,175 (40.8) | 10,260 (45.6) | 11,240 (50.0) | 12,980 (57.7) |
| | 4 (102) | 4-7/16 (113) | 5,480 (24.4) | 6,125 (27.2) | 6,710 (29.8) | 7,750 (34.5) | 13,465 (59.9) | 15,055 (67.0) | 16,490 (73.4) | 19,040 (84.7) |
| 3/4 | 3-3/4 (95) | 4-5/16 (110) | 6,000 (26.7) | 6,705 (29.8) | 7,345 (32.7) | 8,480 (37.7) | 12,100 (53.8) | 13,530 (60.2) | 14,820 (65.9) | 17,115 (76.1) |
| | 4-3/4 (121) | 5-9/16 (141) | 7,590 (33.8) | 8,485 (37.7) | 9,295 (41.3) | 10,730 (47.7) | 17,395 (77.4) | 19,450 (86.5) | 21,305 (94.8) | 24,600 (109.4) |
| 1 | 4 (102) | 4-5/16 (110) | 6,730 (29.9) | 7,525 (33.5) | 8,245 (36.7) | 9,520 (42.3) | 13,465 (59.9) | 15,055 (67.0) | 16,490 (73.4) | 19,040 (84.7) |
| | 5 3/4 (146) | 5-9/16 (141) | 10,895 (48.5) | 12,180 (54.2) | 13,340 (59.3) | 15,405 (68.5) | 23,055 (102.6) | 25,780 (114.7) | 28,240 (125.6) | 32,610 (145.0) |

1 See section 3.1.8 to convert factored resistance value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 14 to 19 as necessary. Compare to the steel values in table 31. The lesser of the values is to be used for the design.

4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 22 — Steel resistance for Hilti KWIK Bolt 3 hot-dip galvanized carbon steel anchors[1,2]

| Nominal anchor diameter in. | Nominal embedment in. (mm) | Tensile $N_{sar}$[3] lb (kN) | Shear $V_{sar}$[4] lb (kN) |
|---|---|---|---|
| 1/2 | 2-1/4 (57) | 7,930 (35.3) | 2,870 (12.8) |
| | 3-1/2 (89) | | 3,740 (16.6) |
| 5/8 | 3-1/2 (89) | 12,255 (54.5) | 7,415 (33.0) |
| | 4-3/8 (111) | | |
| 3/4 | 4-1/4 (108) | 17,300 (77.0) | 10,840 (48.2) |
| | 5-1/2 (140) | | |

1 See section 3.1.8 to convert design strength value to ASD value.

2 KWIK Bolt 3 hot-dip galvanized carbon steel anchors are to be considered ductile steel elements.

3 Tensile $N_{sar} = A_{se,N}\, \Phi_s\, f_{uta}\, R$ as noted in ACI 318 Chapter 17.

4 Shear values determined by static shear tests with $V_{sar} < A_{se,V}\, \Phi_s\, 0.6\, f_{uta}\, R$ as noted in ACI 318 Chapter 17.

## Table 23 — Hilti KWIK Bolt 3 hot-dip galvanized carbon steel design information in accordance with CSA A23.3 Annex D[1]

| Design parameter | Symbol | Units | 1/2 | | | | 5/8 | | | 3/4 | | | Ref A23.3-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anchor O.D. | $d_a$ | in. (mm) | 0.5 (12.7) | | | | 0.625 (15.9) | | | 0.75 (19.1) | | | |
| Effective minimum embedment[2] | $h_{ef}$ | in. (mm) | 2 (51) | | 3-1/4 (83) | | 3-1/8 (79) | 4 (102) | | 3-3/4 (95) | | 4-3/4 (121) | |
| Minimum concrete thickness | $h_{min}$ | in. (mm) | 4 (102) | 6 (152) | 6 (152) | 8 (203) | 5 (127) | 6 (152) | 8 (203) | 6 (152) | 8 (203) | 8 (203) | |
| Critical edge distance | $c_{ac}$ | in. (mm) | 4-7/8 (124) | 3-5/8 (92) | 7-1/2 (191) | 5.75 (146) | 8 (194) | 9-1/2 (241) | 8 (197) | 9-3/4 (248) | 7-1/2 (191) | 9-1/2 (241) | |
| Minimum edge distance | $c_{min}$ | in. (mm) | 2-7/8 (73) | | 2-1/8 (54) | | 3-1/4 (83) | 2-3/8 (60) | | 4-1/4 (108) | | 4 (102) | |
| | for s > | in. (mm) | 5-3/4 (146) | | 5-1/4 (133) | | 5-1/2 (140) | 5-1/2 (140) | | 10 (254) | | 8-1/2 (216) | |
| Minimum anchor spacing | $s_{min}$ | in. (mm) | 2-7/8 (73) | | 2 (51) | | 2-3/4 (70) | 2-3/8 (60) | | 5 (127) | | 4 (102) | |
| | for c > | in. (mm) | 4-1/2 (114) | | 3-1/4 (83) | | 4-1/8 (105) | 4-1/4 (108) | | 9-1/2 (241) | | 7 (178) | |
| Minimum hole depth in concrete | $h_o$ | in. (mm) | 2-5/8 (67) | | 4 (102) | | 3-3/4 (98) | 4-3/4 (121) | | 4-1/2 (117) | | 5-3/4 (146) | |
| Minimum specified yield strength | $f_{ya}$ | psi ($N/mm^2$) | 92,000 (634) | | | | 92,000 (634) | | | 76,125 (525) | | | |
| Minimum specified ultimate strength | $f_{uta}$ | psi ($N/mm^2$) | 115,000 (793) | | | | 115,000 (793) | | | 101,500 (700) | | | |
| Effective tensile stress area | $A_{se,N}$ | $in^2$ ($mm^2$) | 0.101 (65.0) | | | | 0.162 (104.6) | | | 0.237 (152.8) | | | |
| Steel embedment material resistance factor for reinforcement | $\phi_s$ | - | 0.85 | | | | | | | | | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes[4] | R | - | 0.80 | | | | | | | | | | D.5.3 |
| Resistance modification factor for shear, steel failure modes[4] | R | - | 0.75 | | | | | | | | | | D.5.3 |
| Factored steel resistance in tension | $N_{sar}$ | lb (kN) | 7,930 (35.3) | | | | 12,255 (54.5) | | | 17,300 (77.0) | | | D.6.1.2 |
| Factored steel resistance in shear | $V_{sar}$ | lb (kN) | 2,870 (12.8) | | 3,740 (16.6) | | 7,415 (33.0) | | | 10,840 (48.2) | | | D.7.1.2 |
| Coefficient for factored concrete breakout resistance, uncracked concrete | $k_{c,uncr}$ | - | 10 | | | | | | | | | | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked concrete[4] | $\psi_{c,N}$ | - | 1.00 | | | | | | | | | | D.6.2.6 |
| Anchor category | - | - | 1 | | | | | | | | | | D.5.3 (c ) |
| Concrete material resistance factor | $\phi_c$ | - | 0.65 | | | | | | | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B[5] | R | - | 1.00 | | | | | | | | | | D.5.3 (c ) |
| Factored pullout resistance in 20 MPa uncracked concrete[6] | $N_{pr,uncr}$ | lb (kN) | N/A | | 4,585 (20.4) | | 4,540 (20.2) | 6,315 (28.1) | | NA | | 7,125 (31.7) | D.6.3.2 |

1 Design information in this table is taken from ICC-ES ESR-2302, dated December 1, 2020 table 4, and converted for use with CSA A23.3 Annex D.
2 See figure 1 of this section.
3 The hot-dip galvanized carbon steel KWIK Bolt 3 is considered a ductile steel element as defined by CSA A23.3 Annex D section D.2.
4 For all design cases, $\psi_{c,N}$ = 1.0. The appropriate coefficient for breakout resistance for uncracked concrete ($k_{c,uncr}$) must be used.
5 For use with the load combinations of CSA A23.3 chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
6 For all design cases, $\psi_{c,P}$ = 1.0. NA (not applicable) denotes that this value does not control for design. See section 4.1.4 of ESR-2302 for additional information.

## Table 24 — Hilti KWIK Bolt 3 hot-dip galvanized carbon steel factored resistance with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/2 | 2 (51) | 2 3/8 (60) | 2,380 (10.6) | 2,660 (11.8) | 2,915 (13.0) | 3,365 (15.0) | 2,380 (10.6) | 2,660 (11.8) | 2,915 (13.0) | 3,365 (15.0) |
| | 3-1/4 (83) | 3 5/8 (92) | 4,580 (20.4) | 5,120 (22.8) | 5,610 (25.0) | 6,480 (28.8) | 9,885 (44.0) | 11,050 (49.2) | 12,105 (53.8) | 13,975 (62.2) |
| 5/8 | 3-1/8 (79) | 3-9/16 (90) | 4,535 (20.2) | 5,070 (22.5) | 5,555 (24.7) | 6,410 (28.5) | 9,175 (40.8) | 10,260 (45.6) | 11,240 (50.0) | 12,980 (57.7) |
| | 4 (102) | 4-7/16 (113) | 6,315 (28.1) | 7,060 (31.4) | 7,730 (34.4) | 8,930 (39.7) | 13,465 (59.9) | 15,055 (67.0) | 16,490 (73.4) | 19,040 (84.7) |
| 3/4 | 3-3/4 (95) | 4-5/16 (110) | 6,050 (26.9) | 6,765 (30.1) | 7,410 (33.0) | 8,555 (38.1) | 12,100 (53.8) | 13,530 (60.2) | 14,820 (65.9) | 17,115 (76.1) |
| | 4-3/4 (121) | 5-9/16 (141) | 7,130 (31.7) | 7,975 (35.5) | 8,735 (38.9) | 10,085 (44.9) | 17,395 (77.4) | 19,450 (86.5) | 21,305 (94.8) | 24,600 (109.4) |

1 See section 3.1.8 to convert factored resistance value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Apply spacing, edge distance, and concrete thickness factors in tables 23 to 25 as necessary. Compare to the steel values in table 34. The lesser of the values is to be used for the design.

4 Tablular values are for normal-weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: for sand-lightweight, $\lambda_a$ = 0.68; for all-lightweight, $\lambda_a$ = 0.60

5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

## Table 25 — Hilti KWIK Bolt 3 stainless steel factored resistance in the soffit of uncracked lightweight concrete over metal deck[1,2,3,4,5,6,7]

| Nominal anchor diameter in. | Effective embed. in. (mm) | Nominal embed. in. (mm) | Loads according to figure 5 | | |
|---|---|---|---|---|---|
| | | | Tension - $N_r$ | | Shear - $V_r$ |
| | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c \geq$ 20 MPa (2,900 psi) lb (kN) |
| 1/4 | 1-1/2 (38) | 1-11/16 (43) | 980 (4.4) | 1,200 (5.3) | 1,290 (5.7) |
| 3/8 | 2 (51) | 2-5/16 (59) | 1,650 (7.3) | 2,020 (9.0) | 1,645 (7.3) |
| 1/2 | 2 (51) | 2-3/8 (60) | 1,245 (5.5) | 1,520 (6.8) | 1,110 (4.9) |
| | 3-1/4 (83) | 3-5/8 (92) | | | |
| 5/8 | 3-1/8 (79) | 3-9/16 (90) | 2,830 (12.6) | 3,465 (15.4) | 3,625 (16.1) |
| | 4 (102) | 4-7/16 (113) | | | |

1 See section 3.1.8 to convert design strength value to ASD value.

2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.

3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).

4 Tabular value is for lightweight concrete and no additional reduction factor is needed.

5 No additional reduction factors for spacing or edge distance need to be applied.

6 Comparison of the tabular values to the steel strength is not necessary. Tabular values control.

7 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

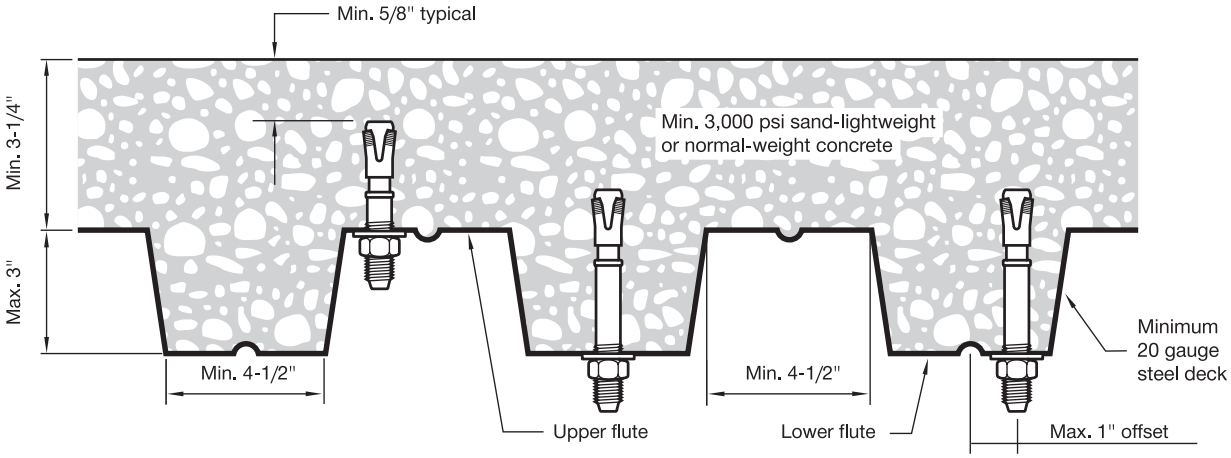



**Figure 5 — Installation in concrete over metal deck**

## DESIGN INFORMATION FOR COUNTERSUNK KWIK BOLT 3



**Table 26 — Countersunk Hilti KWIK Bolt 3 allowable loads in normal-weight concrete[1]**

| Anchor Material | Nominal anchor diameter in. | Embedment depth in. (mm) | | $f'_c$ = 3000 psi (20.7 MPa) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Tension lb (kN) | | Shear[2] lb (kN) | |
| Carbon Steel | 1/4 | 1-1/8 | (29) | 365 | (1.6) | 350 | (1.6) |
| | 3/8 | 1-5/8 | (41) | 810 | (3.6) | 750 | (3.3) |
| Stainless Steel | 1/4 | 1-1/8 | (29) | 320 | (1.4) | 500 | (2.2 |
| | 3/8 | 1-5/8 | (41) | 670 | (3.0) | 1330 | (5.9) |

1 Allowable loads based on using a safety factor of 4.0.

2 Shear values acting thru threads of anchor bolt. If acting through the empty shell, reduce loads by 70%.



## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

# ORDERING INFORMATION

**KWIK Bolt 3 anchor product line**

| Size | Length ($\ell$) | | Thread length ($\ell_{th}$) | | ID stamp | Box | 304 SS | 316 SS | HDG |
|---|---|---|---|---|---|---|---|---|---|
| | in. | (mm) | in. | (mm) | | | | | |
| **1/4 x 1-3/4** | 1-3/4 | (44) | 3/4 | (18) | A | 100 | ● | | |
| **1/4 x 2-1/4** | 2-1/4 | (57) | 7/8 | (22) | B | | ● | ● | |
| **1/4 x 3-1/4** | 3-1/4 | (83) | 2 | (51) | D | | ● | | |
| | | | 7/8 | (22) | | | | ● | |
| **1/4 x 4-1/2** | 4-1/2 | (114) | 2-7/8 | (75) | G | | ● | | |
| **3/8 x 2-1/4** | 2-1/4 | (57) | 7/8 | (22) | B | 50 | ● | | |
| **3/8 x 3** | 3 | (76) | 1-1/4 | (32) | D | | | ● | |
| | | | 1-1/2 | (40) | | | ● | | |
| **3/8 x 3-3/4** | 3-3/4 | (95) | 1-1/4 | (32) | E | | | ● | |
| | | | 2-1/4 | (59) | | | ● | | |
| **3/8 x 5** | 5 | (127) | 3-1/2 | (91) | H | | ● | | |
| **3/8 x 7** | 7 | (178) | 5-1/2 | (142) | L | | ● | | |
| **1/2 x 2-3/4** | 2-3/4 | (70) | 1-1/4 | (33) | C | 25 | ● | | |
| **1/2 x 3-3/4** | 3-3/4 | (95) | 1-5/16 | (35) | E | | | ● | |
| | | | 2-3/16 | (56) | | | ● | | ● |
| **1/2 x 4-1/2** | 4-1/2 | (114) | 1-5/16 | (35) | G | | | ● | |
| | | | 2-7/8 | (75) | | | ● | | ● |
| **1/2 x 5-1/2** | 5-1/2 | (140) | 1-5/16 | (35) | I | | | ● | |
| | | | 3-3/4 | (96) | | | ● | | ● |
| **1/2 x 7** | 7 | (178) | 4-3/4 | (121) | L | | ● | | ● |
| **5/8 x 3-3/4** | 3-3/4 | (95) | 1-1/2 | (41) | E | 15 | ● | ● | |
| **5/8 x 4-3/4** | 4-3/4 | (121) | 1-1/2 | (41) | G | | | ● | |
| | | | 2-3/4 | (70) | | | ● | | ● |
| **5/8 x 6** | 6 | (152) | 1-1/2 | (41) | J | | | ● | |
| | | | 4 | (102) | | | ● | | ● |
| **5/8 x 7** | 7 | (178) | 4-3/4 | (121) | | | | | |
| **5/8 x 8-1/2** | 8-1/2 | (216) | 6-1/2 | (166) | O | | ● | | |
| **5/8 x 10** | 10 | (254) | 7 | (180) | R | | ● | | |
| **3/4 x 4-3/4** | 4-3/4 | (121) | 1-1/2 | (41) | G | 20 | ● | ● | |
| | | | 2-7/16 | (62) | | 10 | | | ● |
| | | | | | | 20 | ● | | |
| **3/4 x 5-1/2** | 5-1/2 | (140) | 1-1/2 | (41) | I | 20 | ● | | |
| | | | 3-7/16 | (85) | | 10 | | | ● |
| | | | | | | 20 | ● | | |
| **3/4 x 7** | 7 | (178) | 4-5/8 | (119) | L | 10 | | | |
| | | | 4-7/8 | (124) | | | ● | | |
| **3/4 x 8** | 8 | (203) | 5-3/4 | (146) | N | | ● | | ● |
| **3/4 x 10** | 10 | (254) | 5-7/8 | (152) | R | | ● | ● | |
| **3/4 x 12** | 12 | (305) | 5-7/8 | (152) | T | | ● | | |
| **1 x 6** | 6 | (152) | 2-1/4 | (57) | J | 5 | ● | ● | |
| **1 x 9** | 9 | (114) | 2-1/4 | (57) | P | | ● | | |
| **1 x 12** | 12 | (114) | 6 | (152) | T | | ● | | |

### Countersunk KWIK Bolt 3 anchor product line

| Size | Length in. | Length (mm) | Box | Carbon steel | 304 SS |
|---|---|---|---|---|---|
| **C1/4 x 2** | 2 | (51) | 100 | • | |
| **C1/4 x 3** | 3 | (76) | 100 | • | • |
| **C1/4 x 5** | 5 | (127) | 100 | • | |
| **C3/8 x 2-1/4** | 2-1/4 | (57) | 100 | • | |
| **C3/8 x 3** | 3 | (76) | 100 | • | |
| **C3/8 x 4** | 4 | (102) | 50 | • | • |
| **C3/8 x 5** | 5 | (127) | 50 | • | |

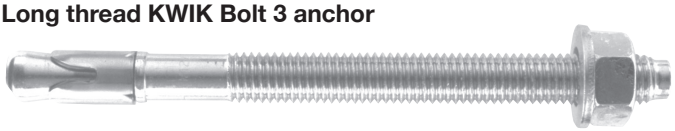
### Rod Coupling KWIK Bolt 3 anchor product line

| Size | Length in. | Length (mm) | Thread length in. | Thread length (mm) | ID stamp | Box quantity |
|---|---|---|---|---|---|---|
| **3/8 x 2-1/4** | 2-1/4 | (57) | 7/8 | (22) | B | 100 |

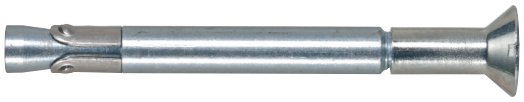
### KWIK Bolt 3 anchor



### Long thread KWIK Bolt 3 anchor



### Countersunk KWIK Bolt 3 anchor



### Rod coupling KWIK Bolt 3 anchor 3/8 x 2 1/4



### Table 43 — KWIK Bolt 3 length identification system

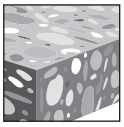
| Length ID marking on bolt head | | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length of anchor, $\ell_{anch}$ in. | From | 1 ½ | 2 | 2 ½ | 3 | 3 ½ | 4 | 4 ½ | 5 | 5 ½ | 6 | 6 ½ | 7 | 7 ½ | 8 | 8 ½ | 9 | 9 ½ | 10 | 11 | 12 | 13 | 14 | 15 |
| | Up to but not including | 2 | 2 ½ | 3 | 3 ½ | 4 | 4 ½ | 5 | 5 ½ | 6 | 6 ½ | 7 | 7 ½ | 8 | 8 ½ | 9 | 9 ½ | 10 | 11 | 12 | 13 | 14 | 15 | 16 |

# 3.3.12 HDI+, HDI-L+, AND HDI DROP IN ANCHORS

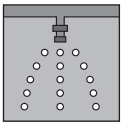
## PRODUCT DESCRIPTION

**HDI+, HDI-L+, and HDI Drop-in anchors**

| Anchor System | | Features and Benefits |
|---|---|---|
|  | HDI-L+ and HDI+ with Auto setting tools 1/4” to 1/2” | • Anchor, setting tool and Hilti drill bit form a matched tolerance system to provide reliable fastenings<br>• Allows shallow embedment without sacrificing performance<br>• Lip allows accurate flush surface setting, independent of hole depth for the HDI-L+<br>• Ideal for repetitive fastenings with threaded rods of equal length<br>• HDI+ and HDI-L+ have an innovative stepped plug that reduces number of hammer blows by up to 50%<br>• HDI+ and HDI-L+ can be installed with the new HDI+ Setting Tool system (stop drill bit and machine setting tool) for improved productivity<br>• HDI-S speed thread designed to accept coil rods and forms a matched tolerance system for forming applications. |
|  | HDI and Manual setting tool<br>5/8” to 3/4”<br>HDI SS303<br>1/4" to 3/4"<br>HDI-S<br>1/2" and 3/4" | |



Uncracked concrete



Fire sprinkler listings

| Approvals/Listings | |
|---|---|
| **FM (Factory Mutual)** | Pipe hanger components for automatic sprinkler systems HDI+ 3/8, HDI-L+ 3/8, HDI+1/2, HDI-L+ 1/2, HDI 5/8 and HDI 3/4 |
| **UL and cUL (Underwriters Laboratory)** | Pipe hanger equipment for fire protection services HDI+ 3/8, HDI-L+ 3/8, HDI+1/2, HDI-L+ 1/2, HDI 5/8 and HDI 3/4 |
| **ANSI/MSS SP-58-2018** | Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information. |

FM APPROVED

c UL us LISTED

## INSTALLATION PARAMETERS

**Table 1 — Hilti HDI+, HDI-L+HDI, HDI-SS303 and HDI-S specifications**

| Setting Information | Symbol | Units | HDI+, HDI-L+ and HDI-SS303 | | | HDI and HDI-SS303 | | HDI-S | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | 3/8 | 1/2 | 5/8 | 3/4 | 1/2 | 3/4 |
| Insert thread | d | UNC | 1/4-20 | 3/8-16 | 1/2-13 | 5/8-11 | 3/4-10 | 1/2-6 | 3/4-4.5 |
| Nominal bit diameter | $d_{bit}$ | in. | 3/8 | 1/2 | 5/8 | 27/32 | 1 | 5/8 | 1 |
| Nominal embedment<br>Anchor length<br>Hole depth | $h_{nom}$<br>$\ell$<br>$h_o$ | in.<br>(mm) | 1<br>(25) | 1-9/16<br>(40) | 2<br>(51) | 2-9/16<br>(65) | 3-3/16<br>(81) | 2<br>(51) | 3-3/16<br>(81) |
| Useable thread length | $\ell_{th}$ | in.<br>(mm) | 7/16<br>(11) | 5/8<br>(15) | 11/16<br>(17) | 7/8<br>(22) | 1-3/8<br>(34) | 11/16<br>(17) | 1-3/8<br>(34) |
| Installation torque | $T_{inst}$ | ft-lb<br>(Nm) | 4<br>(5) | 11<br>(15) | 22<br>(30) | 37<br>(50) | 80<br>(109) | 22<br>(30) | 80<br>(109) |
| Minimum slab thickness | h | in.<br>(mm) | 3<br>(76) | 3-1/8<br>(79) | 4<br>(102) | 5-1/8<br>(130) | 6-3/8<br>(162) | 4<br>(102) | 6-3/8<br>(162) |

## MATERIAL SPECIFICATIONS

| |
|---|
| HDI+, HDI-L, HDI and HDI-S anchors are manufactured from mild carbon steel. Anchor bodies are zinc plated in accordance with ASTM B633, AC 1, Type III |
| HDI SS303 anchors are manufactured from AISI Type 303 stainless steel |

# DESIGN DATA IN CONCRETE USING ALLOWABLE STRESS DESIGN

**Table 2 — Hilti HDI+, HDI-L+ and HDI carbon steel allowable loads in concrete[1,2]**

| Anchor type | Nominal anchor diameter in. | $f'_c$ = 2,000 | | | | $f'_c$ = 4,000 | | | | $f'_c$ = 6,000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tension, lb (kN) | | Shear, lb (kN) | | Tension, lb (kN) | | Shear, lb (kN) | | Tension, lb (kN) | | Shear, lb (kN) | |
| HDI+ | 1/4 | 385 | (1.7) | 450 | (2.0) | 510 | (2.3) | 625 | (2.8) | 640 | (2.8) | 700 | (3.1) |
| | 3/8 | 635 | (2.8) | 965 | (4.3) | 920 | (4.1) | 1,250 | (5.6) | 1,260 | (5.6) | 1,500 | (6.7) |
| | 1/2 | 945 | (4.2) | 1,500 | (6.7) | 1,605 | (7.1) | 2,125 | (9.5) | 1,950 | (8.7) | 2,500 | (11.1) |
| HDI | 5/8 | 1,875 | (8.3) | 2,500 | (11.1) | 2,920 | (13.0) | 3,250 | (14.5) | 3,715 | (16.5) | 3,750 | (16.7) |
| | 3/4 | 2,500 | (11.1) | 3,875 | (17.2) | 4,065 | (18.1) | 5,000 | (22.2) | 5,565 | (24.8) | 5,500 | (24.5) |

**Table 3 — Hilti HDI+, HDI-L+ and HDI carbon steel ultimate loads in concrete[1]**

| Anchor type | Nominal anchor diameter in. | $f'_c$ = 2,000 | | | | $f'_c$ = 4,000 | | | | $f'_c$ = 6,000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tension, lb (kN) | | Shear, lb (kN) | | Tension, lb (kN) | | Shear, lb (kN) | | Tension, lb (kN) | | Shear, lb (kN) | |
| HDI+ | 1/4 | 1,535 | (6.8) | 1,800 | (8.0) | 2,040 | (9.1) | 2,500 | (11.1) | 2,555 | (11.4) | 2,800 | (12.5) |
| | 3/8 | 2,540 | (11.3) | 3,850 | (17.1) | 3,685 | (16.4) | 5,000 | (22.2) | 5,035 | (22.4) | 6,000 | (26.7) |
| | 1/2 | 3,780 | (16.8) | 6,000 | (26.7) | 6,425 | (28.6) | 8,500 | (37.8) | 7,810 | (34.7) | 10,000 | (44.5) |
| HDI | 5/8 | 7,500 | (33.4) | 10,000 | (44.5) | 11,685 | (52.0) | 13,000 | (57.8) | 14,865 | (66.1) | 15,000 | (66.7) |
| | 3/4 | 10,000 | (44.5) | 15,500 | (68.9) | 16,260 | (72.3) | 20,000 | (89.0) | 22,250 | (99.0) | 22,000 | (97.9) |

1 The shear tests were conducted with SAE Grade 5 bolts with minimum yield strength of 85 ksi and minimum tension strength of 120 ksi. Shear testing for the 1/4-in. models were conducted with SAE Grade 8 bolts with minimum yield strength of 120 ksi and minimum tension strength of 150 ksi in 6,000 psi concrete. High-strength bolts were used to force concrete failure modes. When using steel bolts with a lower tensile strength, steel failure must be considered.

2 Allowable loads calculated with a factor of safety of 4.

**Table 4 — Hilti HDI+, HDI-L+ and HDI carbon steel allowable loads in lightweight concrete and lightweight concrete poured over metal deck[1,2,3,4]**

| Anchor type | Nominal anchor diameter in. | 3,000 psi lightweight concrete | | | | 3,000 psi lightweight concrete over metal deck | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Upper flute | | | | Lower flute | | | |
| | | Tension, lb (kN) | | Shear, lb (kN) | | Tension, lb (kN) | | Shear, lb (kN) | | Tension, lb (kN) | | Shear, lb (kN) | |
| HDI+ | 1/4 | 465 | (2.1) | 340 | (1.5) | 530 | (2.4) | 335 | (1.5) | 375 | (1.7) | 250 | (1.1) |
| | 3/8 | 720 | (3.2) | 940 | (4.2) | 810 | (3.6) | 1,010 | (4.5) | 500 | (2.2) | 500 | (2.2) |
| | 1/2 | 1,035 | (4.6) | 1,700 | (7.6) | 1,035 | (4.6) | 1,755 | (7.8) | 625 | (2.8) | 750 | (3.3) |
| HDI | 5/8 | 1,465 | (6.5) | 2,835 | (12.6) | 1,035 | (4.6) | 1,755 | (7.8) | 875 | (3.9) | 875 | (3.9) |
| | 3/4 | 2,075 | (9.2) | 3,680 | (16.4) | 1,250 | (5.6) | 1,755 | (7.8) | 1,250 | (5.6) | 1,000 | (4.4) |

1 The shear tests were conducted with SAE Grade 5 bolts with minimum yield strength of 85 ksi and minimum tension strength of 120 ksi. Shear testing for the 1/4-in. models were conducted with SAE Grade 8 bolts with minimum yield strength of 120 ksi and minimum tension strength of 150 ksi in 6,000 psi concrete. High-strength bolts were used to force concrete failure modes. When using steel bolts with a lower tensile strength, steel failure must be considered.

2 Minimum compressive strength of structural lightweight concrete is 3,000 psi.

3 See figure 1 for typical details.

4 Allowable loads calculated with a factor of safety of 4.



**Table 5 — Hilti HDI stainless steel allowable loads in concrete[1,2]**

| Nominal anchor diameter in. | $f'_c$ = 4,000 | | | | $f'_c$ = 6,000 | | | |
|---|---|---|---|---|---|---|---|---|
| | Tension, lb (kN) | | Shear, lb (kN) | | Tension, lb (kN) | | Shear, lb (kN) | |
| 1/4 | 480 | (2.1) | 600 | (2.7) | 740 | (3.3) | 600 | (2.7) |
| 3/8 | 1,040 | (4.6) | 1,230 | (5.5) | 1,460 | (6.5) | 1,230 | (5.5) |
| 1/2 | 1,840 | (8.2) | 2,760 | (12.3) | 2,410 | (10.7) | 2,760 | (12.3) |
| 5/8 | 2,630 | (11.7) | 4,510 | (20.1) | 3,770 | (16.8) | 4,510 | (20.1) |
| 3/4 | 3,830 | (17.0) | 5,580 | (24.8) | 5,030 | (22.4) | 5,580 | (24.8) |

1 Shear testing conducted with 18-8 stainless steel bolts.

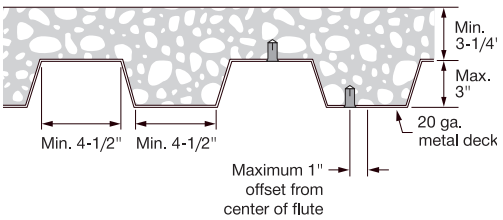
2 Allowable loads calculated with a factor of safety of 4.

**Table 6 — Hilti HDI-S speed thread allowable loads in concrete[1]**

| Nominal anchor diameter in. | $f'_c$ = 4,000 | | | | $f'_c$ = 6,000 | | | |
|---|---|---|---|---|---|---|---|---|
| | Tension, lb (kN) | | Shear, lb (kN) | | Tension, lb (kN) | | Shear, lb (kN) | |
| 1/2 | 1,785 | (7.9) | 1,570 | (7.0) | 2,345 | (10.4) | 1,570 | (7.0) |
| 3/4 | 4,065 | (18.1) | 3,700 | (16.5) | 5,565 | (24.8) | 3,700 | (16.5) |

1 Allowable loads calculated with a factor of safety of 4.

**Figure 1 — Installation of Hilti HDI+ and HDI drop-in anchor in the soffit of concrete over metal deck floor and roof assemblies W – deck**




**Combined shear and tension loading**

$$\left(\frac{N_d}{N_{rec}}\right)^{5/3} + \left(\frac{V_d}{V_{rec}}\right)^{5/3} \leq 1.0$$

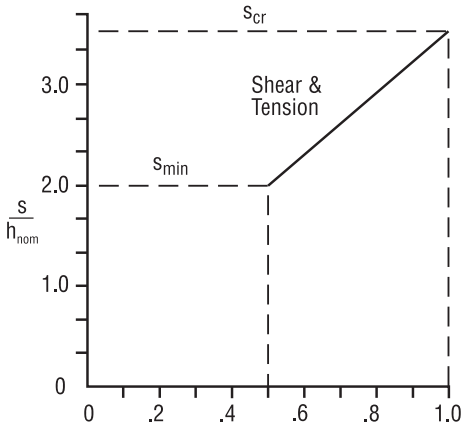
# Anchor spacing and edge distance guidelines

### Anchor spacing adjustment factors

s = Actual Spacing

$s_{min}$ = 2.0 $h_{nom}$

$s_{cr}$ = 3.5 $h_{nom}$



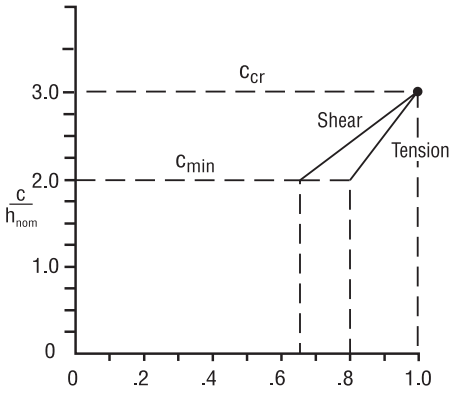

Anchor spacing adjustment Factor

### Edge distance adjustment factors

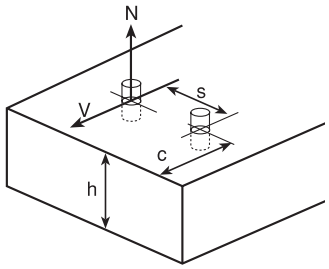
c = Actual edge distance

$c_{min}$ = 2.0 $h_{nom}$

$c_{cr}$ = 3.0 $h_{nom}$




Edge distance adjustment factor




### Influence of anchor spacing and edge distance $f_A$ and $f_R$

| Anchor Size | | $h_{nom}$ | |
|---|---|---|---|
| in. | (mm) | in. | (mm) |
| 1/4 | (6.4) | 1 | ( 25) |
| 3/8 | (9.5) | 1-9/16 | (40) |
| 1/2 | (12.7) | 2 | ( 51) |
| 5/8 | (15.8) | 2-9/16 | ( 65) |
| 3/4 | (19.1) | 3-3/16 | ( 81) |

$h_{nom}$ = nominal embedment depth

### Table 7 — Load adjustment factors for Hilti HDI drop-in anchors in concrete

| Load adjustment factors for anchor spacing $f_A$ | | | | | | | Load adjustment factors for edge distance $f_R$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tension/shear loads | | | | | | | Tension $f_{RN}$ | | | | | | | Shear $f_{RV}$ | | | | |
| Spacing s | | Anchor diameter | | | | | Edge distance c | | Anchor diameter | | | | | Anchor diameter | | | | |
| in. | (mm) | 1/4 | 3/8 | 1/2 | 5/8 | 3/4 | in. | (mm) | 1/4 | 3/8 | 1/2 | 5/8 | 3/4 | 1/4 | 3/8 | 1/2 | 5/8 | 3/4 |
| 2 | ( 51) | .50 | | | | | 2 | ( 51) | .80 | | | | | .65 | | | | |
| 2-1/2 | ( 64) | .67 | | | | | 2-1/2 | ( 64) | .90 | | | | | .83 | | | | |
| 3 | ( 76) | .83 | .50 | | | | 3 | ( 76) | 1.0 | .80 | | | | 1.0 | .65 | | | |
| 3-1/2 | ( 89) | 1.0 | .58 | | | | 3-1/2 | ( 89) | | .85 | | | | | .73 | | | |
| 4 | (102) | | .69 | .50 | | | 4 | (102) | | .91 | .80 | | | | .85 | .65 | | |
| 4-1/2 | (114) | | .79 | .58 | | | 4-1/2 | (114) | | .98 | .85 | | | | .96 | .74 | | |
| 5 | (127) | | .90 | .67 | .50 | | 5 | (127) | | 1.0 | .90 | .80 | | | 1.0 | .83 | .65 | |
| 5-1/2 | (140) | | 1.0 | .75 | .55 | | 5-1/2 | (140) | | | .95 | .83 | | | | .91 | .70 | |
| 6 | (152) | | | .83 | .61 | .50 | 6 | (152) | | | 1.0 | .87 | | | | 1.0 | .77 | |
| 7 | (178) | | | 1.0 | .74 | .57 | 6-1/2 | (165) | | | | .91 | .80 | | | | .84 | .65 |
| 8 | (203) | | | | .87 | .67 | 7 | (178) | | | | .95 | .84 | | | | .91 | .72 |
| 9 | (229) | | | | 1.0 | .77 | 8 | (203) | | | | 1.0 | .90 | | | | 1.0 | .83 |
| 10 | (254) | | | | | .88 | 9 | (229) | | | | | .96 | | | | | .94 |
| 11 | (279) | | | | | .98 | 10 | (254) | | | | | 1.0 | | | | | 1.0 |
| 12 | (305) | | | | | 1.0 | | | | | | | | | | | | |

$s_{min}$ = 2.0 $h_{nom}$ $s_{cr}$ = 3.5 $h_{nom}$

$f_A = 0.33 \frac{s}{h_{nom}} - 0.17$

for $s_{cr} > s > s_{min}$

$c_{min}$ =2.0 $h_{nom}$ $c_{cr}$ = 3.0 $h_{nom}$

$f_{RN} = 0.2 \frac{c}{h_{nom}} + 0.4$

for $c_{cr} > c > c_{min}$

$c_{min}$ = 2.0 $h_{nom}$ $c_{cr}$ = 3.0 $h_{nom}$

$f_{RV} = 0.35 \frac{c}{h_{nom}} - 0.05$

for $c_{cr} > c > c_{min}$

## INSTALLATION INSTRUCTIONS

Manufacturer's Printed Installation Instructions (MPII) are included with each product package. They can also be viewed or downloaded at www.hilti.com. Because of the possibility of changes, always verify that downloaded MPII are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the MPII.

## ORDERING INFORMATION[1]

### HDI+, HDI-L+ and HDI

### Carbon steel

| Description | Description | Description | Anchor thread size | Qty / box |
|---|---|---|---|---|
| **HDI+ 1/4** | **HDI-L+ 1/4** | - | 1/4 | 100 |
| **HDI+ 3/8** | **HDI-L+ 3/8** | - | 3/8 | 50 |
| **HDI+ 1/2** | **HDI-L+ 1/2** | HDI-S 1/2" | 1/2 | 50 |
| **HDI 5/8** | **–** | - | 5/8 | 25 |
| **HDI 3/4** | **–** | HDI-S 3/4" | 3/4 | 25 |

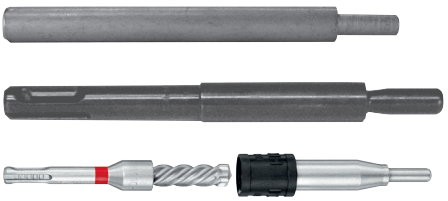
### HDI-SS303 anchors

### Stainless steel

| Description | Anchor thread size | Qty / box |
|---|---|---|
| **HDI 1/4 SS303** | 1/4 | 100 |
| **HDI 3/8 SS303** | 3/8 | 50 |
| **HDI 1/2 SS303** | 1/2 | 50 |
| **HDI 5/8 SS303** | 5/8 | 25 |
| **HDI 3/4 SS303** | 3/4 | 25 |

### Setting Tools for HDI+ and HDI-L+

| Anchor thread size | Description |
|---|---|
| 1/4 | HST 1/4 Setting tool |
| | HSD-MM 1/4 (TE-C-24D6 1/4 Setting tool) |
| | HDI+ Setting Tool includes a TE-CX 3/8x1 carbide bit |
| 3/8 | HST 3/8 Setting tool |
| | HSD-MM 3/8 (TE-C-24SD10 3/8 Setting tool) |
| | HDI+ Setting Tool includes a TE-CX 1/2x1-9/16 carbide bit |
| 1/2 | HST 1/2 Setting tool |
| | HSD-MM 1/2 (TE-C-24SD12 1/2 Setting tool) |
| | HDI+ Setting Tool includes a TE-CX 5/8x2 carbide bit |



### Setting tools for HDI and HDI-SS303 anchors

| Description | Sets anchor size | Qty |
|---|---|---|
| **HST 1/4" Hand Setting Tool** | 1/4" HDI SS303 | 1 |
| **HST 3/8" Hand Setting Tool** | 3/8" HDI SS303 | 1 |
| **HST 1/2" Hand Setting Tool** | 1/2" HDI SS303 / HDI-S | 1 |
| **HST 5/8" Hand Setting Tool** | 5/8" HDI / HDI SS303 | 1 |
| **HST 3/4" Hand Setting Tool** | 3/4" HDI / HDI SS303 / HDI-S | 1 |



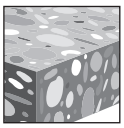
1 All dimensions in inches

# 3.3.13 HDI-P TZ DROP-IN ANCHORS

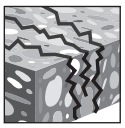
## PRODUCT DESCRIPTION

**HDI-P TZ Flush anchors**

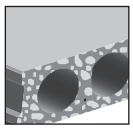
| Anchor System | | Features and Benefits |
|---|---|---|
|  | Carbon steel HDI-P TZ | • Drop-in anchor with optimized length for reliable fastenings in post-tensioned cable concrete slabs<br>• Suitable for uncracked and cracked concrete including seismic areas<br>• Productive installation with HDI-P TZ automatic setting tool with hammer drill<br>• Used with Hilti Dust Removal System (DRS) for compliance with Table 1 of OSHA 1926.1153 regulations for silica dust exposure<br>• Shallow drilling for fast installations<br>• Easy installation with Auto Setting Tool<br>• Lip provides flush installation, consistent anchor depth, and easy rod alignment<br>• Auto Setting Tool includes stop drill bit and setting tool, no tool change necessary |
|  | Auto-setting tool HDI-P TZ | |
|  | Hand-setting tool HDI-P TZ | |



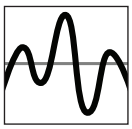
Uncracked concrete



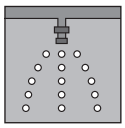
Cracked concrete



Hollow core concrete



Seismic design categories A-F



Fire sprinkler listings

| Approvals/Listings | |
|---|---|
| **ICC-ES (International Code Council)** | ESR-4236 in concrete per ACI 318 Ch. 17 / ACI 355.2 / ICC-ES AC193 |
| **City of Los Angeles** | 2017 LABC Supplement (within ESR-4236) |
| **Florida Building Code** | 2017 FBC Supplement (within ESR-4236) |
| **FM (Factory Mutual)** | Pipe hanger components for automatic sprinkler systems for 3/8 (4-inch nominal pipe diameter) |
| **UL (Underwriters Laboratory)** | Pipe hanger equipment for fire protection services for 3/8 (4-inch nominal pipe diameter) |
| **ANSI/MSS SP-58-2018** | Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information. |

## MATERIAL SPECIFICATIONS

HDI-P TZ drop-in anchors are manufactured from carbon steel with zinc plating per DIN EN ISO 4042 A2K.

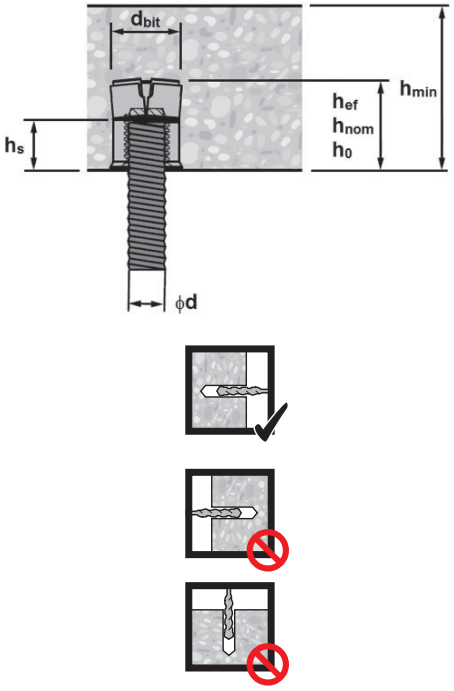
## INSTALLATION PARAMETERS

**Table 1 — Hilti HDI-P TZ setting information**

| Setting information | Symbol | Unit | Nominal anchor size / internal thread dia. (in) | |
|---|---|---|---|---|
| | | | 3/8 | |
| Internal thread diameter | d | in. | 3/8 | |
| Nominal bit diameter | $d_{bit}$ | in. | 9/16 | |
| Nominal embedment | $h_{nom}$ | in.<br>(mm) | 3/4<br>(19) | |
| Hole depth in base material | $h_0$ | in.<br>(mm) | 3/4<br>(19) | |
| Effective embedment | $h_{ef}$ | in.<br>(mm) | 3/4<br>(19) | |
| Thread engagement length | $h_a$ | in.<br>(mm) | 3/8<br>(10) | |
| Maximum installation torque for threaded element | $T_{max}$ | ft-lb<br>(Nm) | 5<br>(7) | |
| Minimum base material thickness — concrete | $h_{min}$ | in.<br>(mm) | 2-1/2<br>(64) | 4<br>(102) |
| Minimum edge distance — concrete | $c_{min}$ | in.<br>(mm) | 6<br>(152) | 2-1/2<br>(64) |
| Minimum anchor spacing — concrete | $s_{min}$ | in.<br>(mm) | 8<br>(203) | 3<br>(76) |
| Minimum base material thickness — hollow core concrete panels | $h_{min}$ | in.<br>(mm) | 1/3/8<br>(35) | |
| Minimum edge distance — hollow core concrete panels | $c_{min}$ | in.<br>(mm) | 6<br>(152) | |
| Minimum anchor spacing — hollow core concrete panels | $s_{min}$ | in.<br>(mm) | 8<br>(203) | |

For **SI:** 1 inch = 25.4mm, 1 ft-lb = 1.356 Nm

**Figure 1 — Hilti HDI-P TZ installation parameters**



# DESIGN DATA IN CONCRETE PER ACI 318

### ACI 318 Chapter 17 Design

The design tables in Tables 2 to 4 are Hilti Simplified Design Tables. The load values were developed using the design parameters and variables of ICC Evaluation Services ESR-4236 and the equations within ACI 318 Chapter 17 as amended by ICC-ES AC193. The strength design capacities calculated from the tables below are to be compared to the factored loads determined from strength design load combinations. For a detailed explanation of the Hilti Simplified Design Tables, refer to Section 3.1.8. Data tables from ESR-4236 are not contained in this section, but can be found at www.hilti.com or www.icc-es.org.

**Table 2 — Hilti HDI-P TZ design strength based on concrete failure modes in uncracked concrete per ACI 318 14 Ch. 17** [1,2,3,4,5]

| Nominal anchor diameter in. | Nominal embed. in. (mm) | Tension (lesser of concrete breakout / pullout) - $\varphi N_n$ | | | | Shear (lesser of concrete breakout or pryout) - $\varphi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6000 psi (41.4 MPa) lb (kN) |
| 3/8 | 3/4 (19) | 310 (1.4) | 340 (1.5) | 395 (1.8) | 485 (2.1) | 350 (1.6) | 385 (1.7) | 445 (2.0) | 545 (2.4) |

**Table 3 — Hilti HDI-P TZ design strength based on concrete failure modes in cracked concrete per ACI 318 14 Ch. 17** [1,2,3,4,5,6,7]

| Nominal anchor diameter in. | Nominal embed. in. (mm) | Tension (lesser of concrete breakout / pullout) - $\varphi N_n$ | | | | Shear (lesser of concrete breakout or pryout) - $\varphi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6000 psi (41.4 MPa) lb (kN) |
| 3/8 | 3/4 (19) | 190 (0.8) | 200 (0.9) | 220 (1.0) | 255 (1.1) | 250 (1.1) | 270 (1.2) | 315 (1.4) | 385 (1.7) |

**The following footnotes apply to both Table 2 and 3:**

1 See Section 3.1.8.6 of the Anchor Tech Guide Ed. 17 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for a single anchor with a minimum edge distance of 6-1/2-in (166mm) and a minimum spacing of 8-in (204mm). For a 6-in (153mm) edge distance multiply uncracked concrete tension and shear values by 0.92. No reduction needed for cracked concrete.
4 Compare to the steel values in Table 4. The lesser of the values is to be used for the design.
5 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.68. For all-lightweight, $\lambda_a$ = 0.60.
6 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.74.
7 No additional reduction needed for seismic shear for concrete breakout or pryout failure. See Section 3.1.8.7 of the Anchor Tech Guide Ed. 17 for additional information on seismic applications.

**Table 4 — Hilti HDI-P TZ design strength based on steel failure per ACI 318 Ch. 17** [1,2,3]

| Nominal anchor diameter in. | Steel strength of HDI-P TZ anchor | | | Steel strength of ASTM A36 threaded rod | | |
|---|---|---|---|---|---|---|
| | Tensile[4] $\varphi N_{sa}$ lb (kN) | Shear[5] $\varphi V_{sa}$ lb (kN) | Seismic Shear[6,9] $\varphi V_{sa}$ lb (kN) | Tensile[4] $\varphi N_{sa,rod}$ lb (kN) | Shear[7] $\varphi V_{sa,rod}$ lb (kN) | Seismic Shear[8,9] $\varphi V_{sa,rod,eq}$ lb (kN) |
| 3/8 | 4,065 (18.1) | 585 (2.6) | 585 (2.6) | 3,370 (15.0) | 1,885 (8.4) | 1,320 (5.9) |

1 See Section 3.1.8.6 of the Anchor Tech Guide Ed. 17 to convert design strength value to ASD value.
2 Steel strength in tension and shear determined from the lesser of the HDI-P TZ or the inserted threaded rod.
3 Hilti HDI-P TZ anchors are considered a brittle steel element. ASTM A36 threaded rod is considered a ductile steel element.
4 Tensile $\varphi N_{sa} = \varphi A_{se,N} f_{uta}$ as noted in ACI 318 Ch. 17.
5 Shear values for HDI-P TZ determined by static shear tests with $\varphi V_{sa} \le \varphi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
6 Seismic shear values for HDI-P TZ determined by seismic shear tests with $\varphi V_{sa} < \varphi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
7 Shear values for threaded rod determined by $\varphi V_{sa,rod} = \varphi\ 0.60\ A_{se,V} f_{uta}$ as noted in ACI 318 Ch. 17.
8 Seismic shear values for threaded rod determined by $\varphi V_{sa,rod,eq} = \varphi\ 0.70\ V_{sa,rod}$.
9 See Section 3.1.8.7 of the Anchor Tech Guide Ed. 17 for additional information on seismic applications

# DESIGN DATA IN CONCRETE PER CSA A23.3

## CSA A23.3 Annex D Design

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. Tables 8 and 9 in this section contains the Limit State Design tables that are based on the published loads in ICC Evaluation Services ESR-4236 and converted for use with CSA A23.3 Annex D. Tables 5 to 7 below are Hilti Simplified Design Tables which are pre-factored resistance tables based on the design parameters and variables in Tables 8 and 9. All the figures in the previous ACI 318 14 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

**Table 5 — Hilti HDI-P TZ factored resistance based on concrete failure modes in uncracked concrete per CSA A23.3 Annex D [1,2,3,4,5]**

| Nominal anchor diameter in. | Nominal embed. in. (mm) | Tension (lesser of concrete breakout / pullout) - $N_r$ | | | | Shear (lesser of concrete breakout or pryout) - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 3/4 (19) | 325 (1.5) | 365 (1.6) | 400 (1.8) | 460 (2.1) | 380 (1.7) | 425 (1.9) | 465 (2.1) | 540 (2.4) |

**Table 6 — Hilti HDI-P TZ factored resistance based on concrete failure modes in cracked concrete per CSA A23.3 Annex D [1,2,3,4,5,6,7]**

| Nominal anchor diameter in. | Nominal embed. in. (mm) | Tension (lesser of concrete breakout / pullout) - $N_r$ | | | | Shear (lesser of concrete breakout or pryout) - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 3/8 | 3/4 (19) | 195 (0.9) | 210 (0.9) | 220 (1.0) | 245 (1.1) | 270 (1.2) | 300 (1.3) | 330 (1.5) | 380 (1.7) |

**The following footnotes apply to both Table 5 and 6:**

1 See Section 3.1.8.6 of the Anchor Tech Guide Ed. 17 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for a single anchor with a minimum edge distance of 6-1/2-in (166mm) and a minimum spacing of 8-in (204mm). For a 6-in (153mm) edge distance multiply uncracked concrete tension and shear values by 0.92. No reduction needed for cracked concrete.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.68. For all-lightweight, $\lambda_a$ = 0.60.
5 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.74.
6 No additional reduction needed for seismic shear for concrete breakout or pryout failure. See Section 3.1.8.7 of the Anchor Tech Guide Ed. 17 for additional information on seismic applications.



**Table 7 — Hilti HDI-P TZ factored resistance based on steel failure per CSA A23.3 Annex D [1,2,3]**

| Nominal anchor diameter in. | Steel strength of HDI-P TZ anchor | | | Steel strength of ASTM A36 threaded rod | | |
|---|---|---|---|---|---|---|
| | Tensile[4] $N_{sar}$ lb (kN) | Shear[5] $V_{sar}$ lb (kN) | Seismic Shear[6,9] $V_{sar,eq}$ lb (kN) | Tensile[4] $N_{sar}$ lb (kN) | Shear[7] $V_{sar}$ lb (kN) | Seismic Shear[8,9] $V_{sar,eq}$ lb (kN) |
| 3/8 | 3,720 (16.5) | 540 (2.4) | 540 (2.4) | 3,055 (13.6) | 1,720 (7.7) | 1,200 (5.3) |

1 See Section 3.1.8.6 of the Anchor Tech Guide Ed. 17 to convert design strength value to ASD value.
2 Steel strength in tension and shear determined from the lesser of the HDI-P TZ or the inserted threaded rod.
3 Hilti HDI-P TZ anchors are considered a brittle steel element. ASTM A36 threaded rod is considered a ductile steel element.
4 Tensile $N_{sar} = A_{se,N}\ \varphi_s\ f_{uta}$ as noted in CSA A23.3 Annex D.
5 Shear values for HDI-P TZ determined by static shear tests with $V_{sar} \le 0.6\ A_{se,V}\ \varphi s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
6 Seismic shear values for HDI-P TZ determined by seismic shear tests with $V_{sar,eq} \le 0.60\ A_{se,V}\ \varphi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
7 Shear values for threaded rod determined by $V_{sar} = 0.6\ A_{se,V}\ \varphi_s\ f_{uta}$ R as noted in CSA A23.3 Annex D.
8 Seismic shear values for threaded rod determined by $V_{sar,rod,eq} = 0.70\ V_{sar,rod}$.
9 See Section 3.1.8.7 of the Anchor Tech Guide Ed. 17 for additional information on seismic applications.

## Table 8 — Design information, Hilti HDI-P TZ, in accordance with CSA A23.3[1]

| Setting information | Symbol | Unit | Nominal anchor size/internal thread dia. (in) | Ref |
|---|---|---|---|---|
| | | | 3/8 | CSA A23.3 |
| Anchor O.D. | $d_a$ | in. (mm) | 0.561 (14.25) | |
| Effective embedment | $h_{ef}$ | in. (mm) | 3/4 (19) | |
| Steel embed. material resistance factor for reinforcement | $\varphi_s$ | - | 0.85 | 8.4.3 |
| Resistance modification factor for tension, steel failure modes [2,3] | $R_{s,N}$ | - | 0.70 | D.5.3 b) |
| Min. specified yield strength | $f_{ya}$ | psi ($N/mm^2$) | 70,400 (484) | |
| Min. specified ultimate strength | $f_{uta}$ | psi ($N/mm^2$) | 88,000 (605) | |
| Effective-cross sectional steel area in tension | $A_{se,N}$ | $in^2$ ($mm^2$) | 0.071 (45.8) | |
| Factored steel resistance in tension [4] | $N_{sa}$ | lb (kN) | 6,250 (27.8) | D.6.1.2 Eq. D.2 |
| Concrete material resistance factor | $\varphi_c$ | - | 0.65 | 8.4.2 |
| Anchor category | - | - | 1 | D.5.3 c) |
| Resistance modification factor for tension, concrete failure [3] | $R_{c,N}$ | - | 0.60 | |
| Coeff. for factored conc. breakout resistance, uncracked concrete | $k_{c,uncr}$ | in-lb (SI) | 24 (10.0) | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete | $k_{c,cr}$ | in-lb (SI) | 17 (7.1) | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked conc. [5] | $\psi_{c,N}$ | - | 1.0 | D.6.2.6 |
| Critical edge distance | $c_{ac}$ | in. (mm) | 6 (152) | |
| Factored pullout resistance in 20 MPa uncracked concrete [6] | $N_{pr,uncr}$ | lb (kN) | N/A | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete [6] | $N_{pr,cr}$ | lb (kN) | 495 (2.2) | D.6.3.2 |
| Factored pullout resistance in 20 MPa cracked concrete, seismic [6] | $N_{pr,eq}$ | lb (kN) | 490 (2.2) | D.6.3.2 |
| Resistance modification factor for shear, steel failure modes [2,3] | $R_{s,V}$ | - | 0.65 | D.5.3 b) |
| Factored steel resistance in shear [7] | $V_{sa}$ | lb (kN) | 975 (4.3) | D7.1.2 |
| Factored steel resistance in shear, seismic [7] | $V_{sa,eq}$ | lb (kN) | 975 (4.3) | |
| Resistance modification factor for shear, concrete failure modes [3] | $R_{c,V}$ | - | 0.70 | |
| Coefficient for pryout resistance | $k_{cp}$ | - | 1.0 | D.7.3 |

1 Design information is taken from ICC-ES ESR-4236, dated July 2018, table 2, and converted for use with CSA A23.3 Annex D.
2 The HDI-P TZ is considered a brittle steel element as defined by CSA A23.3 Annex D Section D.2.
3 All values of R are applicable with the load combinations of CSA A23.3 Chapter 8. For concrete failure modes, no increase for Condition A is permitted.
4 $N_{sar} = N_{sa}\ \varphi_s\ R_{s,N}$ where $N_{sa}$ tabular value above is precalculated from $A_{se,N}\ f_{uta}$.
5 For all design cases, $\psi_{c,N} = 1.0$. The appropriate effectiveness factor for cracked concrete ($k_{c,cr}$) or uncracked concrete ($k_{c,uncr}$) must be used.
6 For all design cases, $\psi_{c,P} = 1.0$. Tabular value for pullout resistance is for a concrete compressive strength of 20 MPa (2,900 psi). Pullout resistance for concrete compressive strength greater than 20 MPa (2,900 psi) may be increased by multiplying the tabular pullout resistance by $(f'_c / 20)^{0.35}$ for MPa or $(f'_c / 2{,}900)^{0.35}$ for psi. NA (not applicable) denotes that pullout strength does not need to be considered for design.
7 Shear and seismic shear tests are all performed in cracked concrete member per ICC-ES AC193 section 9.4 and 9.6 respectively. Value of $V_{sa(,eq)} < 0.6\ A_{se,V}\ f_{uta}$ for all cases. Multiply $V_{sa}$ tabular value above by $\varphi_s\ R_{s,V}$ to get $V_{sar}$ and $V_{sar,eq}$.

**Table 9 - Steel design information for inserted threaded rod, in accordance with CSA A23.3[1]**

| Setting information | Symbol | Unit | Nominal anchor size / internal thread dia. (in) |
|---|---|---|---|
| | | | 3/8 |
| Nominal rod diameter | $d_{rod}$ | in. | 0.375 |
| Steel embed. material resistance factor for reinforcement | $\varphi_s$ | - | 0.85 |
| Resistance modification factor for tension, steel failure modes, ASTM A36 steel material [2] | $R_{s,N}$ | - | 0.80 |
| Min. specified ult. strength, ASTM A36 steel material | $f_{uta}$ | psi (MPa) | 58,000 (400) |
| Rod effective cross-sectional area | $A_{se,rod}$ | in.$^2$ (mm$^2$) | 0.0775 (50) |
| Factored steel resistance in tension ASTM A36 steel material [3] | $N_{sa,rod}$ | lb (kN) | 4,495 (20.0) |
| Factored steel resistance in tension, seismic ASTM A36 steel material [3] | $N_{sa,rod,eq}$ | lb (kN) | 4,495 (20.0) |
| Resistance modification factor for steel in shear ASTM A36 steel material [2] | $R_{sa,rod,V}$ | - | 0.75 |
| Factored steel resistance in shear ASTM A36 steel material [4] | $V_{sa,rod}$ | lb (kN) | 2,695 (12.0) |
| Factored steel resistance, seismic ASTM A36 steel material [4] | $V_{sa,rod,eq}$ | lb (kN) | 1,885 (8.4) |

1 Values provided for steel element material types, or equivalent, based on minimum specified strengths and calculated in accordance with CSA A23.3 14 Eq. D.2 and Eq. D.30, as applicable.
2 All values of R are applicable with the load combinations of CSA A23.3 Chapter 8. Values correspond to a ductile steel element.
3 $N_{sar,rod(eq)} = N_{sa,rod(eq} \varphi_s R_{s,N}$ where $N_{sa,rod(eq)}$ tabular value above is precalculated from $A_{se,rod} f_{uta}$. $N_{sar}$ shall be the lower of $N_{sar,rod}$ or $N_{sar,HDI\text{-}P\ TZ}$ for static steel strength in tension; for seismic loads, $N_{sar,eq}$ shall be the lower of $N_{sar,rod,eq}$ or $N_{sar,eq}$, HDI-P TZ.
4 $V_{sar,rod(eq)} = V_{sa,rod(eq)} \varphi_s R_{s,V}$ where $V_{sa,rod}$ tabular value above is precalculated from 0.6 $A_{se,rod} f_{uta}$, and $V_{sa,rod,eq}$ must be taken as 0.7 $V_{sa,rod}$. $V_{sar}$ shall be the lower of $V_{sar,rod}$ or $V_{sar,HDI\text{-}P\ TZ}$ for static steel strength in tension; for seismic loading, $V_{sar,eq}$ shall be the lower of $V_{sar,eq}$,rod or $V_{sar,eq,HDI\text{-}P\ TZ}$.

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com or www.hilti.ca. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.



## ORDERING INFORMATION

| Description | Item number |
|---|---|
| **Flush anchor HDI-P TZ 3/8"** | 2204029 |
| **HDI-P TZ 3/8" MC (1200 PCS / MC)** | 3596870 |
| **HDI-P TZ 3/8" (1/3 Pallet = 9600 PCS)** | 3596872 |
| **HDI-P TZ 3/8" Pallet** | 3597043 |
| **HDI-P TZ 3/8" (300) with auto set tool** | 3597044 |
| **HDI-P TZ 3/8" (600) with auto set tool** | 3597045 |
| **HDI-P TZ 3/8" (1200) with 3 auto set tools** | 3597046 |

**Accessories**

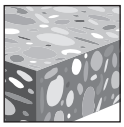
| Description | Item number |
|---|---|
| **Auto setting tool HDI-P TZ 3/8"** | 2204112 |
| **Setting tool HST HDI-P TZ 3/8"x20** | 2204110 |

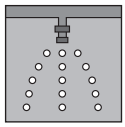
# 3.3.14 HDI-P DROP-IN ANCHORS

## PRODUCT DESCRIPTION

**HDI-P Drop-in Anchors**

| Anchor System | Features and Benefits |
|---|---|
| HDI-P Drop-in Anchor  | • Optimized anchor length to allow reliable fastenings in hollow core panels, precast plank and post tensioned slabs<br>• Shallow drilling enables fast installation<br>• Lip provides flush installation, consistent anchor depth and easy rod alignment<br>• HSD-G 3/8 setting tool with hand guard leaves mark on flange when anchor is set properly to enable inspection and verification of proper expansion |


Uncracked concrete


Fire sprinkler listings

## MATERIAL SPECIFICATIONS

The HDI-P is manufactured from mild carbon steel, which is zinc plated for corrosion protection in accordance with ASTM B633, SC 1, Type III.

| Approvals/Listings | |
|---|---|
| **FM (Factory Mutual)** | Pipe hanger components for automatic sprinkler systems for ¾=8-in. model |
| **ANSI/MSS SP-58-2018** | Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information |

FM APPROVED

## DESIGN DATA IN CONCRETE USING ALLOWABLE STRESS DESIGN

**Technical data**

**Table 1 — Hilti HDI-P loads in normal-weight concrete and hollow core concrete panels**

| Nominal anchor diameter | Length in. (mm) | Nom. bit dia. in. | Ultimate loads, lb (kN) | | | | | | | | Allowable loads, lb (kN)[3] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 4,000 psi concrete | | | | Hollow core[1,2] | | | | $f'_c$ = 4,000 psi concrete | | | | Hollow core[1,2] | | | |
| | | | Tension | | Shear | | Tension | | Shear | | Tension | | Shear | | Tension | | Shear | |
| 1/4 | 5/8 | (15.9) | 3/8 | 1,430 | (6.4) | 1,870 | (8.3) | 1,550 | (6.9) | 2,275 | (10.1) | 285 | (1.3) | 375 | (1.7) | 310 | (1.4) | 455 | (2.0) |
| 3/8 | 3/4 | (19.1) | 1/2 | 1,900 | (8.5) | 3,000 | (13.3) | 2,100 | (9.3) | 4,000 | (17.8) | 380 | (1.7) | 600 | (2.7) | 420 | (1.9) | 800 | (3.6) |
| 1/2 | 1 | (25.4) | 5/8 | 3,000 | (13.3) | 6,075 | (27.0) | 3,110 | (13.8) | 5,495 | (24.5) | 600 | (2.7) | 1215 | (5.4) | 620 | (2.8) | 1,100 | (4.9) |

1 The Admissible Anchor Location must be established to prevent damage to the prestressed cable during the drilling process. Verify the location and height of the cable with the hollow core plank supplier to confirm Admissible Anchor Location.

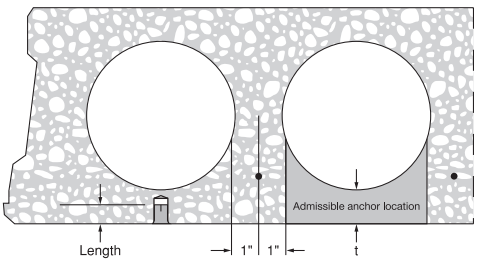
2 Minimum compressive strength of hollow core panels is 7,000 psi at the time of installation. The minimum thickness "t" is 1-3/8 inches.

3 Allowable loads calculated with a 5:1 factor-of-safety.

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com (Canada). Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

**Figure 1 — Installation of Hilti HDI-P in hollow core concrete**




## ORDERING INFORMATION

**HDI-P anchor**

| Description | Bit diameter | Qty / box |
|---|---|---|
| HDI-P 1/4 | 3/8 | 100 |
| HDI-P 3/8 | 1/2 | 100 |
| HDI-P 1/2 | 5/8 | 50 |

**Setting tools for HDI-P anchors**

| Description |
|---|
| HST-P 1/4 Hand Setting Tool |
| HST-P 3/8 Hand Setting Tool |
| HSD-G 3/8 Hand Setting Tool with hand guard |
| HST-P 1/2 Hand Setting Tool |

## INSTALLATION INSTRUCTIONS

Manufacturer's Printed Installation Instructions (MPII) are included with each product package. They can also be viewed or downloaded at www.hilti.com. Because of the possibility of changes, always verify that downloaded MPII are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the MPII.

## ORDERING INFORMATION[1]

### HDI+, HDI-L+ and HDI

#### Carbon steel

| Description | Description | Anchor thread size | Qty / box |
|---|---|---|---|
| **HDI+ 1/4** | **HDI-L+ 1/4** | 1/4 | 100 |
| **HDI+ 3/8** | **HDI-L+ 3/8** | 3/8 | 50 |
| **HDI+ 1/2** | **HDI-L+ 1/2** | 1/2 | 50 |
| **HDI 5/8** | **–** | 5/8 | 25 |
| **HDI 3/4** | **–** | 3/4 | 25 |

### HDI-SS anchors

#### Stainless steel

| Description | Anchor thread size | Qty / box |
|---|---|---|
| **HDI 1/4 SS303** | 1/4 | 100 |
| **HDI 3/8 SS303** | 3/8 | 50 |
| **HDI 1/2 SS303** | 1/2 | 50 |
| **HDI 5/8 SS303** | 5/8 | 25 |
| **HDI 3/4 SS303** | 3/4 | 25 |

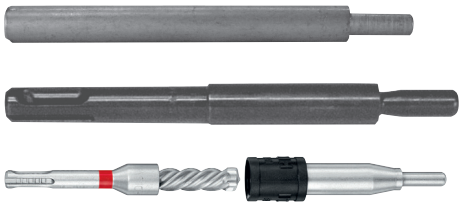
### Setting tools for HDI and HDI-SS anchors

| Description | Anchor thread size |
|---|---|
| **HST 5/8 Setting Tool** | 5/8 |
| **HST 3/4 Setting Tool** | 3/4 |



### Setting Tools for HDI+ and HDI-L+

| Anchor thread size | Description |
|---|---|
| 1/4 | HST 1/4 Setting tool |
| | HSD-MM 1/4 (TE-C-24D6 1/4 Setting tool) |
| | HDI+ Setting Tool includes a TE-CX 3/8x1 carbide bit |
| 3/8 | HST 3/8 Setting tool |
| | HSD-MM 3/8 (TE-C-24SD10 3/8 Setting tool) |
| | HDI+ Setting Tool includes a TE-CX 1/2x1-9/16 carbide bit |
| 1/2 | HST 1/2 Setting tool |
| | HSD-MM 1/2 (TE-C-24SD12 1/2 Setting tool) |
| | HDI+ Setting Tool includes a TE-CX 5/8x2 carbide bit |



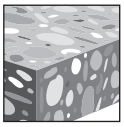
1 All dimensions in inches

# 3.3.15 KCM-WF/PD CAST-IN ANCHORS

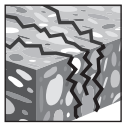
## PRODUCT DESCRIPTION

**KCM-WF/PD cast-in anchors**

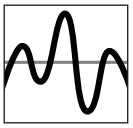
| Anchor System | | Features and Benefits |
|---|---|---|
|  | KCM-WF internally threaded cast-in anchors for wood | • Application-relevant multi-thread configurations allow for the installation of different diameters of threaded rods. KCM-WF/PD have color coded perforated Foam inserts to prevent concrete intrusion<br>• KCM-WF have notched nails that snap off easily at the concrete surface after the wood forms are stripped.<br>• KCM-WF nails above the head lock the metal head to the plastic body preventing head popping off due to rebar hits<br>• KCM-WF nail and anchor design profile reduce the risk of anchor knock over due to accidental rebar hit<br>• KCM-PD has a design without nails for fastening to pan joist deck<br>• Wider base of the KCM-PD allows for easy fastening to pan joist deck. |
|  | KCM-PD internally threaded cast in anchors for pan deck | |
|  | KCM-WF setting tool | |



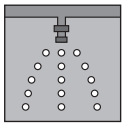
Uncracked concrete



Cracked concrete



Seismic design categories A-F



Fire sprinkler listings

| Approvals/Listings | |
|---|---|
| **ICC-ES (International Code Council)**<br>**2015 International Building Code / International Residential Code (IBC/IRC)** | ESR-4145 in concrete per ACI 318 Ch. 17 / ICC-ES AC446 |
| **City of Los Angeles** | 2017 LABC Supplement (within ESR-4145) |
| **FM (Factory Mutual)** | Pipe hanger components for automatic sprinkler systems for 3/8 through 3/4 |
| **UL and cUL (Underwriters Laboratory)** | Pipe hanger equipment for fire protection services for 3/8 through 3/4 |
| **ANSI/MSS SP-58-2018** | Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information. |

## MATERIAL SPECIFICATIONS

KCM-WF and KCM-PD anchors have an insert body made from carbon steel with an engineered plastic flange. The insert body is zinc plated per ASTM B633 Fe/Zn 5 Type III.

# INSTALLATION PARAMETERS

**Table 1 — Hilti KCM-WF and KCM-PD specification table**

| Design Information | Symbol | Units | 1/4"-3/8" | 3/8"-1/2" | 3/8"-1/2"-5/8" | 3/8"-1/2"-5/8"-3/4" |
|---|---|---|---|---|---|---|
| Insert type | - | - | WF and PD | Only WF | WF and PD | WF and PD |
| Plastic housing color | - | - | Green | Orange | Red | Grey |
| Effective embedment | $h_{ef}$ | in. (mm) | 1.12 (28) | 1.63 (41) | 2.04 (52) | 3.0 (76) |
| Min. member thickness | $h_{min}$ | in. (mm) | 2.5 (64) | 2.5 (64) | 3 (76) | 4 (10) |
| Outside diameter of anchor steel body | $d_a$ | in. (mm) | 0.50 (12.8) | 0.66 (16.9) | 0.87 (22.1) | 1.02 (25.9) |
| Bearing area | $A_{brg}$ | in.$^2$ (mm$^2$) | 0.91 (590) | 1.00 (643) | 1.23 (792) | 2.25 (1,451) |
| Minimum anchor spacing[1] | $s_{min}$ | in. (mm) | 2.00 (50.8) | 2.64 (67.1) | 3.48 (88.4) | 4.08 (103.6) |

1 Minimum anchor spacing values correspond to $4d_a$ for an un-torqued anchor as specified by ACI 318 17.7.1.

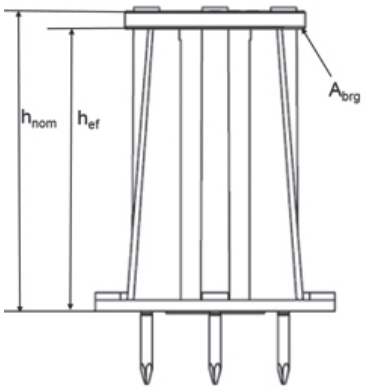



**Figure 1 — KCM-WF Anchor**

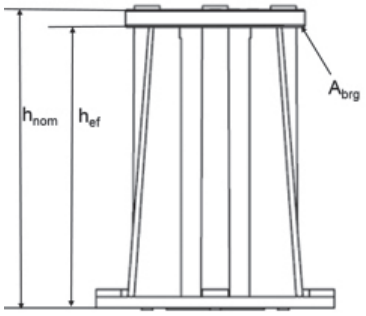
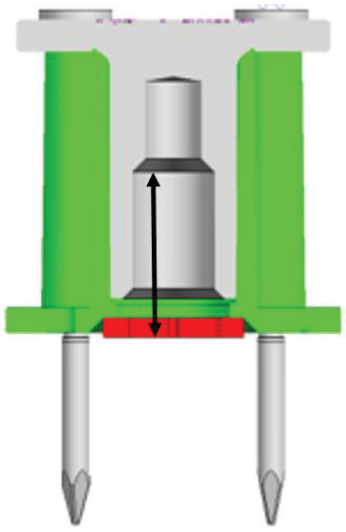



**Figure 2 — KCM-PD Anchor**

**Thread engagement measurements**

| Anchor body | Rod Dia. [in.] | Thread Engagment [in.] Plastic on/Metal tube on [in.] |
|---|---|---|
| 1/4" + 3/8" | 1/4" | 1.1 |
| | 3/8" | 0.7 |
| 3/8" + 1/2" | *3/8"* | 1.5 |
| | *1/2"* | 0.9 |
| 3/8" + 1/2" + 5/8" | *3/8"* | 1.9 |
| | *1/2"* | 1.5 |
| | *5/8"* | 0.9 |
| 3/8" + 1/2" + 5/8" + 3/4" | *3/8"* | 2.8 |
| | *1/2"* | 2.3 |
| | *5/8"* | 1.7 |
| | *3/4"* | 0.9 |



# DESIGN DATA IN CONCRETE PER ACI 318

**ACI 318 Chapter 17 Design**

The technical data contained in this section are Hilti Simplified Design Tables. The load values were developed using the Strength Design parameters and variables of ESR-4145 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-4145 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

**Table 2 — Hilti KCM-WF and KCM-PD cast-in insert design strength with concrete/pullout failure in uncracked concrete [1,2,3,4,5]**

| Nominal anchor internal diameter | Effective embedment depth in. (mm) | Tension - $\varphi N_n$ | | | | Shear - $\varphi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 1/4"-3/8" | 1.12 (28) | 1,240 (5.5) | 1,355 (6.0) | 1,570 (7.0) | 1,920 (8.5) | 1,240 (5.5) | 1,355 (6.0) | 1,570 (7.0) | 1,920 (8.5) |
| 3/8"-1/2" | 1.63 (41) | 2,180 (9.7) | 2,390 (10.6) | 2,760 (12.3) | 3,380 (15.0) | 2,180 (9.7) | 2,390 (10.6) | 2,760 (12.3) | 3,380 (15.0) |
| 3/8"-1/2"-5/8" | 2.04 (52) | 3,055 (13.6) | 3,345 (14.9) | 3,865 (17.2) | 4,735 (21.1) | 3,055 (13.6) | 3,345 (14.9) | 3,865 (17.2) | 4,735 (21.1) |
| 3/8"-1/2"-5/8"-3/4" | 3.00 (76) | 5,455 (24.3) | 5,975 (26.6) | 6,900 (30.7) | 8,450 (37.6) | 10,910 (48.5) | 11,950 (53.2) | 13,800 (61.4) | 16,900 (75.2) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for single anchor located at edge distance (c) and spacing (s) greater than 24". For anchors with edge distance or spacing less than 24" use ACI 318 to calculate load reduction factor. Compare the value to the steel values (threaded rod and inserts) in Tables 4 and 5. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.85. For all-lightweight, $\lambda_a$ = 0.75
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

**Table 3 — Hilti KCM-WF and KCM-PD cast-in insert design strength with concrete / pullout failure in cracked concrete [1,2,3,4,5]**

| Nominal anchor internal diameter | Effective embed-ment depth in. (mm) | Tension - $\varphi N_n$ | | | | Shear - $\varphi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 1/4"-3/8" | 1.12 (28) | 990 (4.4) | 1,085 (4.8) | 1,255 (5.6) | 1,535 (6.8) | 990 (4.4) | 1,085 (4.8) | 1,255 (5.6) | 1,535 (6.8) |
| 3/8"-1/2" | 1.63 (41) | 1,745 (7.8) | 1,910 (8.5) | 2,210 (9.8) | 2,705 (12.0) | 1,745 (7.8) | 1,910 (8.5) | 2,210 (9.8) | 2,705 (12.0) |
| 3/8"-1/2"-5/8" | 2.04 (52) | 2,445 (10.9) | 2,675 (11.9) | 3,090 (13.7) | 3,785 (16.8) | 2,445 (10.9) | 2,675 (11.9) | 3,090 (13.7) | 3,785 (16.8) |
| 3/8"-1/2"-5/8"-3/4" | 3.00 (76) | 4,360 (19.4) | 4,780 (21.3) | 5,520 (24.6) | 6,760 (30.1) | 8,725 (38.8) | 9,560 (42.5) | 11,040 (49.1) | 13,520 (60.1) |

1 See Section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for single anchor located at edge distance (c) and spacing (s) greater than 24". For anchors with edge distance or spacing less than 24" use ACI 318 to calculate load reduction factor. Compare the value to the steel values (threaded rod and inserts) in Tables 4 and 5. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.85. For all-lightweight, $\lambda_a$ = 0.75.
5 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear.

### Table 4 — Design strength for steel failure of common threaded rods[1,5]

| Nominal rod diameter in. | Grade A36 threaded rod | | | ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod | | | ASTM A 307, Grade A threaded rod | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN) | Shear[3] $\phi V_{sa,rod}$ lb (kN) | Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN) | Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN) | Shear[3] $\phi V_{sa,rod}$ lb (kN) | Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN) | Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN) | Shear[3] $\phi V_{sa,rod}$ lb (kN) | Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN) |
| 1/4 | 1,390 (6.2) | 720 (3.2) | 505 (2.2) | 3,000 (13.3) | 1,550 (6.9) | 1,085 (4.8) | 1,425 (6.3) | 740 (3.3) | 518 (2.3) |
| 3/8 | 3,395 (15.1) | 1,750 (7.8) | 1,225 (5.4) | 7,315 (32.5) | 3,780 (16.8) | 2,646 (11.8) | 3,490 (15.5) | 1,815 (8.1) | 1,271 (5.7) |
| 1/2 | 6,175 (27.5) | 3,210 (14.3) | 2,245 (10.0) | 13,315 (59.2) | 6,915 (30.8) | 4,841 (21.5) | 6,375 (28.4) | 3,315 (14.7) | 2,321 (10.3) |
| 5/8 | 9,835 (43.7) | 5,110 (22.7) | 3,575 (15.9) | 21,190 (94.3) | 11,020 (49.0) | 7,714 (34.3) | 10,165 (45.2) | 5,285 (23.5) | 3,700 (16.5) |
| 3/4 | 14,550 (64.7) | 7,565 (33.7) | 5,295 (23.6) | 31,405 (139.7) | 16,305 (72.5) | 11,414 (50.8) | 15,040 (66.9) | 7,820 (34.8) | 5,474 (24.3) |

1 See Section 3.1.8 for additional information on seismic applications.
2 Tensile values determined by static tension tests with $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17. Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic tension loads.
3 Shear values determined by static shear tests with $\phi V_{sa} = \phi 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17. Only the largest size of threaded rod specified for each insert must be used for applications resisting shear loads.
4 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi 0.60 A_{se,V} f_{uta}$ as noted in ACI 318, Chapter 17. Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic shear load.
5 Values are for the threaded rod only. The capacity of the insert must be also be determined from Table 5. The design strength of concrete must be in accordance with ACI 318 Chapter 17 and Tables 2 to 3 as necessary. Compare the values (threaded rod, inserts, and concrete). The lesser of the values is to be used for the design.

### Table 5 — Design strength for steel failure of KCM-WF and KCM-PD inserts[1]

| Design information | 1/4"-3/8" | 3/8"-1/2" | 3/8"-1/2"-5/8" | 3/8"-1/2"-5/8"-3/4" |
|---|---|---|---|---|
| | WF and PD | Only WF | WF and PD | WF and PD |
| Design steel strength of insert in tension, $\phi N_{sa,insert}$ lb (kN) | 5,315 (23.6) | 8,775 (39.0) | 10,920 (48.6) | 17,795 (79.2) |
| Design seismic steel strength of insert in tension,[2] $\phi N_{sa,insert,eq}$ lb (kN) | 5,315 (23.6) | 8,775 (39.0) | 10,920 (48.6) | 17,795 (79.2) |
| Design steel strength of insert in shear,[2] $\phi V_{sa,insert}$ lb (kN) | 1,775 (7.9) | 3,490 (15.5) | 5,785 (25.7) | 11,140 (49.6) |
| Design seismic steel strength of insert in shear,[2] $\phi V_{sa,insert,eq}$ lb (kN) | 1,775 (7.9) | 3,490 (15.5) | 5,785 (25.7) | 11,140 (49.6) |

1 Values are for the inserts only. The capacity of the threaded rods must be also determined from Table 4. The design strength of concrete must be in accordance with ACI 318 Chapter 17 and Tables 2 to 3 as necessary. Compare the values (threaded rod, inserts, and concrete). The lesser of the values is to be used for the design.
2 Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic tension, static shear, and seismic shear loads.

# DESIGN DATA IN CONCRETE PER CSA A23.3

**CSA A23.3 Annex D design**

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-4145. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

**Table 6 — Hilti KCM-WF/PD design information in accordance with CSA A23.3 (R2014) Annex D [1]**

| Design parameter | Symbol | Units | Nominal anchor diameter | | | | Ref A23.3-14 |
|---|---|---|---|---|---|---|---|
| | | | 1/4"-3/8" | 3/8"-1/2" | 3/8"-1/2"-5/8" | 3/8"-1/2"-5/8"-3/4" | |
| Outside diameter of anchor steel body | $d_a$ | in. (mm) | 0.5 (13) | 0.66 (17) | 0.87 (22) | 1.02 (26) | |
| Effective embedment | $h_{ef}$ | in. (mm) | 1.12 (28) | 1.63 (41) | 2.04 (52) | 3 (76) | |
| Min. concrete thickness | $h_{min}$ | in. (mm) | 2-1/2 (64) | | 3 (76) | 4 (102) | |
| Minimum edge distance | $c_{min}$ | in. (mm) | 1-1/2 (38) | | | | |
| Minimum anchor spacing | $s_{min}$ | in. (mm) | 2.00 (51) | 2.64 (67) | 3.48 (88) | 4.08 (104) | |
| Steel embed. material resistance factor for reinforcement | $\phi_s$ | | 0.85 | | | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes [2] | R | | 0.70 | | | | D.5.3 |
| Resistance modification factor for shear, steel failure modes [2] | R | | 0.65 | | | | D.5.3 |
| Factored steel resistance in tension | $N_{sar}$ | lb. (kN) | 4,864 (21.6) | 8,033 (35.7) | 9,996 (44.4) | 16,291 (72.4) | D.6.1.2 |
| Factored steel resistance in tension, seismic [4] | $N_{sar,eq}$ | lb. (kN) | 4,864 (21.6) | 8,033 (35.7) | 9,996 (44.4) | 16,291 (72.4) | D.6.1.2 |
| Factored steel resistance in shear[4] | $V_{sar}$ | lb. (kN) | 1,633 (7.3) | 3,216 (14.3) | 5,326 (23.7) | 10,260 (45.6) | D.7.1.2 |
| Factored steel resistance in shear, seismic[4] | $V_{sar,eq}$ | lb. (kN) | 1,633 (7.3) | 3,216 (14.3) | 5,326 (23.7) | 10,260 (45.6) | D.7.1.2 |
| Coeff. for factored conc. breakout resistance, uncracked concrete | $k_{c,uncr}$ | - | 10 | | | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete | $k_{c,cr}$ | - | 10 | | | | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked conc. | $\Psi_{c,N}$ | - | 1.25 | | | | D.6.2.6 |
| Modification factor for anchor resistance, tension, cracked conc. | $\Psi_{c,N}$ | | 1.0 | | | | D.6.2.6 |
| Anchor category | - | - | cast-in | | | | D.5.3 (c) |
| Concrete material resistance factor | $\phi_c$ | - | 0.65 | | | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B [3] | R | - | 1.00 | | | | |

1 Design information in this table is taken from ICC-ES ESR-4145, dated 4/2018, and converted for use with CSA A23.3 (R2014) Annex D.
2 The carbon steel KCM-WF/PD is considered a brittle steel element as defined by CSA A23.3 (R2014) Annex D section D.2.
3 For use with the load combinations of CSA A23.3 (R2014) chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 (R2014) section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
4 Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic tension, static shear, and seismic shear loads.

### Table 7 — Hilti KCM-WF/PD cast-in insert design strength with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

| Nominal anchor diameter in. (mm) | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4"-3/8" | 1.12 (28) | 1.12 (28) | 1,235 (5.5) | 1,380 (6.1) | 1,515 (6.7) | 1,750 (7.8) | 1,235 (5.5) | 1,380 (6.1) | 1,515 (6.7) | 1,750 (7.8) |
| 3/8"-1/2" | 1.63 (41) | 1.63 (41) | 2,175 (9.7) | 2,435 (10.8) | 2,665 (11.9) | 3,075 (13.7) | 2,175 (9.7) | 2,435 (10.8) | 2,665 (11.9) | 3,075 (13.7) |
| 3/8"-1/2"-5/8" | 2.04 (52) | 2.04 (52) | 3,045 (13.6) | 3,405 (15.2) | 3,730 (16.6) | 4,305 (19.2) | 3,045 (13.6) | 3,405 (15.2) | 3,730 (16.6) | 4,305 (19.2) |
| 3/8"-1/2"-5/8"-3/4" | 3.00 (76) | 3.00 (76) | 5,435 (24.2) | 6,075 (27.0) | 6,655 (29.6) | 7,685 (34.2) | 10,865 (48.3) | 12,150 (54.1) | 13,310 (59.2) | 15,370 (68.4) |

1 See section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for single anchor located at edge distance (c) and spacing (s) greater than 24". For anchors with edge distance or spacing less than 24" use CSA A23.3 to calculate load reduction factor. Compare the value to the steel values in Tables 6 and 9. The lesser of the values is to be used for the design.
4 Tablular values are for normal weight concrete only.
For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.85; for all-lightweight, $\lambda_a$ = 0.75.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete.

### Table 8 — Hilti KCM-WF/PD cast-in insert design strength with concrete / pullout failure in cracked concrete[1,2,3,4,5]

| Nominal anchor diameter in. (mm) | Effective embed. in. (mm) | Nominal embed. in. (mm) | Tension - $N_r$ | | | | Shear - $V_r$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 25 MPa (3,625 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 40 MPa (5,800 psi) lb (kN) |
| 1/4"-3/8" | 1.12 (28) | 1.12 (28) | 990 (4.4) | 1,105 (4.9) | 1,210 (5.4) | 1,400 (6.2) | 990 (4.4) | 1,105 (4.9) | 1,210 (5.4) | 1,400 (6.2) |
| 3/8"-1/2" | 1.63 (41) | 1.63 (41) | 1,740 (7.7) | 1,945 (8.7) | 2,130 (9.5) | 2,460 (10.9) | 1,740 (7.7) | 1,945 (8.7) | 2,130 (9.5) | 2,460 (10.9) |
| 3/8"-1/2"-5/8" | 2.04 (52) | 2.04 (52) | 2,435 (10.8) | 2,725 (12.1) | 2,985 (13.3) | 3,445 (15.3) | 2,435 (10.8) | 2,725 (12.1) | 2,985 (13.3) | 3,445 (15.3) |
| 3/8"-1/2"-5/8"-3/4" | 3.00 (76) | 3.00 (76) | 4,345 (19.3) | 4,860 (21.6) | 5,325 (23.7) | 6,145 (27.3) | 8,695 (38.7) | 9,720 (43.3) | 10,650 (47.4) | 12,295 (54.7) |

1 See section 3.1.8 to convert factored resistance value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for single anchor located at edge distance (c) and spacing (s) greater than 24". For anchors with edge distance or spacing less than 24" use CSA A23.3 to calculate load reduction factor. Compare the value to the steel values in Tables 6 and 9. The lesser of the values is to be used for the design.
4 Tablular values are for normal weight concrete only.
For lightweight concrete multiply design strength by $\lambda_a$ as follows: For sand-lightweight, $\lambda_a$ = 0.85; for all-lightweight, $\lambda_a$ = 0.75.
5 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear.

## Table 9 — Design strength for steel failure of common threaded rods used with KCM-WF/PD cast-in inserts[1,2,3]

| Nominal rod diameter in. | Grade A36 threaded rod | | | ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod | | | ASTM A 307, Grade A threaded rod | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN) | Shear[5] $V_{sar,rod}$ lb (kN) | Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN) | Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN) | Shear[5] $V_{sar,rod}$ lb (kN) | Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN) | Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN) | Shear[5] $V_{sar,rod}$ lb (kN) | Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN) |
| 1/4 | 1,260 (5.6) | 705 (3.1) | 495 (2.2) | 2,720 (12.1) | 1,520 (6.8) | 1,064 (4.7) | 1,290 (5.7) | 725 (3.2) | 508 (2.3) |
| 3/8 | 3,075 (13.7) | 1,720 (7.7) | 1,205 (5.4) | 6,630 (29.5) | 3,705 (16.5) | 2,594 (11.5) | 3,160 (14.1) | 1,780 (7.9) | 1,246 (5.5) |
| 1/2 | 5,600 (24.9) | 3,150 (14.0) | 2,205 (9.8) | 12,070 (53.7) | 6,785 (30.2) | 4,750 (21.1) | 5,780 (25.7) | 3,250 (14.5) | 2,275 (10.1) |
| 5/8 | 8,915 (39.7) | 5,010 (22.3) | 3,505 (15.6) | 19,210 (85.4) | 10,805 (48.1) | 7,564 (33.6) | 9,215 (41.0) | 5,185 (23.1) | 3,630 (16.1) |
| 3/4 | 13,190 (58.7) | 7,420 (33.0) | 5,195 (23.1) | 28,475 (126.7) | 15,990 (71.1) | 11,193 (49.8) | 13,635 (60.7) | 7,670 (34.1) | 5,369 (23.9) |

1 See section 3.1.8 to convert design strength value to ASD value.
2 Hilti KCM-WF/PD anchors are to be considered brittle steel elements
3 See Section 3.1.8 for additional information on seismic applications.
4 Tensile $N_{sar} = \phi_s A_{se,N} R f_{ut}$ as noted in CSA A23.3 Annex D. Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic tension loads.
5 Shear values determined by static shear tests with $V_{sar} < \phi_s 0.60 A_{se,V} f_{ut} R$. as noted in CSA A23.3 Annex D. Only the largest size of threaded rod specified for each insert must be used for applications resisting shear loads.
6 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < \phi_s 0.60 A_{se,V} f_{ut} R$. as noted in CSA A23.3 Annex D. Only the largest size of threaded rod specified for each insert must be used for applications resisting seismic shear loads.

**Table 10 — UL LLC and FM approvals[1,2]**

| Design information | 1/4"-3/8" | | | 3/8"-1/2" | | | 3/8"-1/2"-5/8" | | | 3/8"-1/2"-5/8"-3/4" | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | WF and PD | | | Only WF | | | WF and PD | | | WF and PD | | |
| **Nominal rod diameter** | **UL max pipe size (in.)** | **UL test load (lb)** | **FM max pipe size (in.)** | **UL max pipe size (in.)** | **UL test load (lb)** | **FM max pipe size (in.)** | **UL max pipe size (in.)** | **UL test load (lb)** | **FM max pipe size (in.)** | **UL max pipe size (in.)** | **UL test load (lb)** | **FM max pipe size (in.)** |
| 3/8 | 4 | 1,500 | 4 | 4 | 1,500 | 4 | 4 | 1,500 | - | 4 | 1,500 | 4 |
| 1/2 | - | - | - | 8 | 4,050 | 8 | 8 | 4,050 | - | 8 | 4,050 | 8 |
| 5/8 | - | - | - | - | - | - | 8 | 4,050 | - | 12 | 7,900 | 12 |
| 3/4 | - | - | - | - | - | - | - | - | - | 12 | 7,900 | 12 |

1 UL LLC Listing based on successful completion of testing in accordance with UL 203.
2 FM Approval based on successful completion of testing in accordance with FM 1952.

## ORDERING INFORMATION[1]

### KCM – WF cast-in anchor for use in wood forms

| Description | Sleeve color[2] | Qty / box |
|---|---|---|
| KCM – WF 1/4"-3/8" | Green | 250 |
| KCM – WF 3/8"-1/2" | Orange | 150 |
| KCM – WF 3/8"-1/2"-5/8" | Red | 100 |
| KCM – WF 3/8"-1/2"-5/8"-3/4" | Grey | 25 |

### KCM – PD cast-in anchor for use in pan joist deck

| Description | Sleeve color[2] | Qty / box |
|---|---|---|
| KCM – PD 1/4"-3/8" | Green | 250 |
| KCM – PD 3/8"-1/2"-5/8" | Red | 100 |
| KCM – PD 3/8"-1/2"-5/8"-3/4" | Grey | 25 |

[1] All dimensions in inches
[2] Identifies anchor size

## INSTALLATION INSTRUCTIONS

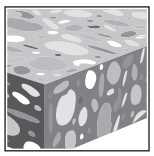
Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com (US), or www.hilti.ca (Canada). Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

# 3.3.16 KCM-MD CAST IN ANCHOR

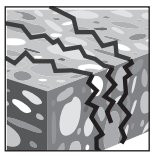
## PRODUCT DESCRIPTION

**KCM-MD cast-in anchors**

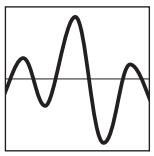
| Anchor System | | Features and Benefits |
|---|---|---|
|  | Internally threaded short plate cast-in anchors for metal deck (KCM-MD SP) | • Application-relevant multi-thread configurations<br>• Color-coded plastic anchor housing identifies the internal thread diameters<br>• Pre-installed screws increase productivity for attaching the anchor to the metal deck<br>• KCM-MD SP — Color-coded plastic plug prevents concrete intrusion and allows for differentiation between anchors of the same thread configuration<br>• KCM-MD SP — Plastic protective tube extends below the metal deck to protect the internal threads from concrete, sprayed-on fireproofing, or sprayed-on insulation<br>• KCM-MD LP — Multi-thread cast-in anchor, which can be installed at any location on the metal deck including in the incline.<br>• KCM-MD LP — Metal protective tube extends below the metal deck to protect the internal threads from concrete, sprayed-on fireproofing, or sprayed-on insulation.<br>• KCM-MD LP — Anchor installs to the top of the flutes of the metal deck, so anchoring point is at consistent height throughout, which is ideal for pre-fabricated hangers |
|  | Internally threaded long plate cast-in anchors for metal deck (KCM-MD LP) | |



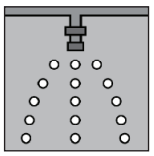
Uncracked concrete



Cracked concrete



Seismic Design Categories A-F



Fire sprinkler listings

## Approvals/ Listings

| | |
|---|---|
| **ICC-ES (International Code Council) 2018 International Building Code / International Residential Code (IBC/IRC)** | ESR-4145 in concrete per ACI 318 Ch. 17 / ICC-ES AC446 |
| **City of Los Angeles** | 2018 LABC Supplement (within ESR-4145) |
| **Florida Building Code** | 2017 FBC with HVHZ |
| **UL LLC (Underwriters Laboratory LLC)** | Pipe Hanger Equipment for Fire Protection Services for 3/8 through 3/4 (See Tables 19A and 19B) |
| **FM (Factory Mutual) Pipe** | Hanger Components for Automatic Sprinkler Systems for 3/8 through 3/4 (See Tables 19A and 19B) |
| **ANSI/MSS SP-58-2018** | Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information. |

LISTED

APPROVED

## MATERIAL SPECIFICATIONS

KCM-MD short plate and long plate anchors KCM-MD have an insert body made from carbon steel with an engineered plastic flange. The insert body is zinc plated per ASTM B633 Fe/Zn 5 Type III.

## INSTALLATION PARAMETERS

### Table 1A — Hilti KCM-MD Short Plate cast-in anchor installation information

| Design information | Symbol | Units | Nominal anchor diameter (in.) | | | |
|---|---|---|---|---|---|---|
| | | | SP 1/4"-3/8" | SP 3/8"-1/2" | SP 3/8"-1/2"-5/8" | SP 5/8"-3/4" |
| Plastic section color | - | - | Green | Orange | Red | Grey |
| Effective embedment | $h_{ef}$ | in. | 1.76 | 2 | 2.5 | 2.5 |
| | | (mm) | (45) | (51) | (64) | (64) |
| Nominal embedment | $h_{nom}$ | in. | 1.88 | 2.13 | 2.63 | 2.65 |
| | | (mm) | (48) | (54) | (67) | (67) |
| Metal hole saw diameter | $d_{bit}$ | in. | 9/16 | 11/16 | 13/16 | 15/16 |
| Steel head thickness | $t_{sh}$ | mm | 3.3 | 3.3 | 3.3 | 3.7 |
| Min. concrete cover over metal deck — upper flute install (see Figure 4A) | $h_{upper,min}$ | in. | 2.5 | 2.5 | 3.25 | 3.25 |
| | | (mm) | (64) | (64) | (83) | (83) |
| Min. concrete cover over metal deck — lower flute install (see Figures 4B and 4C) | $h_{lower,min}$ | in. | 2.5 | 2.5 | 2.5 | 2.5 |
| | | (mm) | (64) | (64) | (64) | (64) |
| Min. metal deck gauge | - | - | 20 | | | |
| Min. anchor spacing | $s_{min}$ | in. | 5.28 | 6 | 7.5 | 7.5 |
| | | (mm) | (134) | (152) | (191) | (191) |

### Table 1B — Hilti KCM-MD Long Plate cast-in anchor installation information

| Design information | Symbol | Units | Nominal anchor diameter (in.) | | | |
|---|---|---|---|---|---|---|
| | | | LP 1/4"-3/8" | LP 3/8"-1/2" | LP 3/8"-1/2"-5/8" | LP 5/8"-3/4" |
| Plastic section color | - | - | Green | Orange | Red | Grey |
| Effective embedment | $h_{ef}$ | in. | 1.76 | 2 | 2.5 | 2.5 |
| | | (mm) | (45) | (51) | (64) | (64) |
| Nominal embedment | $h_{nom}$ | in. | 1.96 | 2.21 | 2.71 | 2.72 |
| | | (mm) | (50) | (56) | (69) | (69) |
| Metal hole saw diameter | $d_{bit}$ | in. | 1/2 | 5/8 | 3/4 | 7/8 |
| Steel head thickness | $t_{sh}$ | mm | 3.3 | 3.3 | 3.3 | 3.7 |
| Min. concrete cover over metal deck (see Figures 4B, 4C and 4D) | $h_{lower,min}$ | in. | 2.5 | 2.5 | 3.25 | 3.25 |
| | | (mm) | (64) | (64) | (83) | (83) |
| Min. metal deck gauge | - | - | 20 | | | |
| Min. anchor spacing | $s_{min}$ | in. | 5.28 | 6 | 7.5 | 7.5 |
| | | (mm) | (134) | (152) | (191) | (191) |

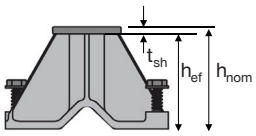



Figure 1 — KCM-MD SP

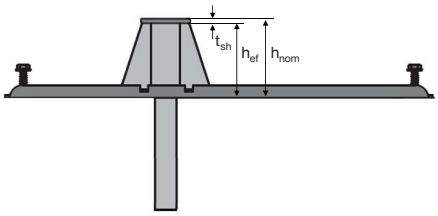



Figure 2 — KCM-MD LP

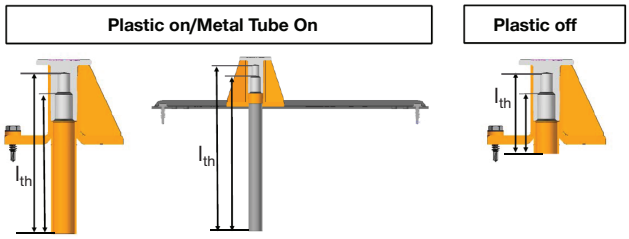



Figure 3 — KCM-MD Thread engagement measurement

**Table 2 — Thread engagement length measured for various threaded sizes**

| Anchor | Anchor body | Rod diameter (in.) | Thread engagement length ($l_{th}$) | | |
|---|---|---|---|---|---|
| | | | Plastic on/ Metal tube on (in.) | Plastic off (in.) | Comments |
| Short plate | 1/4" - 3/8" | 1/4" | 3.9 | 2.2 | -Perforated tube is 1.75"<br>-Base to perforation is 1/2" |
| | | 3/8" | 3.5 | 1.7 | |
| | 3/8" - 1/2" | 3/8" | 4.2 | 2.4 | |
| | | 1/2" | 3.5 | 1.7 | |
| | 3/8" - 1/2" - 5/8" | 3/8" | 4.7 | 3.0 | |
| | | 1/2" | 4.2 | 2.5 | |
| | | 5/8" | 3.5 | 1.7 | |
| | 5/8" - 3/4" | 5/8" | 4.6 | 2.9 | |
| | | 3/4" | 3.9 | 2.1 | |
| Long Plate | 1/4"-3/8" | 1/4" | 6.4 | - | -Metal is not broken off and measured<br>-Tube is 4.75" |
| | | 3/8" | 6.0 | - | |
| | 3/8"-1/2" | 3/8" | 6.8 | - | -Metal is not broken off and measured<br>-Tube is 4.75" |
| | | 1/2" | 6.1 | - | |
| | 3/8"-1/2"-5/8" | 3/8" | 7.3 | - | -Metal is not broken off and measured<br>-Tube is 4.75" |
| | | 1/2" | 6.8 | - | |
| | | 5/8" | 6.1 | - | |
| | 5/8"-3/4" | 5/8" | 6.9 | - | -Metal is not broken off and measured<br>-Tube is 4.5" |
| | | 3/4" | 6.1 | - | |

## DESIGN INFORMATION IN CONCRETE PER ACI 318

### ACI 318 Chapter 17

The technical data contained in this section are Hilti Simplified Design Tables. The load values were developed using the Strength Design parameters and variables of ESR- 4145 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8 of the Hilti Product Technical Guide Volume 2 Edition 19. Data tables from ESR-4145 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

## Table 3A — Design strength for steel failure of KCM-MD Short Plate anchor[1,2,3,4]

| DESIGN INFORMATION | Symbol | Units | Insert Type | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SP 1/4"-3/8" | | SP 3/8"-1/2" | | SP 3/8"-1/2"-5/8" | | | SP 5/8"-3/4" | |
| Nominal rod diameter in. | | | 1/4 | 3/8 | 3/8 [5] | 1/2 | 3/8 | 1/2 [5] | 5/8 | 5/8 [5] | 3/4 |
| Design steel strength of insert in tension | $\Phi N_{sa,insert}$ | lb (kN) | 5,395 (24.0) | | 8,775 (39.0) | | 8,010 (35.6) | | | 7,815 (34.8) | |
| Design seismic steel strength of insert in tension | $\Phi N_{sa,insert,eq}$ | lb (kN) | - | 5,395 (24) | 8,775 (39) | 8,775 (39) | - | 8,010 (36) | 8,010 (36) | 7,815 (35) | 7,815 (35) |
| Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figures 4A | | | | | | | | | | | |
| Design steel strength of insert in shear | $\Phi V_{sa,insert}$ | lb (kN) | - | 2,810 (21) | - | 5,295 (39) | - | - | 7,180 (53) | - | 8,255 (61) |
| Design seismic steel strength of insert in shear | $\Phi V_{sa,insert,eq}$ | lb (kN) | - | 2,810 (21) | - | 5,295 (39) | - | - | 7,180 (53) | - | 8,255 (61) |
| Installations in lower flute of metal deck (i.e. W-deck) according to Figures 4B | | | | | | | | | | | |
| Design steel strength of insert in shear | $\Phi V_{sa,insert}$ | lb (kN) | - | 2,060 (21) | 1,995 (9) | 2,510 (39) | - | 3,180 (14) | 3,265 (53) | 2,815 (13) | 3,265 (61) |
| Design seismic steel strength of insert in shear | $\Phi V_{sa,insert,eq}$ | lb (kN) | - | 2,060 (21) | 1,995 (9) | 2,510 (39) | - | 2,225 (10) | 3,265 (53) | 2,815 (13) | 3,265 (61) |
| Installations in lower flute of metal deck (i.e. B-deck) according to Figures 4C | | | | | | | | | | | |
| Design steel strength of insert in shear | $\Phi V_{sa,insert}$ | lb (kN) | - | 1,895 (8) | - | 2,380 (11) | - | - | 3,350 (15) | - | |
| Design seismic steel strength of insert in shear | $\Phi V_{sa,insert,eq}$ | lb (kN) | - | 1,895 (8) | - | 2,380 (11) | - | - | 3,015 (13) | | |

## Table 3B — Design strength for steel failure of KCM-MD Long Plate anchor[1,2,3,4]

| DESIGN INFORMATION | Symbol | Units | Insert Type | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | LP 1/4"-3/8" | | LP 3/8"-1/2" | | LP 3/8"-1/2"-5/8" | | | LP 5/8"-3/4" | |
| Nominal rod diameter in. | | | 1/4 | 3/8 | 3/8 [5] | 1/2 | 3/8 | 1/2 [5] | 5/8 | 5/8 [5] | 3/4 |
| Design steel strength of insert in tension | $\Phi N_{sa,insert}$ | lb (kN) | 5,395 (24.0) | | 8,775 (39.0) | | 8,010 (35.6) | | | 7,815 (34.8) | |
| Design seismic steel strength of insert in tension | $\Phi N_{sa,insert,eq}$ | lb (kN) | - | 5,395 (24) | 8,775 (39) | 8,775 (39) | - | 8,010 (36) | 8,010 (36) | 7,815 (35) | 7,815 (35) |
| Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figures 4A | | | | | | | | | | | |
| Design steel strength of insert in shear | $\Phi V_{sa,insert}$ | lb (kN) | - | 2,810 (13) | - | 5,295 (24) | - | - | 7,180 (32) | - | 8,255 (37) |
| Design seismic steel strength of insert in shear | $\Phi V_{sa,insert,eq}$ | lb (kN) | - | 2,810 (13) | - | 5,295 (24) | - | - | 7,180 (32) | - | 8,255 (37) |
| Installations in lower flute of metal deck (i.e. W-deck) according to Figures 4B | | | | | | | | | | | |
| Design steel strength of insert in shear | $\Phi V_{sa,insert}$ | lb (kN) | - | 3,515 (15.6) | 2,605 (12) | 3,985 (18) | - | 2,425 (10.8) | 4,625 (20.6) | 2,815 (12.5) | 4,625 (21) |
| Design seismic steel strength of insert in shear | $\Phi V_{sa,insert,eq}$ | lb (kN) | - | 3,515 (16) | 2,605 (12) | 3,985 (18) | - | 2,425 (11) | 4,625 (21) | 2,815 (13) | 4,625 (21) |
| Installations in lower flute of metal deck (i.e. B-deck) according to Figures 4C | | | | | | | | | | | |
| Design steel strength of insert in shear | $\Phi V_{sa,insert}$ | lb (kN) | - | 2,890 (12.9) | - | 4,525 (20.1) | - | - | 5,750 (25.6) | - | 7,150 (31.8) |
| Design seismic steel strength of insert in shear | $\Phi V_{sa,insert,eq}$ | lb (kN) | - | 2,890 (13) | - | 4,525 (20) | - | - | 5,750 (26) | - | 7,150 (32) |
| Installations over flute incline of metal deck (i.e. W-deck) according to Figures 4D | | | | | | | | | | | |
| Design steel strength of insert in shear | $\Phi V_{sa,insert}$ | lb (kN) | - | 1,030 (4.6) | - | 2,665 (11.9) | - | - | 5,985 (26.6) | - | 5,985 (27) |
| Design seismic steel strength of insert in shear | $\Phi V_{sa,insert,eq}$ | lb (kN) | - | 1,030 (4.6) | - | 2,135 (9.5) | - | - | 3,370 (15.0) | - | 5,685 (25) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Hilti KCM-MD Inserts are considered as brittle steel elements
3 Tension values are for the inserts only. The capacity of the threaded rods must be also determined from Table 10. The design strength of concrete must be obtained from tables 4 to 9. Compare the tension values of threaded rod, inserts, and concrete. The lesser of the values is to be used for the design.
4 Shear values are for the inserts only. The capacity of the threaded rods must be also determined from Table 10. The calculation of concrete shear strength is not required. Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.
5 Only threaded rod ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 is permitted to be used for the applications resisting shear, seismic shear, or seismic tension loads.

## Table 4 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of uncracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4C | |
|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) |
| SP 1/4”-3/8” | 1.88 (48) | 2,910 (12.9) | 3,360 (14.9) | 605 (2.7) | 700 (3.1) |
| SP 3/8”-1/2” | 2.13 (54) | 3,610 (16.1) | 4,170 (18.5) | 635 (2.8) | 735 (3.3) |
| SP 3/8”-1/2"-5/8" | 2.63 (67) | 4,580 (20.4) | 5,290 (23.5) | 695 (3.1) | 805 (3.6) |
| SP 5/8”-3/4” | 2.65 (67) | 4,580 (20.4) | 5,290 (23.5) | - | - |
| LP 1/4”-3/8” | 1.96 (50) | 2,910 (12.9) | 3,360 (14.9) | 2,910 (12.9) | 3,360 (14.9) |
| LP 3/8”-1/2" | 2.21 (56) | 3,610 (16.1) | 4,170 (18.5) | 3,610 (16.1) | 4,170 (18.5) |
| LP 3/8”-1/2"-5/8" | 2.71 (69) | 4,580 (20.4) | 5,290 (23.5) | 4,580 (20.4) | 5,290 (23.5) |
| LP 5/8”-3/4" | 2.72 (69) | 4,580 (20.4) | 5,290 (23.5) | 4,580 (20.4) | 5,290 (23.5) |

## Table 5 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4C | |
|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) |
| SP 1/4”-3/8” | 1.88 (48) | 2,325 (10.3) | 2,685 (11.9) | 485 (2.2) | 560 (2.5) |
| SP 3/8”-1/2" | 2.13 (54) | 2,890 (12.9) | 3,335 (14.8) | 505 (2.2) | 585 (2.6) |
| SP 3/8”-1/2""-5/8" | 2.63 (67) | 3,660 (16.3) | 4,225 (18.8) | 555 (2.5) | 640 (2.8) |
| SP 5/8”-3/4” | 2.65 (67) | 3,660 (16.3) | 4,225 (18.8) | - | - |
| LP 1/4”-3/8” | 1.96 (50) | 2,325 (10.3) | 2,685 (11.9) | 2,325 (10.3) | 2,685 (11.9) |
| LP 3/8”-1/2" | 2.21 (56) | 2,890 (12.9) | 3,335 (14.8) | 2,890 (12.9) | 3,335 (14.8) |
| LP 3/8”-1/2"-5/8" | 2.71 (69) | 3,660 (16.3) | 4,225 (18.8) | 3,660 (16.3) | 4,225 (18.8) |
| LP 5/8”-3/4" | 2.72 (69) | 3,660 (16.3) | 4,225 (18.8) | 3,660 (16.3) | 4,225 (18.8) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Tables 3A and 3B and threaded rod steel strength values in Table 10. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 3A and 3B for shear calculations.

## Table 6 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 3-7/8" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4B | | Inclined per Figure 4D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) |
| SP 1/4"-3/8" | 1.88 (48) | 2,910 (12.9) | 3,360 (14.9) | 1,400 (6.2) | 1,615 (7.2) | - | - |
| SP 3/8"-1/2" | 2.13 (54) | 3,610 (16.1) | 4,170 (18.5) | 1,850 (8.2) | 2,135 (9.5) | - | - |
| SP 3/8"-1/2"-5/8" | 2.63 (67) | 4,580 (20.4) | 5,290 (23.5) | 2,120 (9.4) | 2,450 (10.9) | - | - |
| SP 5/8"-3/4" | 2.65 (67) | 4,580 (20.4) | 5,290 (23.5) | 2,120 (9.4) | 2,450 (10.9) | - | - |
| LP 1/4"-3/8" | 1.96 (50) | 2,910 (12.9) | 3,360 (14.9) | 4,895 (21.8) | 5,650 (25.1) | 2,910 (12.9) | 3,360 (14.9) |
| LP 3/8"-1/2" | 2.21 (56) | 3,610 (16.1) | 4,170 (18.5) | 4,895 (21.8) | 5,650 (25.1) | 3,610 (16.1) | 4,170 (18.5) |
| LP 3/8"-1/2"-5/8" | 2.71 (69) | 4,580 (20.4) | 5,290 (23.5) | 6,565 (29.2) | 7,580 (33.7) | 4,580 (20.4) | 5,290 (23.5) |
| LP 5/8"-3/4" | 2.72 (69) | 4,580 (20.4) | 5,290 (23.5) | 6,565 (29.2) | 7,580 (33.7) | 4,580 (20.4) | 5,290 (23.5) |

## Table 7 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 3-7/8" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4B | | Inclined per Figure 4D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) |
| SP 1/4"-3/8" | 1.88 (48) | 2,325 (10.3) | 2,685 (11.9) | 1,120 (5.0) | 1,295 (5.8) | - | - |
| SP 3/8"-1/2" | 2.13 (54) | 2,890 (12.9) | 3,335 (14.8) | 1,480 (6.6) | 1,710 (7.6) | - | - |
| SP 3/8"-1/2"-5/8" | 2.63 (67) | 3,660 (16.3) | 4,225 (18.8) | 1,695 (7.5) | 1,955 (8.7) | - | - |
| SP 5/8"-3/4" | 2.65 (67) | 3,660 (16.3) | 4,225 (18.8) | 1,695 (7.5) | 1,955 (8.7) | - | - |
| LP 1/4"-3/8" | 1.96 (50) | 2,325 (10.3) | 2,685 (11.9) | 3,915 (17.4) | 4,520 (20.1) | 2,325 (10.3) | 2,685 (11.9) |
| LP 3/8"-1/2" | 2.21 (56) | 2,890 (12.9) | 3,335 (14.8) | 3,915 (17.4) | 4,520 (20.1) | 2,890 (12.9) | 3,335 (14.8) |
| LP 3/8"-1/2""-5/8" | 2.71 (69) | 3,660 (16.3) | 4,225 (18.8) | 5,250 (23.4) | 6,060 (27.0) | 3,660 (16.3) | 4,225 (18.8) |
| LP 5/8"-3/4" | 2.72 (69) | 3,660 (16.3) | 4,225 (18.8) | 5,250 (23.4) | 6,060 (27.0) | 3,660 (16.3) | 4,225 (18.8) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Tables 3A and 3B and threaded rod steel strength values in Table 10. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 3A and 3B for shear calculations.

## Table 8 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of uncracked Sand-Lightweight concrete Over Metal Deck (W profile with 4-1/2" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4B | | Inclined per Figure 4D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) |
| SP 1/4"-3/8" | 1.88 (48) | 2,910 (12.9) | 3,360 (14.9) | 1,400 (6.2) | 1,615 (7.2) | - | - |
| SP 3/8"-1/2" | 2.13 (54) | 3,610 (16.1) | 4,170 (18.5) | 1,850 (8.2) | 2,135 (9.5) | - | - |
| SP 3/8"-1/2"-5/8" | 2.63 (67) | 4,580 (20.4) | 5,290 (23.5) | 2,120 (9.4) | 2,450 (10.9) | - | - |
| SP 5/8"-3/4" | 2.65 (67) | 4,580 (20.4) | 5,290 (23.5) | 2,120 (9.4) | 2,450 (10.9) | - | - |
| LP 1/4"-3/8" | 1.96 (50) | 2,910 (12.9) | 3,360 (14.9) | 4,895 (21.8) | 5,650 (25.1) | 2,910 (12.9) | 3,360 (14.9) |
| LP 3/8"-1/2" | 2.21 (56) | 3,610 (16.1) | 4,170 (18.5) | 4,895 (21.8) | 5,650 (25.1) | 3,610 (16.1) | 4,170 (18.5) |
| LP 3/8"-1/2"-5/8" | 2.71 (69) | 4,580 (20.4) | 5,290 (23.5) | 6,565 (29.2) | 7,580 (33.7) | 4,580 (20.4) | 5,290 (23.5) |
| LP 5/8"-3/4" | 2.72 (69) | 4,580 (20.4) | 5,290 (23.5) | 6,565 (29.2) | 7,580 (33.7) | 4,580 (20.4) | 5,290 (23.5) |

## Table 9 — Hilti KCM-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 4-1/2" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4B | | Inclined per Figure 4D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4000 psi (27.6 MPa) lb (kN) |
| SP 1/4"-3/8" | 1.88 (48) | 2,325 (10.3) | 2,685 (11.9) | 1,120 (5.0) | 1,295 (5.8) | - | - |
| SP 3/8"-1/2" | 2.13 (54) | 2,890 (12.9) | 3,335 (14.8) | 1,480 (6.6) | 1,710 (7.6) | - | - |
| SP 3/8"-1/2"-5/8" | 2.63 (67) | 3,660 (16.3) | 4,225 (18.8) | 1,695 (7.5) | 1,955 (8.7) | - | - |
| SP 5/8"-3/4" | 2.65 (67) | 3,660 (16.3) | 4,225 (18.8) | 1,695 (7.5) | 1,955 (8.7) | - | - |
| LP 1/4"-3/8" | 1.96 (50) | 2,325 (10.3) | 2,685 (11.9) | 3,915 (17.4) | 4,520 (20.1) | 2,325 (10.3) | 2,685 (11.9) |
| LP 3/8"-1/2" | 2.21 (56) | 2,890 (12.9) | 3,335 (14.8) | 3,915 (17.4) | 4,520 (20.1) | 2,890 (12.9) | 3,335 (14.8) |
| LP 3/8"-1/2"-5/8" | 2.71 (69) | 3,660 (16.3) | 4,225 (18.8) | 5,250 (23.4) | 6,060 (27.0) | 3,660 (16.3) | 4,225 (18.8) |
| LP 5/8"-3/4" | 2.72 (69) | 3,660 (16.3) | 4,225 (18.8) | 5,250 (23.4) | 6,060 (27.0) | 3,660 (16.3) | 4,225 (18.8) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Tables 3A and 3B and threaded rod steel strength values in Table 10. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 3A and 3B for shear calculations.

## Table 10 — Design strength for steel failure of common threaded rods[1,5]

| Nominal anchor diameter | Grade A36 threaded rod | | | ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod | | | ASTM A 307, Grade A threaded rod | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN) | Shear[3] $\phi V_{sa,rod}$ lb (kN) | Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN) | Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN) | Shear[3] $\phi V_{sa,rod}$ lb (kN) | Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN) | Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN) | Shear[3] $\phi V_{sa,rod}$ lb (kN) | Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN) |
| 1/4 | 1,390 (6.2) | 720 (3.2) | 505 (2.2) | 3,000 (13.3) | 1,550 (6.9) | 1,085 (4.8) | 1,425 (6.3) | 740 (3.3) | 520 (2.3) |
| 3/8 | 3,395 (15.1) | 1,750 (7.8) | 1,225 (5.4) | 7,315 (32.5) | 3,780 (16.8) | 2,645 (11.8) | 3,490 (15.5) | 1,815 (8.1) | 1,270 (5.7) |
| 1/2 | 6,175 (27.5) | 3,210 (14.3) | 2,245 (10.0) | 13,315 (59.2) | 6,915 (30.8) | 4,840 (21.5) | 6,375 (28.4) | 3,315 (14.7) | 2,320 (10.3) |
| 5/8 | 9,835 (43.7) | 5,110 (22.7) | 3,575 (15.9) | 21,190 (94.3) | 11,020 (49.0) | 7,715 (34.3) | 10,165 (45.2) | 5,285 (23.5) | 3,700 (16.5) |
| 3/4 | 14,550 (64.7) | 7,565 (33.7) | 5,295 (23.6) | 31,405 (139.7) | 16,305 (72.5) | 11,415 (50.8) | 15,040 (66.9) | 7,820 (34.8) | 5,475 (24.4) |

1 See Section 3.1.8.7 for additional information on seismic applications.
2 Tensile values determined by static tension tests with $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
3 Shear values determined by static shear tests with $\phi V_{sa} = \phi 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17. .
4 Seismic shear values determined by seismic shear tests with $\phi V_{sa} \leq \phi 0.60 A_{se,V} f_{uta}$ as noted in ACI 318, Chapter 17.
5 Shear values are for the threaded rods only. The capacity of the insert must be also determined from Table 3A or 3B. The calculation of concrete shear strength is not required. Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.

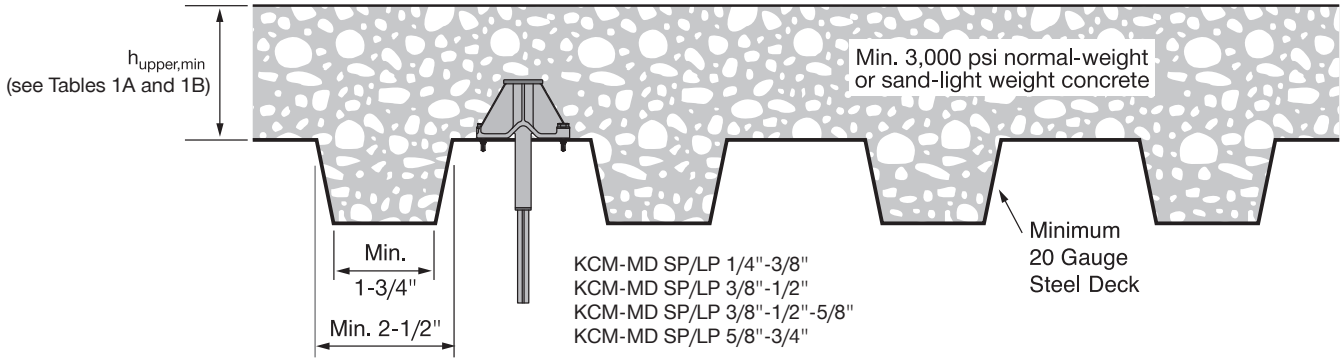
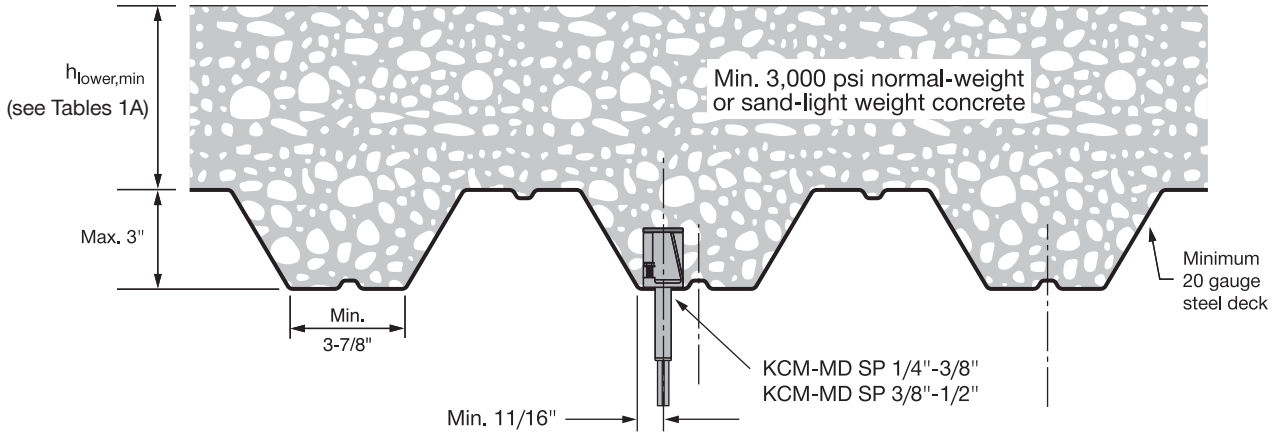
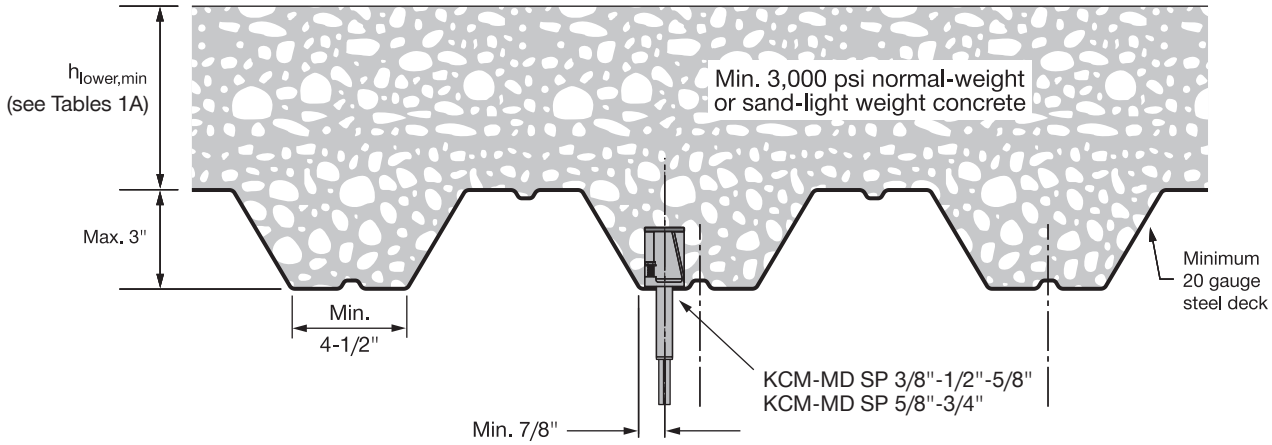



Figure 4A —Installation in the soffit of concrete filled metal deck floor and roof assemblies-over upper flute (B-deck and W-deck)



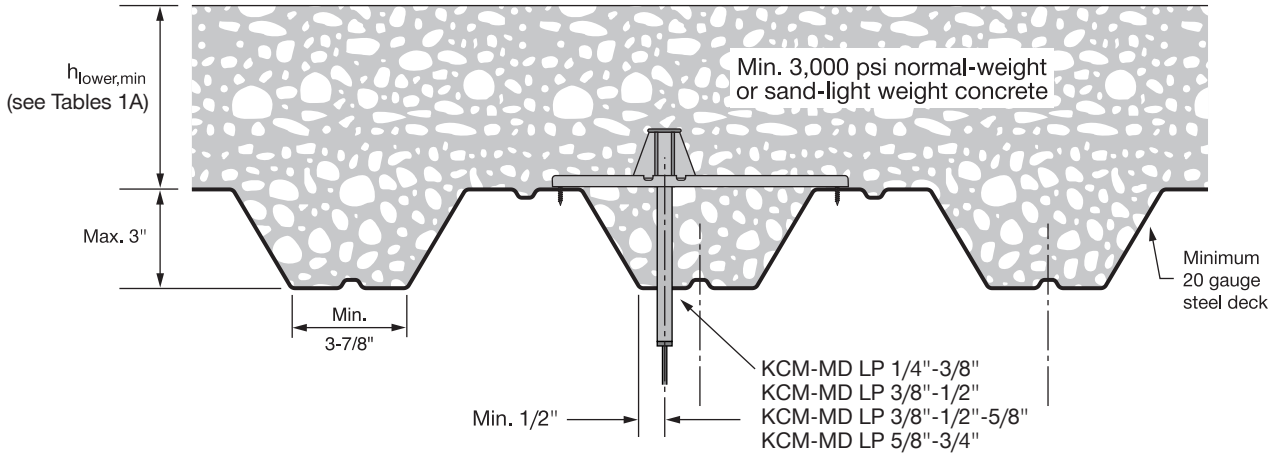




Figure 4B —Installation in the soffit of concrete filled metal deck floor and roof assemblies-over upper flute (W-deck)

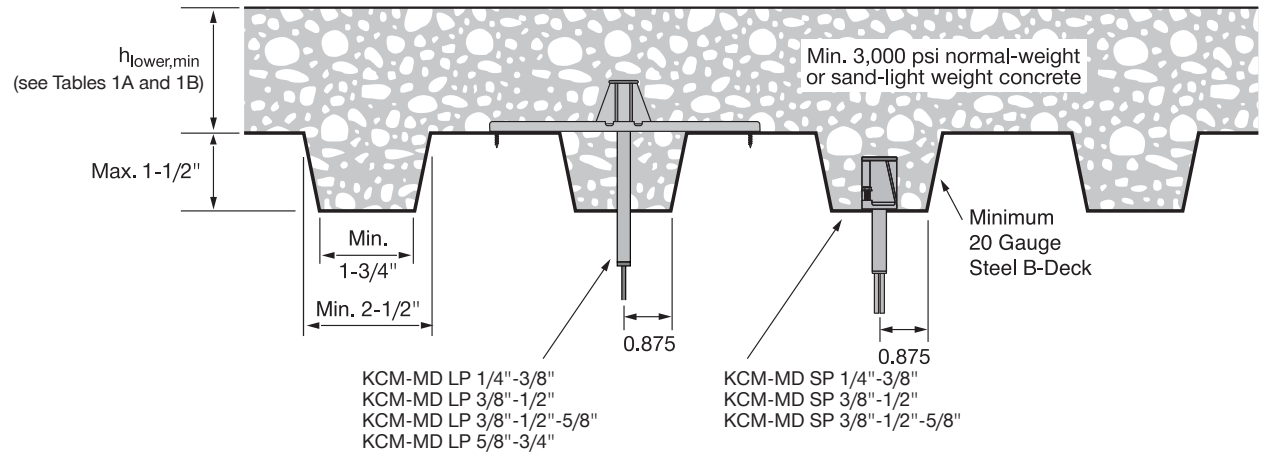



Figure 4C — Installation in the soffit of concrete filled metal deck floor and roof assemblies-over lower flute (B-deck )

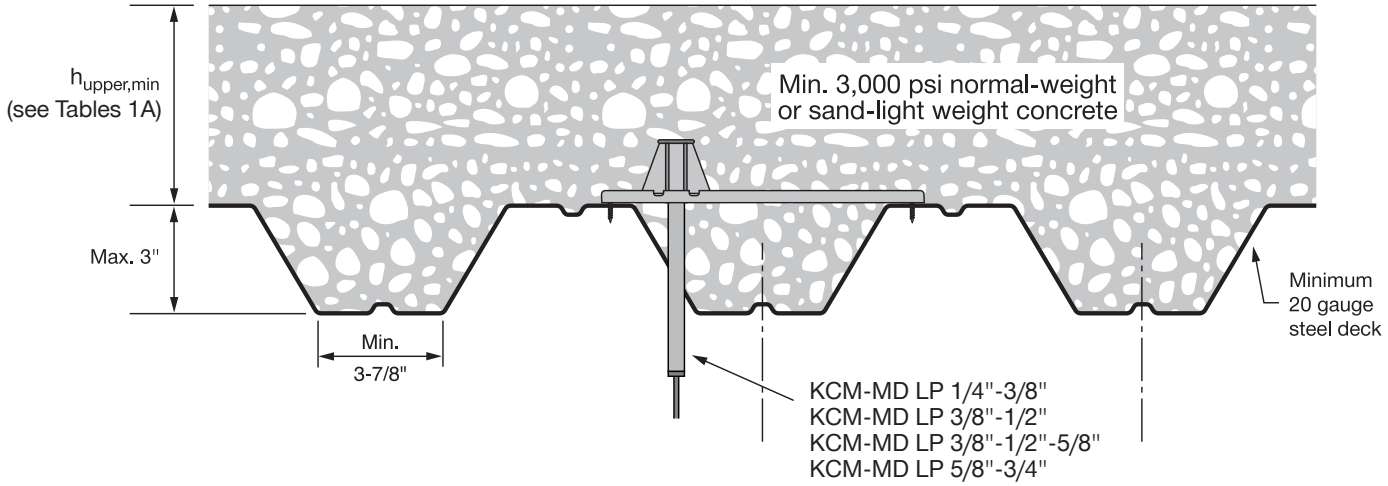



Figure 4D — Installation in the soffit of concrete filled metal deck floor and roof assemblies-over flute incline (W-deck )

# DESIGN DATA IN CONCRETE PER CSA A23.3

**CSA A23.3 Annex D Design**

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-4145. These tables are followed by factored resistance tables. The factored resitance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing or edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to PTG ED. 19, Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

## Table 11A — Design strength for steel failure of KCM-MD Short Plate anchor[1,2,3,4]

| Design information | Insert Type | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | SP | | SP | | SP | | | SP | |
| | 1/4"-3/8" | | 3/8"-1/2" | | 3/8"-1/2"-5/8" | | | 5/8"-3/4" | |
| Nominal rod diameter in. | 1/4 | 3/8 | 3/8 [5] | 1/2 | 3/8 | 1/2 [5] | 5/8 | 5/8 [5] | 3/4 |
| Anchor O.D., $d_a$ in (mm) | 0.52 (13) | | 0.67 (17) | | 0.88 (22) | | | 1.00 (25) | |
| Effective embedment, $h_{ef}$ in (mm) | 1.76 (45) | | 2 (51) | | 2.5 (64) | | | 2.5 (64) | |
| Min. specified ult. Strength, $f_{ut}$ lb (kN) | 8,300 (36.9) | | 13,500 (60.1) | | 16,800 (74.8) | | | 22,500 (100.1) | |
| Anchor category | Cast-In | | | | | | | | |
| Concrete material resistance factor, $\Phi_c$ | 0.65 | | | | | | | | |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B, R | 1.00 | | | | | | | | |
| Steel embed. material resistance factor for reinforcement, $\Phi_s$ | 0.85 | | | | | | | | |
| Resistance modification factor for tension, steel failure modes, R | 0.70 | | | | | | | | |
| Resistance modification factor for shear, steel failure modes, R | 0.65 | | | | | | | | |
| Factored steel strength of insert in tension, $\Phi N_{sa,insert}$ lb (kN) | 4,940 (22.0) | | 8,030 (35.7) | | 7,330 (32.6) | | | 7,155 (31.8) | |
| Factored seismic steel strength of insert in tension, $\Phi N_{sa,insert,eq}$ lb (kN) | - | 4,940 (22) | 8,030 (36) | 8,030 (36) | - | 7,330 (33) | 7,330 (33) | 7,155 (32) | 7,155 (32) |
| Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figures 4A | | | | | | | | | |
| Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN) | - | 2,590 (12) | - | 4,875 (22) | - | - | 6,615 (29) | - | 7,600 (34) |
| Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN) | - | 2,590 (12) | - | 4,875 (22) | - | - | 6,615 (29) | - | 7,600 (34) |
| Installations in lower flute of metal deck (i.e. W-deck) according to Figures 4B | | | | | | | | | |
| Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN) | - | 1,900 (8) | 1,835 (8) | 2,310 (10) | - | 2,930 (13) | 3,005 (13) | 2,590 (12) | 3,005 (13) |
| Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN) | - | 1,900 (8) | 1,835 (8) | 2,310 (10) | - | 2,050 (9) | 3,005 (13) | 2,590 (12) | 3,005 (13) |
| Installations in lower flute of metal deck (i.e. B-deck) according to Figures 4C | | | | | | | | | |
| Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN) | - | 1,745 (8) | - | 2,190 (10) | - | - | 3,085 (14) | - | - |
| Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN) | - | 1,745 (8) | - | 2,190 (10) | - | - | 2,775 (12) | - | - |

1 Design information in this table is taken from ICC-ES ESR-4145, Table 4A, and converted for use with CSA A23.3 (R2014) Annex D.
2 The carbon steel KCM-MD is considered a brittle steel element as defined by CSA A23.3 (R2014) Annex D section D.2.
3 Tension values are for the inserts only. The capacity of the threaded rods must be also determined from Table 18. The design strength of concrete must be obtained from tables 12 to 17. Compare the tension values of threaded rod, inserts, and concrete. The lesser of the values is to be used for the design.
4 Shear values are for the inserts only. The capacity of the threaded rods must be also determined from Table 18. The calculation of concrete shear strength is not required. Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.
5 Only threaded rod ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 is permitted to be used for the applications resisting shear, seismic shear, or seismic tension loads.

## Table 11B — Design strength for steel failure of KCM-MD Long Plate anchor[1,2,3,4]

| Design information | Insert Type | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | LP 1/4"-3/8" | | LP 3/8"-1/2" | | LP 3/8"-1/2"-5/8" | | | LP 5/8"-3/4" | |
| Nominal rod diameter (in.) | 1/4 | 3/8 | 3/8[5] | 1/2 | 3/8 | 1/2[5] | 5/8 | 5/8[5] | 3/4 |
| Anchor O.D., $d_a$ in (mm) | 0.52 (13.2) | | 0.67 (17.0) | | 0.88 (22.4) | | | 1.00 (25.4) | |
| Effective embedment, $h_{ef}$ in (mm) | 1.76 (45) | | 2 (50.8) | | 2.5 (63.5) | | | 2.5 (63.5) | |
| Min. specified ult. Strength, $f_{ut}$ lb (kN) | 8,300 (36.9) | | 13,500 (60.1) | | 16,800 (74.8) | | | 22,500 (100.1) | |
| Anchor category | Cast-In | | | | | | | | |
| Concrete material resistance factor, $\Phi_c$ | 0.65 | | | | | | | | |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B, R | 1.00 | | | | | | | | |
| Steel embed. material resistance factor for reinforcement, $\Phi_s$ | 0.85 | | | | | | | | |
| Resistance modification factor for tension, steel failure modes, R | 0.70 | | | | | | | | |
| Resistance modification factor for shear, steel failure modes, R | 0.65 | | | | | | | | |
| Factored steel strength of insert in tension, $\Phi N_{sa,insert}$ lb (kN) | 4,940 (22.0) | | 8,030 (35.7) | | 7,330 (32.6) | | | 7,155 (31.8) | |
| Factored seismic steel strength of insert in tension, $\Phi N_{sa,insert,eq}$ lb (kN) | - | 4,940 (22.0) | 8,030 (35.7) | 8,030 (35.7) | - | 7,330 (32.6) | 7,330 (32.6) | 7,155 (31.8) | 7,155 (31.8) |
| Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figures 4A | | | | | | | | | |
| Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN) | - | 2,590 (11.5) | - | 4,875 (21.7) | - | - | 6,615 (29.4) | - | 7,600 (33.8) |
| Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN) | - | 2,590 (11.5) | - | 4,875 (21.7) | - | - | 6,615 (29.4) | - | 7,600 (33.8) |
| Installations in lower flute of metal deck (i.e. W-deck) according to Figures 4B | | | | | | | | | |
| Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN) | - | 2,985 (13.3) | 2,400 (10.7) | 3,670 (16.3) | - | 2,230 (9.9) | 4,260 (19.0) | 5,935 (26.4) | 4,260 (19.0) |
| Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN) | - | 2,985 (13.3) | 2,400 (10.7) | 3,670 (16.3) | - | 2,230 (9.9) | 4,260 (19.0) | 5,935 (26.4) | 4,260 (19.0) |
| Installations in lower flute of metal deck (i.e. B-deck) according to Figures 4C | | | | | | | | | |
| Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN) | - | 2,660 (11.8) | - | 4,165 (18.5) | - | - | 5,295 (23.6) | - | 6,585 (29.3) |
| Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN) | - | 2,660 (11.8) | - | 4,165 (18.5) | - | - | 5,295 (23.6) | - | 6,585 (29.3) |
| Installations over flute incline of metal deck (i.e. W-deck) according to Figures 4D | | | | | | | | | |
| Factored steel strength of insert in shear, $\Phi V_{sa,insert}$ lb (kN) | - | 950 (4.2) | - | 2,455 (10.9) | - | - | 5,510 (24.5) | - | 5,510 (24.5) |
| Factored seismic steel strength of insert in shear, $\Phi V_{sa,insert,eq}$ lb (kN) | - | 950 (4.2) | - | 1,965 (8.7) | - | - | 3,100 (13.8) | - | 5,235 (23.3) |

1 Design information in this table is taken from ICC-ES ESR-4145, Table 4B, and converted for use with CSA A23.3 (R2014) Annex D.
2 The carbon steel KCM-MD is considered a brittle steel element as defined by CSA A23.3 (R2014) Annex D section D.2.
3 Tension values are for the inserts only. The capacity of the threaded rods must be also determined from Table 18. The design strength of concrete must be obtained from tables 12 to 17.
Compare the tension values of threaded rod, inserts, and concrete. The lesser of the values is to be used for the design.
4 Shear values are for the inserts only. The capacity of the threaded rods must be also determined from Table 18. The calculation of concrete shear strength is not required.
Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.
5 Only threaded rod ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 is permitted to be used for the applications resisting shear, seismic shear, or seismic tension loads.

## Table 12 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

| Anchor | Nominal embed. in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4C | |
|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 1/4”-3/8” | 1.88 (48) | 2,655 (11.8) | 3,250 (14.5) | 555 (2.5) | 675 (3.0) |
| SP 3/8”-1/2" | 2.13 (54) | 3,300 (14.7) | 4,040 (18.0) | 580 (2.6) | 710 (3.2) |
| SP 3/8”-1/2"-5/8" | 2.63 (67) | 4,180 (18.6) | 5,120 (22.8) | 635 (2.8) | 775 (3.4) |
| SP 5/8”-3/4” | 2.65 (67) | 4,180 (18.6) | 5,120 (22.8) | - | - |
| LP 1/4”-3/8” | 1.96 (50) | 2,655 (11.8) | 3,250 (14.5) | 2,655 (11.8) | 3,250 (14.5) |
| LP 3/8”-1/2" | 2.21 (56) | 3,300 (14.7) | 4,040 (18.0) | 3,300 (14.7) | 4,040 (18.0) |
| LP 3/8”-1/2"-5/8" | 2.71 (69) | 4,180 (18.6) | 5,120 (22.8) | 4,180 (18.6) | 5,120 (22.8) |
| LP 5/8”-3/4" | 2.72 (69) | 4,180 (18.6) | 5,120 (22.8) | 4,180 (18.6) | 5,120 (22.8) |

## Table 13 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

| Anchor | Nominal embed. in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4C | |
|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 1/4”-3/8” | 1.88 (48) | 2,125 (9.5) | 2,600 (11.6) | 440 (2.0) | 540 (2.4) |
| SP 3/8”-1/2" | 2.13 (54) | 2,640 (11.7) | 3,230 (14.4) | 465 (2.1) | 565 (2.5) |
| SP 3/8”-1/2"-5/8" | 2.63 (67) | 3,345 (14.9) | 4,095 (18.2) | 505 (2.2) | 620 (2.8) |
| SP 5/8”-3/4” | 2.65 (67) | 3,345 (14.9) | 4,095 (18.2) | - | - |
| LP 1/4”-3/8” | 1.96 (50) | 2,125 (9.5) | 2,600 (11.6) | 2,125 (9.5) | 2,600 (11.6) |
| LP 3/8”-1/2" | 2.21 (56) | 2,640 (11.7) | 3,230 (14.4) | 2,640 (11.7) | 3,230 (14.4) |
| LP 3/8”-1/2"-5/8" | 2.71 (69) | 3,345 (14.9) | 4,095 (18.2) | 3,345 (14.9) | 4,095 (18.2) |
| LP 5/8”-3/4" | 2.72 (69) | 3,345 (14.9) | 4,095 (18.2) | 3,345 (14.9) | 4,095 (18.2) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Tables 11A or 11B and threaded rod steel strength values in Table 18. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 11A or 11B for shear calculations.

## Table 14 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 3-7/8" width)[1,2,3,4,5,6,7,8]

| Anchor | Nominal embed. in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4B | | Inclined per Figure 4D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 1/4"-3/8" | 1.88 (48) | 2,655 (11.8) | 3,250 (14.5) | 1,280 (5.7) | 1,565 (7.0) | - | - |
| SP 3/8"-1/2" | 2.13 (54) | 3,300 (14.7) | 4,040 (18.0) | 1,685 (7.5) | 2,065 (9.2) | - | - |
| SP 3/8"-1/2"-5/8" | 2.63 (67) | 4,180 (18.6) | 5,120 (22.8) | 1,935 (8.6) | 2,370 (10.5) | - | - |
| SP 5/8"-3/4" | 2.65 (67) | 4,180 (18.6) | 5,120 (22.8) | 1,935 (8.6) | 2,370 (10.5) | - | - |
| LP 1/4"-3/8" | 1.96 (50) | 2,655 (11.8) | 3,250 (14.5) | 4,470 (19.9) | 5,475 (24.4) | 2,655 (11.8) | 3,250 (14.5) |
| LP 3/8"-1/2" | 2.21 (56) | 3,300 (14.7) | 4,040 (18.0) | 4,470 (19.9) | 5,475 (24.4) | 3,300 (14.7) | 4,040 (18.0) |
| LP 3/8"-1/2"-5/8" | 2.71 (69) | 4,180 (18.6) | 5,120 (22.8) | 5,990 (26.6) | 7,340 (32.6) | 4,180 (18.6) | 5,120 (22.8) |
| LP 5/8"-3/4" | 2.72 (69) | 4,180 (18.6) | 5,120 (22.8) | 5,990 (26.6) | 7,340 (32.6) | 4,180 (18.6) | 5,120 (22.8) |

## Table 15 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 3-7/8" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal embed. in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4B | | Inclined per Figure 4D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 1/4"-3/8" | 1.88 (48) | 2,125 (9.5) | 2,600 (11.6) | 1,025 (4.6) | 1,250 (5.6) | - | - |
| SP 3/8"-1/2" | 2.13 (54) | 2,640 (11.7) | 3,230 (14.4) | 1,350 (6.0) | 1,655 (7.4) | - | - |
| SP 3/8"-1/2"-5/8" | 2.63 (67) | 3,345 (14.9) | 4,095 (18.2) | - | - | - | - |
| SP 5/8"-3/4" | 2.65 (67) | 3,345 (14.9) | 4,095 (18.2) | - | - | - | - |
| LP 1/4"-3/8" | 1.96 (50) | 2,125 (9.5) | 2,600 (11.6) | 3,575 (15.9) | 4,380 (19.5) | 2,125 (9.5) | 2,600 (11.6) |
| LP 3/8"-1/2" | 2.21 (56) | 2,640 (11.7) | 3,230 (14.4) | 3,575 (15.9) | 4,380 (19.5) | 2,640 (11.7) | 3,230 (14.4) |
| LP 3/8"-1/2"-5/8" | 2.71 (69) | 3,345 (14.9) | 4,095 (18.2) | 4,795 (21.3) | 5,870 (26.1) | 3,345 (14.9) | 4,095 (18.2) |
| LP 5/8"-3/4" | 2.72 (69) | 3,345 (14.9) | 4,095 (18.2) | 4,795 (21.3) | 5,870 (26.1) | 3,345 (14.9) | 4,095 (18.2) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Tables 11A or 11B and threaded rod steel strength values in Table 18. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 11A or 11B for shear calculations.

## Table 16 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 4-1/2" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal embed. in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4B | | Inclined per Figure 4D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 1/4"-3/8" | 1.88 (48) | 2,655 (11.8) | 3,250 (14.5) | 1,280 (5.7) | 1,565 (7.0) | - | - |
| SP 3/8"-1/2" | 2.13 (54) | 3,300 (14.7) | 4,040 (18.0) | 1,685 (7.5) | 2,065 (9.2) | - | - |
| SP 3/8"-1/2"-5/8" | 2.63 (67) | 4,180 (18.6) | 5,120 (22.8) | 1,935 (8.6) | 2,370 (10.5) | - | - |
| SP 5/8"-3/4" | 2.65 (67) | 4,180 (18.6) | 5,120 (22.8) | 1,935 (8.6) | 2,370 (10.5) | - | - |
| LP 1/4"-3/8" | 1.96 (50) | 2,655 (11.8) | 3,250 (14.5) | 4,470 (19.9) | 5,475 (24.4) | 2,655 (11.8) | 3,250 (14.5) |
| LP 3/8"-1/2" | 2.21 (56) | 3,300 (14.7) | 4,040 (18.0) | 4,470 (19.9) | 5,475 (24.4) | 3,300 (14.7) | 4,040 (18.0) |
| LP 3/8"-1/2"-5/8" | 2.71 (69) | 4,180 (18.6) | 5,120 (22.8) | 5,990 (26.6) | 7,340 (32.6) | 4,180 (18.6) | 5,120 (22.8) |
| LP 5/8"-3/4" | 2.72 (69) | 4,180 (18.6) | 5,120 (22.8) | 5,990 (26.6) | 7,340 (32.6) | 4,180 (18.6) | 5,120 (22.8) |

## Table 17 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 4-1/2" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal embed. in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4B | | Inclined per Figure 4D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 1/4"-3/8" | 1.88 (48) | 2,125 (9.5) | 2,600 (11.6) | 1,025 (4.6) | 1,250 (5.6) | - | - |
| SP 3/8"-1/2" | 2.13 (54) | 2,640 (11.7) | 3,230 (14.4) | 1,350 (6.0) | 1,655 (7.4) | - | - |
| SP 3/8"-1/2"-5/8" | 2.63 (67) | 3,345 (14.9) | 4,095 (18.2) | 1,550 (6.9) | 1,895 (8.4) | - | - |
| SP 5/8"-3/4" | 2.65 (67) | 3,345 (14.9) | 4,095 (18.2) | 1,550 (6.9) | 1,895 (8.4) | - | - |
| LP 1/4"-3/8" | 1.96 (50) | 2,125 (9.5) | 2,600 (11.6) | 3,575 (15.9) | 4,380 (19.5) | 2,125 (9.5) | 2,600 (11.6) |
| LP 3/8"-1/2" | 2.21 (56) | 2,640 (11.7) | 3,230 (14.4) | 3,575 (15.9) | 4,380 (19.5) | 2,640 (11.7) | 3,230 (14.4) |
| LP 3/8"-1/2"'5/8" | 2.71 (69) | 3,345 (14.9) | 4,095 (18.2) | 4,795 (21.3) | 5,870 (26.1) | 3,345 (14.9) | 4,095 (18.2) |
| LP 5/8"-3/4" | 2.72 (69) | 3,345 (14.9) | 4,095 (18.2) | 4,795 (21.3) | 5,870 (26.1) | 3,345 (14.9) | 4,095 (18.2) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Tables 11A or 11B and threaded rod steel strength values in Table 18. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCM-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Tables 11A or 11B for shear calculations.

## Table 18 — Design strength for steel failure of common threaded rods used with KCM-MD cast-in anchor [1,2,3]

| Nominal anchor diameter | Grade A36 threaded rod | | | ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod | | | ASTM A 307, Grade A threaded rod | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN) | Shear[5] $V_{sar,rod}$ lb (kN) | Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN) | Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN) | Shear[5] $V_{sar,rod}$ lb (kN) | Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN) | Tensile[4] $N_{sar,rod}$ or $N_{sar,eq,rod}$ lb (kN) | Shear[5] $V_{sar,rod}$ lb (kN) | Seismic Shear[6] $V_{sar,eq,rod}$ lb (kN) |
| 1/4 | 1,260 (5.6) | 705 (3.1) | 495 (2.2) | 2,720 (12.1) | 1,520 (6.8) | 1,065 (4.7) | 1,290 (5.7) | 725 (3.2) | 505 (2.2) |
| 3/8 | 3,075 (13.7) | 1,720 (7.7) | 1,205 (5.4) | 6,630 (29.5) | 3,705 (16.5) | 2,595 (11.5) | 3,160 (14.1) | 1,780 (7.9) | 1,245 (5.5) |
| 1/2 | 5,600 (24.9) | 3,150 (14.0) | 2,205 (9.8) | 12,070 (53.7) | 6,785 (30.2) | 4,750 (21.1) | 5,780 (25.7) | 3,250 (14.5) | 2,275 (10.1) |
| 5/8 | 8,915 (39.7) | 5,010 (22.3) | 3,505 (15.6) | 19,210 (85.4) | 10,805 (48.1) | 7,565 (33.7) | 9,215 (41.0) | 5,185 (23.1) | 3,630 (16.1) |
| 3/4 | 13,190 (58.7) | 7,420 (33.0) | 5,195 (23.1) | 28,475 (126.7) | 15,990 (71.1) | 11,195 (49.8) | 13,635 (60.7) | 7,670 (34.1) | 5,370 (23.9) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Hilti KCM-MD anchors are to be considered brittle steel elements
3 See PTG ed. 17, Section 3.1.8.7 for additional information on seismic applications.
4 Tensile $N_{sar} = \phi_s A_{se} R f_{ut}$ as noted in CSA A23.3 Annex D.
5 Shear values determined by static shear tests with $V_{sar} < \phi_s 0.60 A_{se,V} f_{ut} R$. as noted in CSA A23.3 Annex D.
6 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < \phi_s 0.60 A_{se,V} f_{ut} R$. as noted in CSA A23.3 Annex D.

### Table 19A — UL cUL LLC and FM approvals for KCM-MD Short Plate Anchors [1,2]

| Design information | | SP 1/4"-3/8" | | | SP 3/8"-1/2" | | | SP 3/8"-1/2"-5/8" | | | SP 5/8"-3/4" | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal rod diameter (in.) | Metal deck soffit | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) |
| 3/8 | Upper flute | 4 | 1,500 | 4 | 4 | 1,500 | 4 | 4 | 1,500 | 4 | - | - | - |
| | Lower flute | 4 | 1,500 | 4 | 4 | 1,500 | 4 | 4 | 1,500 | - | - | - | - |
| 1/2 | Upper flute | - | - | - | 8 | 4,050 | 8 | 8 | 4,050 | 8 | - | - | - |
| | Lower flute | - | - | - | 8 | 4,050 | 8 | 8 | 4,050 | - | - | - | - |
| 5/8 | Upper flute | - | - | - | - | - | - | 12 | 7,900 | 12 | 12 | 7,900 | 12 |
| | Lower flute | - | - | - | - | - | - | 8 | 4,050 | - | 8 | 4,050 | - |
| 3/4 | Upper flute | - | - | - | - | - | - | - | - | - | 12 | 7,900 | 12 |
| | Lower flute | - | - | - | - | - | - | - | - | - | 8 | 4,050 | - |

### Table 19B — UL cUL LLC and FM approvals for KCM-MD Long Plate Anchors [1,2]

| Design information | | LP 1/4"-3/8" | | | LP 3/8"-1/2" | | | LP 3/8"-1/2"-5/8" | | | LP 5/8"-3/4" | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal rod diameter (in.) | Metal deck soffit | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) |
| 3/8 | Upper flute | 4 | 1,500 | 4 | 4 | 1,500 | 4 | 4 | 1,500 | 4 | - | - | - |
| | Lower flute | - | - | - | - | - | - | - | - | - | - | - | - |
| 1/2 | Upper flute | - | - | - | 8 | 4,050 | 8 | 8 | 4,050 | 8 | - | - | - |
| | Lower flute | - | - | - | - | - | - | - | - | - | - | - | - |
| 5/8 | Upper flute | - | - | - | - | - | - | 12 | 7,900 | 12 | 12 | 7,900 | 12 |
| | Lower flute | - | - | - | - | - | - | - | - | - | - | - | - |
| 3/4 | Upper flute | - | - | - | - | - | | - | - | - | 12 | 7,900 | 12 |
| | Lower flute | - | - | - | - | - | | - | - | - | - | - | - |

1 UL LLC Listing based on successful completion of testing in accordance with UL 203.
2 FM Approval based on successful completion of testing in accordance with FM 1952.

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed or downloaded online at www.hilti.com and www.hilti.ca. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## ORDERING INFORMATION[1]

### KCM-MD Short Plate and Long Plate cast-in anchors for use in metal deck

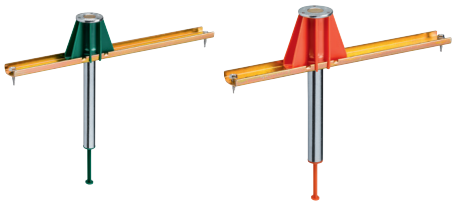
| Description | Sleeve color [2] | Qty / box | Hole saw diameter |
|---|---|---|---|
| KCM-MD SP 1/4"-3/8" | Green | 90 | 9/16" |
| KCM-MD SP 3/8"-1/2" | Orange | 75 | 11/16" |
| KCM-MD SP 3/8"-1/2"-5/8" | Red | 45 | 13/16" |
| KCM-MD SP 5/8"-3/4" | Grey | 40 | 15/16" |
| KCM-MD LP 1/4”-3/8” | Green | 25 | 1/2” |
| KCM-MD LP 3/8"-1/2" | Orange | 20 | 5/8” |
| KCM-MD LP 3/8”-1/2”-5/8” | Red | 15 | 3/4” |
| KCM-MD LP 5/8”-3/4” | Grey | 15 | 7/8” |

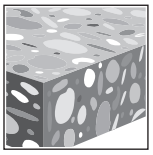
1 All dimensions in inches
2 Identifies anchor size

# 3.3.17 KCC-WF AND KCC-MD CAST-IN ANCHOR

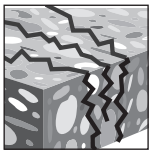
## PRODUCT DESCRIPTION

**KCC-WF and KCC-MD cast-in anchors**

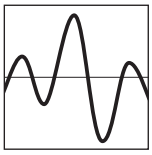
| Anchor System | | Features and Benefits |
|---|---|---|
|  | Internally threaded cast-in anchors for wood form construction (KCC-WF) | • Quick push-to-connect technology offers ultimate productivity<br>• Ideal for pre-assembled / pre-fabricated hanger assemblies<br>• KCC-WF — Color-coded foam covering protects inner threads from concrete intrusion<br>• KCC-WF — Nails through the head helps prevent anchor from being knocked over and from head popping off due to rebar hits<br>• KCC-MD SP and LP — Pre-assembled self-tapping screws reduce installation time<br>• KCC-MD SP and LP — Color-coded plastic plugs protect inner threads from concrete, sprayed-on fireproofing, or sprayed-on insulation<br>• KCC-MD LP — Pre-assembled spanner plate offers flexibility with installation at any location on the metal deck including the incline<br>• KCC-MD LP — Anchor installs to the top of the flutes, so anchoring point is at consistent height throughout, which is ideal for pre-fabricated hangers |
|  | Internally threaded short plate cast-in anchors for lightweight concrete over metal deck construction (KCC-MD SP) | |
|  | Internally threaded long plate cast-in anchors for lightweight concrete over metal deck construction (KCC-MD LP) | |



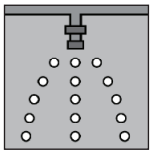
Uncracked concrete



Cracked concrete



Seismic Design Categories A-F



Fire sprinkler listings

## Approvals/ Listings

| | |
|---|---|
| **ICC-ES (International Code Council) 2018 International Building Code / International Residential Code (IBC/IRC)** | ESR-4145 in concrete per ACI 318 Ch. 17 / ICC-ES AC446 |
| **City of Los Angeles** | 2020 LABC Supplement (within ESR-4145) |
| **Florida Building Code** | 2017 FBC with HVHZ |
| **UL LLC (Underwriters Laboratory LLC)** | Pipe Hanger Equipment for Fire Protection Services for 3/8 through 1/2 (See Table 28) |
| **FM (Factory Mutual) Pipe** | Hanger Components for Automatic Sprinkler Systems for 3/8 through 1/2 (See Table 28) |
| **ANSI/MSS SP-58-2018** | Anchors conform to ANSI/MSSP-58-2018. Contact Hilti for more information. |



LISTED

APPROVED

## MATERIAL SPECIFICATIONS

KCC-WF and KCC-MD (short plate and long plate) have an insert body made from carbon steel with an engineered plastic flange. The insert body is zinc plated per ASTM B633 Fe/Zn 5 Type III.

## INSTALLATION PARAMETERS

### Table 1 — Hilti KCC-WF, KCC-MD SP and KCC-MD LP cast-in anchor installation information

| Design Information | Symbol | Units | KCC-WF | | KCC-MD SP | | KCC-MD LP | |
|---|---|---|---|---|---|---|---|---|
| Insert thread | d | UNC | 3/8-16 | 1/2-13 | 3/8-16 | 1/2-13 | 3/8-16 | 1/2-13 |
| Plastic housing color | - | - | Dark Green | Dark Orange | Dark Green | Dark Orange | Dark Green | Dark Orange |
| Outside diameter of anchor steel body | $d_a$ | in. | 0.67 | 0.87 | 0.67 | 0.87 | 0.67 | 0.87 |
| | | (mm) | (17) | (22) | (17) | (22) | (17) | (22) |
| Bearing area | $A_{brg}$ | $in.^2$ | 1.0 | 1.2 | 1.0 | 1.2 | 1.0 | 1.2 |
| | | ($mm^2$) | (643) | (774) | (643) | (774) | (643) | (774) |
| Effective embedment | $h_{ef}$ | in. | 1.63 | 2.04 | 2.00 | 2.50 | 2.00 | 2.50 |
| | | (mm) | (41) | (52) | (51) | (64) | (51) | (64) |
| Nominal embedment | $h_{nom}$ | in. | 1.76 | 2.17 | 2.13 | 2.63 | 2.21 | 2.71 |
| | | (mm) | (45) | (55) | (54) | (67) | (56) | (69) |
| Metal hole saw diameter | $d_{bit}$ | in. | N/A | N/A | 11/16 | 13/16 | 5/8 | 3/4 |
| Steel head thickness | $t_{sh}$ | mm | 3.3 | | | | | |
| Minimum member thickness — wood form installation | $h_{min}$ | in. | 2.5 | 3 | N/A | N/A | N/A | N/A |
| | | (mm) | (64) | (76) | | | | |
| Minimum concrete cover over metal deck — all installations (see Figures 5A, 5B, 5C and 5D) | $h_{deck,min}$ | in. | N/A | N/A | 2.5 | 3.25 | 2.5 | 3.25 |
| | | (mm) | | | (64) | (83) | (64) | (83) |
| Minimum metal deck gauge | - | - | N/A | | 20 | | | |
| Minimum anchor spacing | $S_{min}$ | in. | 2.6 | 3.5 | 6.0 | 7.5 | 6.0 | 7.5 |
| | | (mm) | (67) | (88) | (152) | (191) | (152) | (191) |
| Minimum edge distance | $C_{min}$ | in. | 1.5 | 1.5 | 6.0 | 7.5 | 6.0 | 7.5 |
| | | (mm) | (38) | (38) | (152) | (191) | (152) | (191) |
| Thread engagement length — see Figure 4 | $l_{th}$ | in. | 1.6 | 1.9 | N/A | N/A | N/A | N/A |
| Thread engagement length Plastic on/ Metal tube on — see Figure 4 | $l_{th}$ | in. | N/A | N/A | 4.3 | 4.7 | 6.9 | 7.3 |
| Thread engagement length Plastic off — see Figure 4 | $l_{th}$ | in. | N/A | N/A | 2.5 | 2.9 | N/A | N/A |

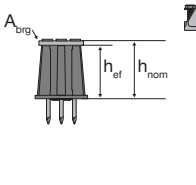



Figure 1 — KCC-WF

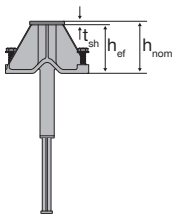



Figure 2 — KCC-MD SP

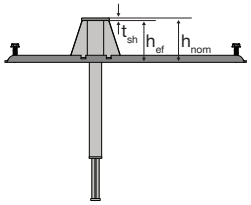
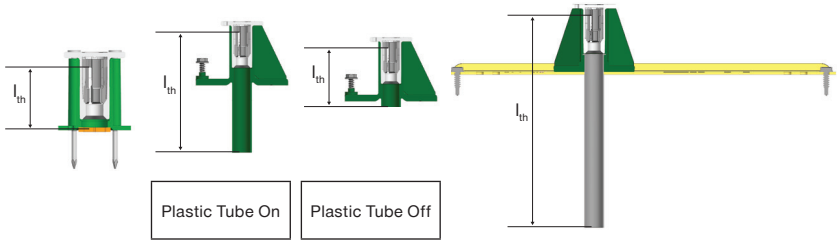



Figure 3 — KCC-MD LP




(a) KCC-WF (b) KCC-MD SP (c) KCC-MD LP (Metal Tube On)

Figure 4 — KCC Thread Engagement Measurement

# DESIGN INFORMATION IN CONCRETE PER ACI 318

### ACI 318 Chapter 17

The technical data contained in this section are Hilti Simplified Tables. The load values were developed using the Strength Design parameters and variables of ESR-4145 and the equations within ACI 318 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-4145 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

### Table 2 — Design strength for steel failure of KCC-WF inserts[1,2,3,4]

| DESIGN INFORMATION | Symbol | Units | Insert type | |
|---|---|---|---|---|
| | | | KCC-WF | |
| Nominal rod diameter | - | in. | 3/8 | 1/2 |
| Design steel strength of insert in tension | $\phi_{Nsa,insert}$ | lb | 2,625 | 3,515 |
| | | (kN) | (11.7) | (15.6) |
| Design seismic steel strength of insert in tension | $\phi_{Nsa,insert,eq}$ | lb | 2,625 | 3,515 |
| | | (kN) | (11.7) | (15.6) |
| Design steel strength of insert in shear | $\phi_{Vsa,insert}$ | lb | 3,220 | 3,340 |
| | | (kN) | (14.3) | (14.9) |
| Design seismic steel strength of insert in shear | $\phi_{Vsa,insert}$ | lb | 3,220 | 3,340 |
| | | (kN) | (14.3) | (14.9) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Hilti KCC-WF Inserts are considered brittle steel elements
3 Values are for the insert only. The capacity of the threaded rod must be also be determined from Table 16. The design strength of concrete must be in accordance with ACI 318 Chapter 17 and Tables 3 to 4 as necessary. Compare the values (threaded rod, inserts, and concrete). The lesser of the values is to be used for the design.
4 Only threaded rods ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 are allowed to be used for applocations resisting shear, seismic shear or seismic tension loads.

### Table 3 — Hilti KCC-WF cast-in insert design strength with concrete / pullout failure in uncracked concrete [1,2,3,4,5,6]

| Nominal anchor internal diameter | Effective embedment depth in. (mm) | Tension - $\Phi N_n$ | | | | Shear - $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 3/8" | 1.63 | 2,185 | 2,390 | 2,760 | 3,385 | 2,185 | 2,390 | 2,760 | 3,385 |
| | (41) | (9.7) | (10.6) | (12.3) | (15.1) | (9.7) | (10.6) | (12.3) | (15.1) |
| 1/2" | 2.04 | 3,055 | 3,350 | 3,865 | 4,735 | 3,055 | 3,350 | 3,865 | 4,735 |
| | (52) | (13.6) | (14.9) | (17.2) | (21.1) | (13.6) | (14.9) | (17.2) | (21.1) |

### Table 4 — Hilti KCC-WF cast-in insert design strength with concrete / pullout failure in cracked concrete [1,2,3,4,5,6]

| Nominal anchor internal diameter | Effective embedment depth in. (mm) | Tension - $\Phi N_n$ | | | | Shear - $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 3/8" | 1.63 | 1,745 | 1,910 | 2,210 | 2,705 | 1,745 | 1,910 | 2,210 | 2,705 |
| | (41) | (7.8) | (8.5) | (9.8) | (12.0) | (7.8) | (8.5) | (9.8) | (12.0) |
| 1/2" | 2.04 | 2,445 | 2,680 | 3,095 | 3,790 | 2,445 | 2,680 | 3,095 | 3,790 |
| | (52) | (10.9) | (11.9) | (13.8) | (16.9) | (10.9) | (11.9) | (13.8) | (16.9) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for single anchors located at edge distance (c) and spacing (s) greater than $3h_{ef}$. For anchors with edge distance or spacing less than $3h_{ef}$ use ACI 318 to calculate load reduction factor. Compare the calculated value to the steel values (threaded rod and inserts) in Tables 16 and 2. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.85. For all-lightweight, $\lambda_a$ = 0.75.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear.
6 Compare tabular value to the insert steel strength values in Table 2 and threaded rod steel strength values in Table 16 The lesser of the values is to be used for the design.

## Table 5 — Load adjustment factors for KCC-WF 3/8" in uncracked concrete [1,2]

| KCC-WF 3/8" uncracked concrete | | | Spacing factor in tension $f_{AN}$ | Edge distance factor in tension $f_{RN}$ | Spacing factor in shear [3] $f_{AV}$ | Edge distance in shear | | Concrete thickness factor in shear [4] $f_{HV}$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | ⊥ Toward edge $f_{RV}$ | ∥ To edge $f_{RV}$ | |
| Embedment $h_{ef}$ | in | | 1.63 | 1.63 | 1.63 | 1.63 | 1.63 | 1.63 |
| | (mm) | | (41) | (41) | (41) | (41) | (41) | (41) |
| Min. conc. thickness $h_{min}$ (in.) | | | 2-1/2 | 2-1/2 | 2-1/2 | 2-1/2 | 2-1/2 | 2-1/2 |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 1-1/2 | (38) | n/a | 0.713 | n/a | 0.282 | 0.564 | n/a |
| | 2 | (51) | n/a | 0.859 | n/a | 0.434 | 0.859 | n/a |
| | 2-1/2 | (64) | n/a | 1.000 | n/a | 0.607 | 1.000 | 0.691 |
| | 2-5/8 | (67) | 0.768 | | 0.625 | 0.653 | | 0.708 |
| | 3 | (76) | 0.807 | | 0.643 | 0.798 | | 0.757 |
| | 3-1/2 | (89) | 0.858 | | 0.667 | 1.000 | | 0.818 |
| | 4 | (102) | 0.909 | | 0.691 | | | 0.874 |
| | 4-1/2 | (114) | 0.960 | | 0.715 | | | 0.927 |
| | 5 | (127) | 1.000 | | 0.739 | | | 0.978 |
| | 5-1/2 | (140) | | | 0.763 | | | 1.000 |
| | 6 | (152) | | | 0.787 | | | |
| | 7 | (178) | | | 0.834 | | | |
| | 8 | (203) | | | 0.882 | | | |
| | 10 | (254) | | | 0.978 | | | |
| | 12 | (305) | | | 1.000 | | | |

## Table 6 — Load adjustment factors for KCC-WF 3/8" in cracked concrete [1,2]

| KCM-WF 1/4"-3/8" cracked concrete | | | Spacing factor in tension $f_{AN}$ | Edge distance factor in tension $f_{RN}$ | Spacing factor in shear [3] $f_{AV}$ | Edge distance in shear | | Concrete thickness factor in shear [4] $f_{HV}$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | ⊥ Toward edge $f_{RV}$ | ∥ To edge $f_{RV}$ | |
| Embedment $h_{ef}$ | in | | 1.63 | 1.63 | 1.63 | 1.63 | 1.63 | 1.63 |
| | (mm) | | (41) | (41) | (41) | (41) | (41) | (41) |
| Min. conc. thickness $h_{min}$ (in.) | | | 2-1/2 | 2-1/2 | 2-1/2 | 2-1/2 | 2-1/2 | 2-1/2 |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 1-1/2 | (38) | n/a | 0.713 | n/a | 0.252 | 0.504 | n/a |
| | 2 | (51) | n/a | 0.859 | n/a | 0.388 | 0.775 | n/a |
| | 2-1/2 | (64) | n/a | 1.000 | n/a | 0.542 | 1.000 | 0.666 |
| | 2-5/8 | (67) | 0.768 | | 0.616 | 0.583 | | 0.682 |
| | 3 | (76) | 0.807 | | 0.633 | 0.712 | | 0.729 |
| | 3-1/2 | (89) | 0.858 | | 0.655 | 0.897 | | 0.788 |
| | 4 | (102) | 0.909 | | 0.677 | 1.000 | | 0.842 |
| | 4-1/2 | (114) | 0.960 | | 0.699 | | | 0.893 |
| | 5 | (127) | 1.000 | | 0.722 | | | 0.941 |
| | 5-1/2 | (140) | | | 0.744 | | | 0.987 |
| | 6 | (152) | | | 0.766 | | | 1.000 |
| | 7 | (178) | | | 0.810 | | | |
| | 8 | (203) | | | 0.854 | | | |
| | 10 | (254) | | | 0.943 | | | |
| | 12 | (305) | | | 1.000 | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 (or CSA A23.3 (R2014) Annex D).
3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

## Table 7 — Load adjustment factors for KCC-WF 1/2” in uncracked concrete [1,2]

| KCM-WF 1/2” uncracked concrete | | | Spacing factor in tension $f_{AN}$ | Edge distance factor in tension $f_{RN}$ | Spacing factor in shear [3] $f_{AV}$ | Edge distance in shear | | Concrete thickness factor in shear [4] $f_{HV}$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | ⊥ Toward edge $f_{RV}$ | ∥ To edge $f_{RV}$ | |
| Embedment $h_{ef}$ | | in (mm) | 2.04 (52) | 2.04 (52) | 2.04 (52) | 2.04 (52) | 2.04 (52) | 2.04 (52) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 1-1/2 | (38) | n/a | 0.631 | n/a | 0.281 | 0.561 | n/a |
| | 2 | (51) | n/a | 0.741 | n/a | 0.432 | 0.741 | n/a |
| | 2-1/2 | (64) | n/a | 0.859 | n/a | 0.604 | 0.859 | n/a |
| | 3 | (76) | n/a | 0.984 | n/a | 0.794 | 0.984 | 0.756 |
| | 3-1/2 | (89) | 0.786 | 1.000 | 0.667 | 1.000 | 1.000 | 0.817 |
| | 4 | (102) | 0.827 | | 0.691 | | | 0.873 |
| | 4-1/2 | (114) | 0.868 | | 0.714 | | | 0.926 |
| | 5 | (127) | 0.908 | | 0.738 | | | 0.976 |
| | 5-1/2 | (140) | 0.949 | | 0.762 | | | 1.000 |
| | 5-3/4 | (146) | 0.970 | | 0.774 | | | |
| | 6 | (152) | 0.990 | | 0.786 | | | |
| | 7 | (178) | 1.000 | | 0.833 | | | |
| | 8 | (203) | | | 0.881 | | | |
| | 9 | (229) | | | 0.929 | | | |
| | 10 | (254) | | | 0.976 | | | |
| | 12 | (305) | | | 1.000 | | | |

## Table 8 — Load adjustment factors for KCC-WF 1/2” in cracked concrete [1,2]

| KCM-WF 3/8”-1/2” cracked concrete | | | Spacing factor in tension $f_{AN}$ | Edge distance factor in tension $f_{RN}$ | Spacing factor in shear [3] $f_{AV}$ | Edge distance in shear | | Concrete thickness factor in shear [4] $f_{HV}$ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | ⊥ Toward edge $f_{RV}$ | ∥ To edge $f_{RV}$ | |
| Embedment $h_{ef}$ | | in (mm) | 2.04 (52) | 2.04 (52) | 2.04 (52) | 2.04 (52) | 2.04 (52) | 2.04 (52) |
| Spacing (s) / Edge Distance ($c_a$) / Concrete Thickness (h) - in. (mm) | 1-1/2 | (38) | n/a | 0.631 | n/a | 0.251 | 0.501 | n/a |
| | 2 | (51) | n/a | 0.741 | n/a | 0.386 | 0.741 | n/a |
| | 2-1/2 | (64) | n/a | 0.859 | n/a | 0.539 | 0.859 | n/a |
| | 3 | (76) | n/a | 0.984 | n/a | 0.709 | 0.984 | 0.728 |
| | 3-1/2 | (89) | 0.786 | 1.000 | 0.655 | 0.893 | 1.000 | 0.786 |
| | 4 | (102) | 0.827 | | 0.677 | 1.000 | | 0.841 |
| | 4-1/2 | (114) | 0.868 | | 0.699 | | | 0.892 |
| | 5 | (127) | 0.908 | | 0.721 | | | 0.940 |
| | 5-1/2 | (140) | 0.949 | | 0.743 | | | 0.986 |
| | 5-3/4 | (146) | 0.970 | | 0.754 | | | 1.000 |
| | 6 | (152) | 0.990 | | 0.765 | | | |
| | 7 | (178) | 1.000 | | 0.809 | | | |
| | 8 | (203) | | | 0.853 | | | |
| | 9 | (229) | | | 0.898 | | | |
| | 10 | (254) | | | 0.942 | | | |
| | 12 | (305) | | | 1.000 | | | |

1 Linear interpolation not permitted
2 When combining multiple load adjustment factors (e.g. for a 4 anchor pattern in a corner with thin concrete member) the design can become very conservative. To optimize the design, use PROFIS Engineering or perform anchor calculation using design equations from ACI 318 Chapter 17 (or CSA A23.3 (R2014) Annex D).
3 Spacing factor reduction in shear, $f_{AV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{AV} = f_{AN}$.
4 Concrete thickness reduction factor in shear, $f_{HV}$, assumes an influence of a nearby edge. If no edge exists, then $f_{HV} = 1.0$.

## Table 9 — Design strength for steel failure of KCC-MD Short Plate and Long Plate inserts [1,2,3,4,5]

| Design information | Symbol | Units | Insert Type | | | |
|---|---|---|---|---|---|---|
| | | | SP 3/8” | SP 1/2” | LP 3/8” | LP 1/2” |
| Nominal rod diameter | | in. | 3/8 | 1/2 | 3/8 | 1/2 |
| Design steel strength of insert in tension | $\phi N_{sa,insert}$ | lb | 2,625 | 3,515 | 2,625 | 3,515 |
| | | (kN) | (11.7) | (15.6) | (11.7) | (15.6) |
| Design seismic steel strength of insert in tension | $\phi N_{sa,insert,eq}$ | lb | 2,625 | 3,515 | 2,625 | 3,515 |
| | | (kN) | (11.7) | (15.6) | (11.7) | (15.6) |
| Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figure 5A | | | | | | |
| Design steel strength of insert in shear | $\phi_{Vsa,insert}$ | lb | 2,810 | 3,340 | 2,810 | 3,340 |
| | | (kN) | (12.5) | (14.9) | (12.5) | (14.9) |
| Design seismic steel strength of insert in shear | $\phi V_{sa,insert,eq}$ | lb | 2,810 | 2,810 | 2,810 | 3,340 |
| | | (kN) | (12.5) | (12.5) | (12.5) | (14.9) |
| Installations in lower flute of metal deck (i.e. W-deck) according to Figure 5B | | | | | | |
| Design steel strength of insert in shear | $\phi V_{sa,insert}$ | lb | 2,060 | 2,510 | 2,970 | 3,340 |
| | | (kN) | (9.2) | (11.2) | (13.2) | (14.9) |
| Design seismic steel strength of insert in shear | $\phi V_{sa,insert,eq}$ | lb | 2,060 | 2,510 | 2,970 | 3,340 |
| | | (kN) | (9.2) | (11.2) | (13.2) | (14.9) |
| Installations in lower flute of metal deck (i.e. B-deck) according to Figure 5C | | | | | | |
| Design steel strength of insert in shear | $\phi V_{sa,insert}$ | lb | 1,895 | 2,380 | 2,890 | 3,340 |
| | | (kN) | (8.4) | (11) | (12.9) | (14.9) |
| Design seismic steel strength of insert in shear | $\phi V_{sa,insert,eq}$ | lb | 1,895 | 2,380 | 2,890 | 3,340 |
| | | (kN) | (8.4) | (11) | (12.9) | (14.9) |
| Installations over flute incline of metal deck (i.e. W-deck) according to Figure 5D | | | | | | |
| Design steel strength of insert in shear | $\phi V_{sa,insert}$ | lb | N/A | | 1,030 | 2,665 |
| | | (kN) | | | (4.6) | (11.9) |
| Design seismic steel strength of insert in shear | $\phi V_{sa,insert,eq}$ | lb | | | 1,030 | 2,135 |
| | | (kN) | | | (4.6) | (9,5) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Hilti KCC-MD Inserts are considered brittle steel elements
3 Tension values are for the inserts only. The capacity of the threaded rods must be also determined from Table 16. The design strength of concrete must be obtained from tables 10 to 15. Compare the tension values of threaded rod, inserts, and concrete. The lesser of the values is to be used for the design.
4 Shear values are for the inserts only. The capacity of the threaded rods must be also determined from Table 16. The calculation of concrete shear strength is not required. Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.
5 Only threaded rod ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 is permitted to be used for the applications resisting shear, seismic shear, or seismic tension loads.

## Table 10 — Hilti KCC Short Plate and Long Plate tension design strength in the soffit of uncracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4C | |
|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) |
| SP 3/8” | 2.13 (54) | 3,610 (16.1) | 4,170 (18.5) | 635 (2.8) | 735 (3.3) |
| SP 1/2” | 2.63 (67) | 4,580 (20.4) | 5,290 (23.5) | 695 (3.1) | 805 (3.6) |
| LP 3/8” | 2.21 (56) | 3,610 (16.1) | 4,170 (18.5) | 3,610 (16.1) | 4,170 (18.5) |
| LP 1/2” | 2.71 (69) | 4,580 (20.4) | 5,290 (23.5) | 4,580 (20.4) | 5,290 (23.5) |

## Table 11 — Hilti KCC-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 4A | | Lower flute per Figure 4C | |
|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) |
| SP 3/8” | 2.13 (54) | 2,890 (12.9) | 3,335 (14.8) | 505 (2.2) | 585 (2.6) |
| SP 1/2” | 2.63 (67) | 3,660 (16.3) | 4,225 (18.8) | 555 (2.5) | 640 (2.8) |
| LP 3/8” | 2.21 (56) | 2,890 (12.9) | 3,335 (14.8) | 2,890 (12.9) | 3,335 (14.8) |
| LP 1/2” | 2.71 (69) | 3,660 (16.3) | 4,225 (18.8) | 3,660 (16.3) | 4,225 (18.8) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x hef (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Table 9 and threaded rod steel strength values in Table 16. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 9 for shear calculations.

## Table 12 — Hilti KCC-MD Short Plate and Long Plate tension design strength in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 3-7/8" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 5A | | Lower flute per Figure 5B | | Inclined per Figure 5D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) |
| SP 3/8" | 2.13 (54) | 3,610 (16.1) | 4,170 (18.5) | 1,850 (8.2) | 2,135 (9.5) | - | - |
| SP 1/2" | 2.63 (67) | 4,580 (20.4) | 5,290 (23.5) | 2,120 (9.4) | 2,450 (10.9) | - | - |
| LP 3/8" | 2.21 (56) | 3,610 (16.1) | 4,170 (18.5) | 4,895 (21.8) | 5,650 (25.1) | 3,610 (16.1) | 4,170 (18.5) |
| LP 1/2" | 2.71 (69) | 4,580 (20.4) | 5,290 (23.5) | 6,565 (29.2) | 7,580 (33.7) | 4,580 (20.4) | 5,290 (23.5) |

## Table 13 — Hilti KCC-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 3-7/8" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 5A | | Lower flute per Figure 5B | | Inclined per Figure 5D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) |
| SP 3/8" | 2.13 (54) | 2,890 (12.9) | 3,335 (14.8) | 1,480 (6.6) | 1,710 (7.6) | - | - |
| SP 1/2" | 2.63 (67) | 3,660 (16.3) | 4,225 (18.8) | 1,695 (7.5) | 1,955 (8.7) | - | - |
| LP 3/8" | 2.21 (56) | 2,890 (12.9) | 3,335 (14.8) | 3,915 (17.4) | 4,520 (20.1) | 2,890 (12.9) | 3,335 (14.8) |
| LP 1/2" | 2.71 (69) | 3,660 (16.3) | 4,225 (18.8) | 5,250 (23.4) | 6,060 (27.0) | 3,660 (16.3) | 4,225 (18.8) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Table 9 and threaded rod steel strength values in Table 16. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 9 for shear calculations.

## Table 14 — Hilti KCC-MD Short Plate and Long Plate tension design strength in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 4-1/2" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 5A | | Lower flute per Figure 5B | | Inclined per Figure 5D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) |
| SP 3/8" | 2.13 (54) | 3,610 (16.1) | 4,170 (18.5) | 1,850 (8.2) | 2,135 (9.5) | - | - |
| SP 1/2" | 2.63 (67) | 4,580 (20.4) | 5,290 (23.5) | 2,120 (9.4) | 2,450 (10.9) | - | - |
| LP 3/8" | 2.21 (56) | 3,610 (16.1) | 4,170 (18.5) | 4,895 (21.8) | 5,650 (25.1) | 3,610 (16.1) | 4,170 (18.5) |
| LP 1/2" | 2.71 (69) | 4,580 (20.4) | 5,290 (23.5) | 6,565 (29.2) | 7,580 (33.7) | 4,580 (20.4) | 5,290 (23.5) |

## Table 15 — Hilti KCC-MD Short Plate and Long Plate tension design strength in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 4-1/2" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal Embed. Depth in. (mm) | Upper flute per Figure 5A | | Lower flute per Figure 5B | | Inclined per Figure 5D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | | Tension - $\Phi N_n$ | |
| | | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) |
| SP 3/8" | 2.13 (54) | 2,890 (12.9) | 3,335 (14.8) | 1,480 (6.6) | 1,710 (7.6) | - | - |
| SP 1/2" | 2.63 (67) | 3,660 (16.3) | 4,225 (18.8) | 1,695 (7.5) | 1,955 (8.7) | - | - |
| LP 3/8" | 2.21 (56) | 2,890 (12.9) | 3,335 (14.8) | 3,915 (17.4) | 4,520 (20.1) | 2,890 (12.9) | 3,335 (14.8) |
| LP 1/2" | 2.71 (69) | 3,660 (16.3) | 4,225 (18.8) | 5,250 (23.4) | 6,060 (27.0) | 3,660 (16.3) | 4,225 (18.8) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Table 9 and threaded rod steel strength values in Table 16. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 9 for shear calculations.

## Table 16 — Design strength for steel failure of common threaded rods [1,5]

| Nominal anchor diameter | Grade A36 threaded rod | | | ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod | | | ASTM A 307, Grade A threaded rod | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN) | Shear[3] $\phi V_{sa,rod}$ lb (kN) | Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN) | Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN) | Shear[3] $\phi V_{sa,rod}$ lb (kN) | Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN) | Tensile[2] $\phi N_{sa,rod}$ or $\phi N_{sa,eq,rod}$ lb (kN) | Shear[3] $\phi V_{sa,rod}$ lb (kN) | Seismic Shear[4] $\phi V_{sa,eq,rod}$ lb (kN) |
| 3/8 | 3,395 (15.1) | 1,750 (7.8) | 1,225 (5.4) | 7,315 (32.5) | 3,780 (16.8) | 2,646 (11.8) | 3,490 (15.5) | 1,815 (8.1) | 1,271 (5.7) |
| 1/2 | 6,175 (27.5) | 3,210 (14.3) | 2,245 (10.0) | 13,315 (59.2) | 6,915 (30.8) | 4,841 (21.5) | 6,375 (28.4) | 3,315 (14.7) | 2,321 (10.3) |

1 See PTG Ed. 19, Section 3.1.8.7 for additional information on seismic applications.
2 Tensile values determined by static tension tests with $\phi N_{sa} = \phi A_{se,N} f_{uta}$ as noted in ACI 318 Chapter 17.
3 Shear values determined by static shear tests with $\phi V_{sa} = \phi 0.60 A_{se,V} f_{uta}$ as noted in ACI 318 Chapter 17.
4 Seismic shear values determined by seismic shear tests with $\phi$ Vsa ≤ $\phi$ 0.60 $A_{se,V} f_{uta}$ as noted in ACI 318, Chapter 17.
5 Values are for the threaded rod only. The capacity of the insert must be also be determined from Tables 2 and 9. The design strength of concrete must be in accordance with ACI 318 Chapter 17 and Tables 10 to 15 as necessary. Compare the values (threaded rod, inserts, and concrete). The lesser of the values is to be used for the design.

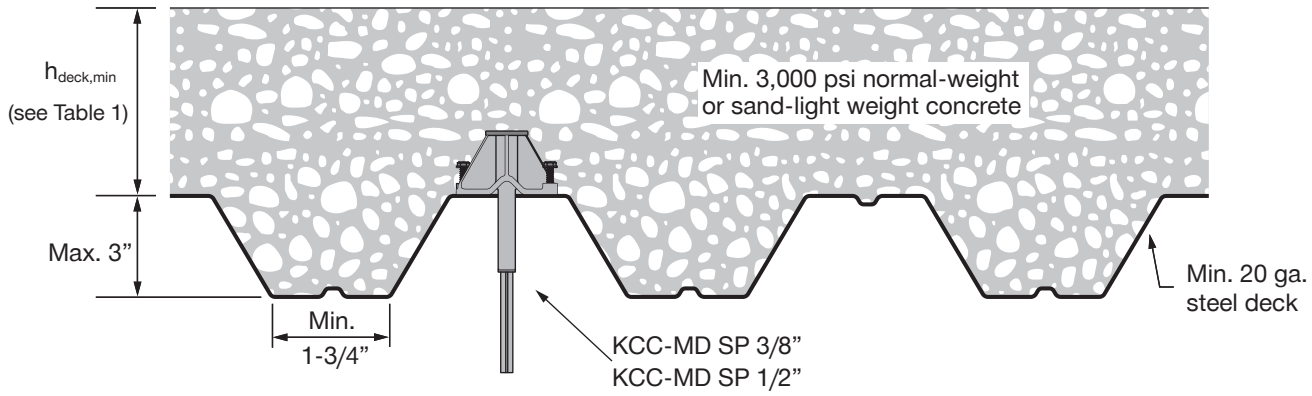
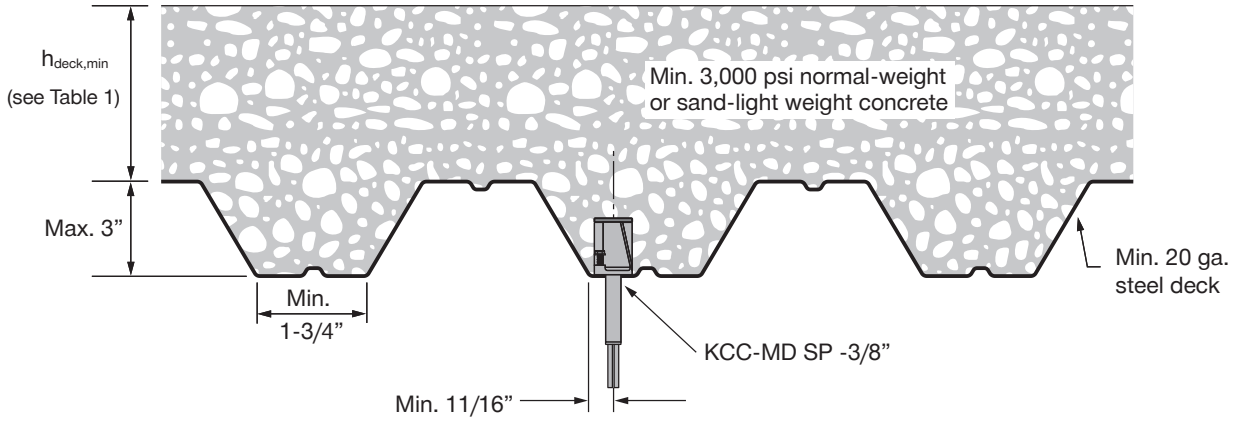
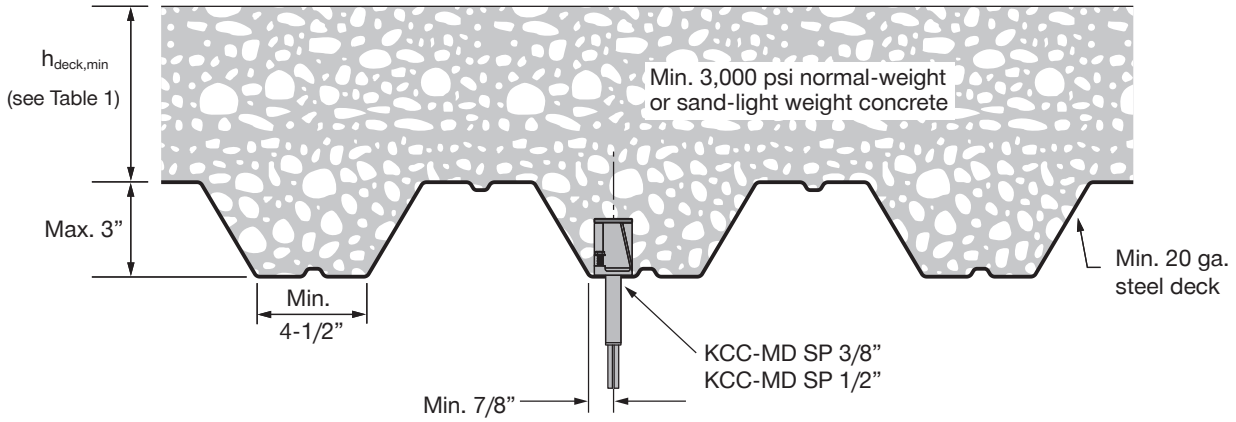



Figure 5A — Installation of KCC-MD inserts in the soffit of concrete filled metal deck floor and roof assemblies-over upper flute (B-deck and W-deck)



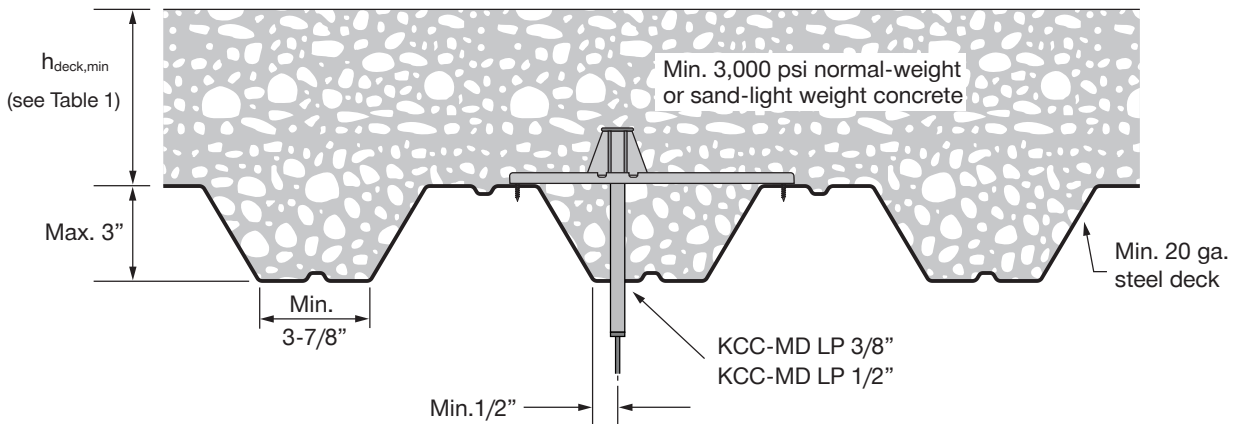




Figure 5B —Installation of KCC-MD inserts in the soffit of concrete filled metal deck floor and roof assemblies-over lower flute (W-deck)

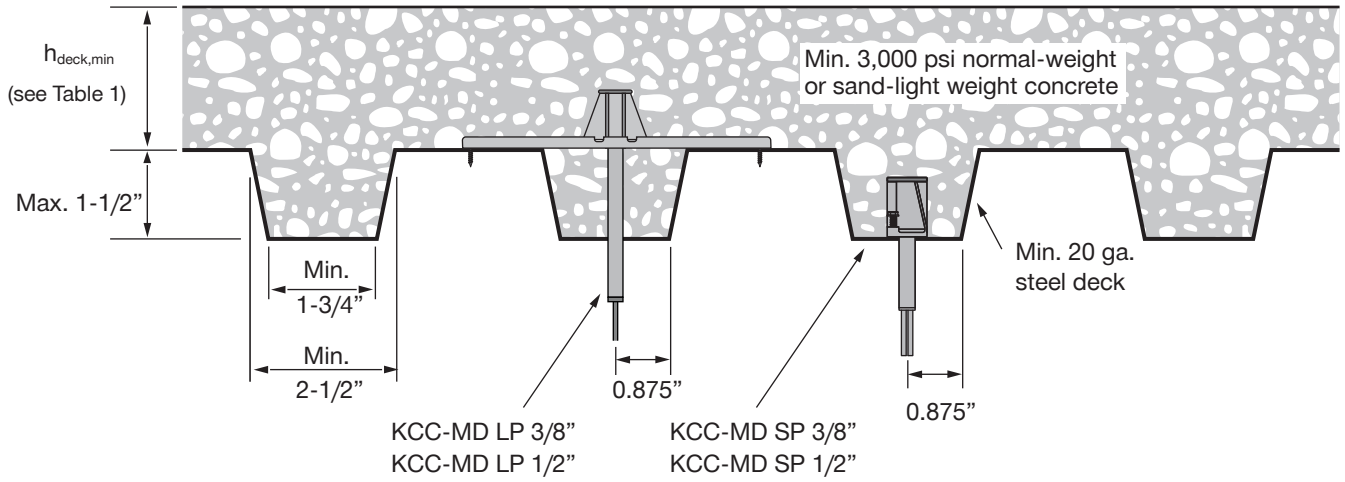



Figure 5C — Installation of KCC-MD inserts in the soffit of concrete filled metal deck floor and roof assemblies-over lower flute (B-deck)

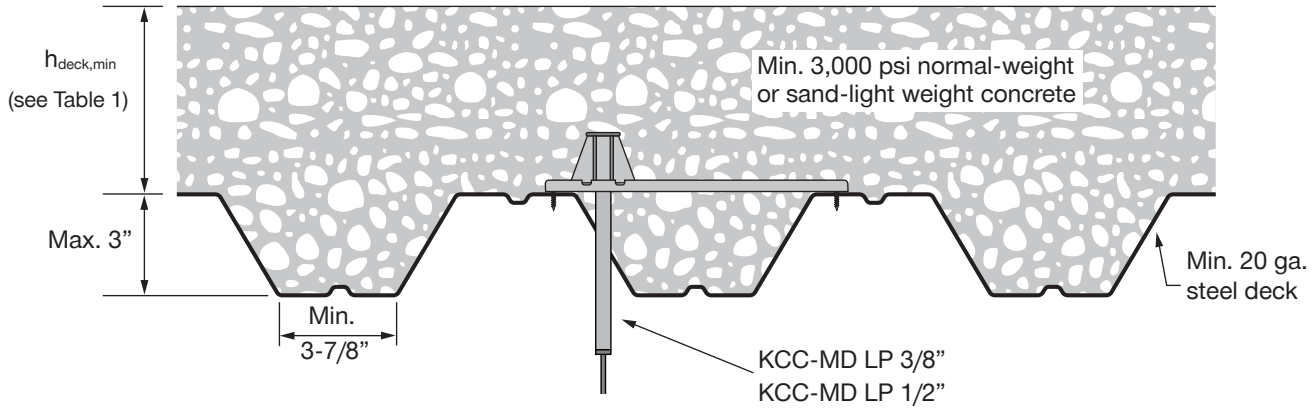



Figure 5D — Installation of KCC-MD inserts in the soffit of concrete filled metal deck floor and roof assemblies-over flute incline (W-deck)

# DESIGN DATA IN CONCRETE PER CSA A23.3

**CSA A23.3 Annex D Design**

Limit State Design of anchors is described in the provisions of CSA A23.3 Annex D for post-installed anchors tested and assessed in accordance with ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors. This section contains the Limit State Design tables with unfactored characteristic loads that are based on the published loads in ICC Evaluation Services ESR-4145. These tables are followed by factored resistance tables. The factored resistance tables have characteristic design loads that are prefactored by the applicable reduction factors for a single anchor with no anchor-to-anchor spacing of edge distance adjustments for the convenience of the user of this document. All the figures in the previous ACI 318 Chapter 17 design section are applicable to Limit State Design and the tables will reference these figures.

For a detailed explanation of the tables developed in accordance with CSA A23.3 Annex D, refer to PTG ED. 19, Section 3.1.8. Technical assistance is available by contacting Hilti Canada at (800) 363-4458 or at www.hilti.ca.

**Table 17 — Hilti KCC-WF insert design information in accordance with CSA A23.3 (R2014) Annex D [1,4]**

| Design parameter | Symbol | Units | Nominal anchor diameter | | Ref A23.3-14 |
|---|---|---|---|---|---|
| | | | 3/8" | 1/2" | |
| Outside diameter of anchor steel body | $d_a$ | in.<br>(mm) | 0.67<br>(17) | 0.87<br>(22) | |
| Effective embedment | $h_{ef}$ | in.<br>(mm) | 1.63<br>(41) | 2.04<br>(52) | |
| Minimum member thickness | $h_{min}$ | in.<br>(mm) | 2.5<br>(51) | 3<br>(76) | |
| Minimum edge distance | $c_{min}$ | in.<br>(mm) | 1-1/2<br>(38) | | |
| Minimum anchor spacing | $s_{min}$ | in.<br>(mm) | 2.6<br>(67) | 3.5<br>(88) | |
| Steel embed. material resistance factor for reinforcement | $\Phi_s$ | - | 0.85 | | 8.4.3 |
| Resistance modification factor for tension, steel failure modes [2] | R | - | 0.70 | | D.5.3 |
| Resistance modification factor for shear, steel failure modes [2] | R | - | 0.65 | | D.5.3 |
| Factored steel resistance in tension | $N_{sar}$ | lb<br>(kN) | 2,404<br>(10.7) | 3,219<br>(14.3) | D.6.1.2 |
| Factored steel resistance in tension, seismic | $N_{sar,eq}$ | lb<br>(kN) | 2,404<br>(10.7) | 3,219<br>(14.3) | D.6.1.2 |
| Factored steel resistance in shear | $V_{sar}$ | lb<br>(kN) | 2,735<br>(12.2) | 3,075<br>(13.7) | D.7.1.2 |
| Factored steel resistance in shear, seismic | $V_{sar,eq}$ | lb<br>(kN) | 2,735<br>(12.2) | 3,075<br>(13.7) | D.7.1.2 |
| Coeff. for factored conc. breakout resistance, uncracked concrete | $k_{c,uncr}$ | - | 10 | | D.6.2.2 |
| Coeff. for factored conc. breakout resistance, cracked concrete | $k_{c,cr}$ | - | 10 | | D.6.2.2 |
| Modification factor for anchor resistance, tension, uncracked conc. | $\Psi_{c,N}$ | - | 1.25 | | D.6.2.6 |
| Modification factor for anchor resistance, tension, cracked conc. | $\Psi_{c,N}$ | | 1.0 | | D.6.2.6 |
| Anchor category | - | - | cast-in | | D.5.3 (c ) |
| Concrete material resistance factor | $\Phi_c$ | - | 0.65 | | 8.4.2 |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B [3] | R | - | 1.00 | | D.5.3 (c ) |

1 Design information in this table is taken from ICC-ES ESR-4145, and converted for use with CSA A23.3 (R2014) Annex D.
2 The carbon steel KCC-WF is considered a brittle steel element as defined by CSA A23.3 (R2014) Annex D section D.2.
3 For use with the load combinations of CSA A23.3 (R2014) chapter 8. Condition B applies where supplementary reinforcement in conformance with CSA A23.3 (R2014) section D.5.3 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the resistance modification factors associated with Condition A may be used.
4 Values are for the insert only. The capacity of the threaded rod must be also be determined from Table 27. The design strength of concrete must be in accordance with CSA A23.3 (R2014) and Tables 18 to 19 as necessary. Compare the values (threaded rod, inserts, and concrete). The lesser of the values is to be used for the design.

## Table 18 — Hilti KCC-WF cast-in insert design strength with concrete / pullout failure in uncracked concrete [1,2,3,4,5,6]

| Nominal anchor internal diameter | Effective embedment depth in. (mm) | Tension - $\Phi N_n$ | | | | Shear - $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 3/8" | 1.63 | 2,185 | 2,390 | 2,760 | 3,385 | 2,185 | 2,390 | 2,760 | 3,385 |
| | (41) | (9.7) | (10.6) | (12.3) | (15.1) | (9.7) | (10.6) | (12.3) | (15.1) |
| 1/2" | 2.04 | 3,055 | 3,350 | 3,865 | 4,735 | 3,055 | 3,350 | 3,865 | 4,735 |
| | (52) | (13.6) | (14.9) | (17.2) | (21.1) | (13.6) | (14.9) | (17.2) | (21.1) |

## Table 19 — Hilti KCC-WF cast-in insert design strength with concrete / pullout failure in cracked concrete [1,2,3,4,5,6]

| Nominal anchor internal diameter | Effective embedment depth in. (mm) | Tension - $\Phi N_n$ | | | | Shear - $\Phi V_n$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.1 MPa) lb (kN) |
| 3/8" | 1.63 | 1,745 | 1,910 | 2,210 | 2,705 | 1,745 | 1,910 | 2,210 | 2,705 |
| | (41) | (7.8) | (8.5) | (9.8) | (12.0) | (7.8) | (8.5) | (9.8) | (12.0) |
| 1/2" | 2.04 | 2,445 | 2,680 | 3,095 | 3,790 | 2,445 | 2,680 | 3,095 | 3,790 |
| | (52) | (10.9) | (11.9) | (13.8) | (16.9) | (10.9) | (11.9) | (13.8) | (16.9) |

1 See PTG Ed. 19, Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular values are for single anchors located at edge distance (c) and spacing (s) greater than $3h_{ef}$. For anchors with edge distance or spacing less than $3h_{ef}$ use ACI 318 to calculate load reduction factor. Compare the calculated value to the steel values (threaded rod and inserts) in Tables 17 and 27. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by $\lambda_a$ as follows:
For sand-lightweight, $\lambda_a$ = 0.85. For all-lightweight, $\lambda_a$ = 0.75.
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear.
6 Compare tabular value to the insert steel strength values in Table 17 and threaded rod steel strength values in Table 27 The lesser of the values is to be used for the design.

## Table 20 — Design strength for steel failure of KCC-MD Short Plate and Long Plate inserts [1,2,3,4,5]

| Design information | Symbol | Units | Insert Type | | | |
|---|---|---|---|---|---|---|
| | | | SP 3/8” | SP 1/2” | LP 3/8” | LP 1/2” |
| Nominal rod diameter (in.) | - | in. | 3/8 | 1/2 | 3/8 | 1/2 |
| Anchor O.D. | $d_a$ | in. | 0.67 | 0.87 | 0.67 | 0.87 |
| | | (mm) | (17) | (22) | (17) | (22) |
| Effective embedment | $h_{ef}$ | in. | 2.00 | 2.50 | 2.00 | 2.50 |
| | | (mm) | (51) | (64) | (51) | (64) |
| Min. specified ult. Strength, $f_{ut}$ lb (kN) | $f_{ut}$ | lb | 4,040 | 5,410 | 4,040 | 5,410 |
| | | (kN) | (18.0) | (24.1) | (18.0) | (24.1) |
| Anchor category | - | - | Cast-In | | | |
| Concrete material resistance factor | $\phi_c$ | - | 0.65 | | | |
| Resistance modification factor for tension and shear, concrete failure modes, Condition B | R | - | 1.00 | | | |
| Steel embed. material resistance factor for reinforcement | $\phi_s$ | - | 0.85 | | | |
| Resistance modification factor for tension, steel failure modes | R | - | 0.70 | | | |
| Resistance modification factor for shear, steel failure modes | R | - | 0.65 | | | |
| Factored steel strength of insert in tension, | $\phi_{Nsa,insert}$ | lb | 2,405 | 3,220 | 2,405 | 3,220 |
| | | (kN) | (10.7) | (14.3) | (10.7) | (14.3) |
| Factored seismic steel strength of insert in tension | $\phi_{Nsa,insert,eq}$ | lb | 2,405 | 3,220 | 2,405 | 3,220 |
| | | (kN) | (11) | (14) | (11) | (14.3) |
| Installations in upper flute of metal deck (i.e. W-deck and B-deck) according to Figures 5A | | | | | | |
| Factored steel strength of insert in shear | $\phi_{Vsa,insert}$ | lb | 2,590 | 3,075 | 2,590 | 3,075 |
| | | (kN) | (12) | (14) | (12) | (14) |
| Factored seismic steel strength of insert in shear | $\phi_{Vsa,insert,eq}$ | lb | 2,590 | 4,875 | 2,590 | 4,875 |
| | | (kN) | (12) | (22) | (12) | (22) |
| Installations in lower flute of metal deck (i.e. W-deck) according to Figures 5B | | | | | | |
| Factored steel strength of insert in shear | $\phi_{Vsa,insert}$ | lb | 1,900 | 2,310 | 2,735 | 3,075 |
| | | (kN) | (8) | (10) | (12) | (14) |
| Factored seismic steel strength of insert in shear | $\phi_{Vsa,insert,eq}$ | lb | 1,900 | 2,310 | 2,735 | 3,075 |
| | | (kN) | (8) | (10) | (12) | (14) |
| Installations in lower flute of metal deck (i.e. B-deck) according to Figures 5C | | | | | | |
| Factored steel strength of insert in shear | $\phi_{Vsa,insert}$ | lb | 1,745 | 2,190 | 2,660 | 3,075 |
| | | (kN) | (8) | (10) | (12) | (14) |
| Factored seismic steel strength of insert in shear | $\phi_{Vsa,insert,eq}$ | lb | 1,745 | 2,190 | 2,660 | 3,075 |
| | | (kN) | (8) | (10) | (12) | (14) |
| Installations in lower flute of metal deck (i.e. W-deck) according to Figures 5D | | | | | | |
| Factored steel strength of insert in shear | $\phi_{Vsa,insert}$ | lb | N/A | | 950 | 2,455 |
| | | (kN) | | | (4) | (11) |
| Factored seismic steel strength of insert in shear | $\phi_{Vsa,insert,eq}$ | lb | | | 950 | 1,965 |
| | | (kN) | | | (4) | (9) |

1 Design information in this table is taken from ICC-ES ESR-4145, Table 4, and converted for use with CSA A23.3 (R2014) Annex D.
2 The carbon steel KCC-MD is considered a brittle steel element as defined by CSA A23.3 (R2014) Annex D section D.2.
3 Tension values are for the inserts only. The capacity of the threaded rods must be also determined from Table 27. The design strength of concrete must be obtained from tables 21-27. Compare the tension values of threaded rod, inserts, and concrete. The lesser of the values is to be used for the design.
4 Shear values are for the inserts only. The capacity of the threaded rods must be also determined from Table 27. The calculation of concrete shear strength is not required. Compare the shear values of threaded rod and inserts. The lesser of the values is to be used for the design strength of the anchor in shear.
5 Only threaded rod ASTM A193 Grade B7, ASTM A325, or ASTM F1554 Grade 105 is permitted to be used for the applications resisting shear, seismic shear, or seismic tension loads.

## Table 21 — Hilti KCC-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

| Anchor | Nominal embed. in. (mm) | Upper flute per Figure 5A | | Lower flute per Figure 5C | |
|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 3/8” | 2.13 (54) | 3,300 (14.7) | 4,040 (18.0) | 580 (2.6) | 710 (3.2) |
| SP 1/2” | 2.63 (67) | 4,180 (18.6) | 5,120 (22.8) | 635 (2.8) | 775 (3.4) |
| LP 3/8” | 2.21 (56) | 3,300 (14.7) | 4,040 (18.0) | 3,300 (14.7) | 4,040 (18.0) |
| LP 1/2” | 2.71 (69) | 4,180 (18.6) | 5,120 (22.8) | 4,180 (18.6) | 5,120 (22.8) |

## Table 22 — Hilti KCC-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (B profile) [1,2,3,4,5,6,7,8]

| Anchor | Nominal embed. in. (mm) | Upper flute per Figure 5A | | Lower flute per Figure 5C | |
|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 3/8” | 2.13 (54) | 2,640 (11.7) | 3,230 (14.4) | 465 (2.1) | 565 (2.5) |
| SP 1/2” | 2.63 (67) | 3,345 (14.9) | 4,095 (18.2) | 505 (2.2) | 620 (2.8) |
| LP 3/8” | 2.21 (56) | 2,640 (11.7) | 3,230 (14.4) | 2,640 (11.7) | 3,230 (14.4) |
| LP 1/2” | 2.71 (69) | 3,345 (14.9) | 4,095 (18.2) | 3,345 (14.9) | 4,095 (18.2) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Table 17 and threaded rod steel strength values in Table 27. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 20 for shear calculations.

## Table 23 — Hilti KCC-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 3-7/8" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal embed. in. (mm) | Upper flute per Figure 5A | | Lower flute per Figure 5B | | Inclined per Figure 5D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 3/8" | 2.13 (54) | 3,300 (14.7) | 4,040 (18.0) | 1,685 (7.5) | 2,065 (9.2) | - | - |
| SP 1/2" | 2.63 (67) | 4,180 (18.6) | 5,120 (22.8) | 1,935 (8.6) | 2,370 (10.5) | - | - |
| LP 3/8" | 2.21 (56) | 3,300 (14.7) | 4,040 (18.0) | 4,470 (19.9) | 5,475 (24.4) | 3,300 (14.7) | 4,040 (18.0) |
| LP 1/2" | 2.71 (69) | 4,180 (18.6) | 5,120 (22.8) | 5,990 (26.6) | 7,340 (32.6) | 4,180 (18.6) | 5,120 (22.8) |

## Table 24 — Hilti KCC-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 3-7/8" width) [1,2,3,4,5,6,7,8]

| Nominal anchor diameter in. | Nominal embed. in. (mm) | Upper flute per Figure 5A | | Lower flute per Figure 5B | | Inclined per Figure 5D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 3/8" | 2.13 (54) | 2,640 (11.7) | 3,230 (14.4) | 1,350 (6.0) | 1,655 (7.4) | - | - |
| SP 1/2" | 2.63 (67) | 3,345 (14.9) | 4,095 (18.2) | 1,550 (6.9) | 1,895 (8.4) | - | - |
| LP 3/8" | 2.21 (56) | 2,640 (11.7) | 3,230 (14.4) | 3,575 (15.9) | 4,380 (19.5) | 2,640 (11.7) | 3,230 (14.4) |
| LP 1/2" | 2.71 (69) | 3,345 (14.9) | 4,095 (18.2) | 4,795 (21.3) | 5,870 (26.1) | 3,345 (14.9) | 4,095 (18.2) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Compare tabular value to the insert steel strength values in Table 17 and threaded rod steel strength values in Table 27. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 20 for shear calculations.

## Table 25 — Hilti KCC-MD Short Plate and Long Plate factored tension resistance in the soffit of uncracked sand-lightweight concrete over metal deck (W profile with 4-1/2" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal embed. in. (mm) | Upper flute per Figure 5A | | Lower flute per Figure 5B | | Inclined per Figure 5D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 3/8" | 2.13 (54) | 3,300 (14.7) | 4,040 (18.0) | 1,685 (7.5) | 2,065 (9.2) | - | - |
| SP 1/2" | 2.63 (67) | 4,180 (18.6) | 5,120 (22.8) | 1,935 (8.6) | 2,370 (10.5) | - | - |
| LP 3/8" | 2.21 (56) | 3,300 (14.7) | 4,040 (18.0) | 4,470 (19.9) | 5,475 (24.4) | 3,300 (14.7) | 4,040 (18.0) |
| LP 1/2" | 2.71 (69) | 4,180 (18.6) | 5,120 (22.8) | 5,990 (26.6) | 7,340 (32.6) | 4,180 (18.6) | 5,120 (22.8) |

## Table 26 — Hilti KCM-MD Short Plate and Long Plate factored tension resistance in the soffit of cracked sand-lightweight concrete over metal deck (W profile with 4-1/2" width) [1,2,3,4,5,6,7,8]

| Anchor | Nominal embed. in. (mm) | Upper flute per Figure 5A | | Lower flute per Figure 5B | | Inclined per Figure 5D | |
|---|---|---|---|---|---|---|---|
| | | Tension - $N_r$ | | Tension - $N_r$ | | Tension - $N_r$ | |
| | | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) | $f'_c$ = 20 MPa (2,900 psi) lb (kN) | $f'_c$ = 30 MPa (4,350 psi) lb (kN) |
| SP 3/8" | 2.13 (54) | 2,640 (11.7) | 3,230 (14.4) | 1,350 (6.0) | 1,655 (7.4) | - | - |
| SP 1/2" | 2.63 (67) | 3,345 (14.9) | 4,095 (18.2) | 1,550 (6.9) | 1,895 (8.4) | - | - |
| LP 3/8" | 2.21 (56) | 2,640 (11.7) | 3,230 (14.4) | 3,575 (15.9) | 4,380 (19.5) | 2,640 (11.7) | 3,230 (14.4) |
| LP 1/2" | 2.71 (69) | 3,345 (14.9) | 4,095 (18.2) | 4,795 (21.3) | 5,870 (26.1) | 3,345 (14.9) | 4,095 (18.2) |

1 See Section 3.1.8.6 to convert design strength value to ASD value.
2 Linear interpolation between concrete compressive strengths is not permitted.
3 Tabular value is for one anchor per flute. Minimum spacing along the length of the flute is 3 x $h_{ef}$ (effective embedment).
4 Tabular values are for normal weight or sand-light weight concrete.
5 No additional reduction factors for spacing or edge distance need to be applied.
6 Compare tabular value to the insert steel strength values in Table 17 and threaded rod steel strength values in Table 27. The lesser of the values is to be used for the design.
7 Tabular values are for static loads only. For seismic tension loads, multiply cracked concrete tabular values in tension by $\alpha_{N,seis}$ = 0.75. See PTG ED.19, Section 3.1.8.7 for additional information on seismic applications.
8 For Hilti KCC-MD anchors, calculation of static and seismic concrete strength in shear is not required. See Table 20 for shear calculations.

## Table 27 — Design strength for steel failure of common threaded rods used with KCC-WF and KCC-MD cast-in anchor [1,2,3]

| Nominal anchor diameter | Grade A36 threaded rod | | | ASTM A 193 B7 or ASTM F1554 Gr. 105 threaded rod | | | ASTM A 307, Grade A threaded rod | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tensile[4] $\phi N_{sar,rod}$ or $\phi N_{sar,eq,rod}$ lb (kN) | Shear[5] $\phi V_{sar,rod}$ lb (kN) | Seismic Shear[6] $\phi V_{sar,eq,rod}$ lb (kN) | Tensile[4] $\phi N_{sar,rod}$ or $\phi N_{sar,eq,rod}$ lb (kN) | Shear[5] $\phi V_{sar,rod}$ lb (kN) | Seismic Shear[6] $\phi V_{sar,eq,rod}$ lb (kN) | Tensile[4] $\phi N_{sar,rod}$ or $\phi N_{sar,eq,rod}$ lb (kN) | Shear[5] $\phi V_{sar,rod}$ lb (kN) | Seismic Shear[6] $\phi V_{sar,eq,rod}$ lb (kN) |
| 1/4 | 1,260 (5.6) | 705 (3.1) | 495 (2.2) | 2,720 (12.1) | 1,520 (6.8) | 1,064 (4.7) | 1,290 (5.7) | 725 (3.2) | 508 (2.3) |
| 3/8 | 3,075 (13.7) | 1,720 (7.7) | 1,205 (5.4) | 6,630 (29.5) | 3,705 (16.5) | 2,594 (11.5) | 3,160 (14.1) | 1,780 (7.9) | 1,246 (5.5) |

1 See section 3.1.8.6 to convert design strength value to ASD value.
2 Hilti KCC-WF and KCC-MD anchors are to be considered brittle steel elements
3 See Section 3.1.8.7 for additional information on seismic applications.
4 Tensile $N_{sar} = \phi_s A_{se,N} R f_{ut}$ as noted in CSA A23.3 Annex D.
5 Shear values determined by static shear tests with $V_{sar} < \phi_s 0.60 A_{se,V} f_{ut} R$. as noted in CSA A23.3 Annex D.
6 Seismic shear values determined by seismic shear tests with $V_{sar,eq} < \phi_s 0.60 A_{se,V} f_{ut} R$. as noted in CSA A23.3 Annex D.

### Table 28 — UL cUL LLC and FM approvals for KCC-WF, KCC-MD Short Plate and KCC-MD Long Plate Anchors [1,2]

| Design information | | WF and SP-MD 3/8" | | | WF and SP-MD 1/2" | | | LP 3/8" | | | LP 1/2" | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal rod diameter (in.) | Metal deck soffit or Wood Form | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) | UL max pipe size (in.) | Test load (lb) | FM max pipe size (in.) |
| 3/8 | Wood Form | 4 | 1,500 | 4 | - | - | - | 4 | 1,500 | 4 | - | - | - |
| | Upper flute | 4 | 1,500 | 4 | - | - | - | 4 | 1,500 | 4 | - | - | - |
| | Lower flute | 4 | 1,500 | 4 | - | - | - | 4 | 1,500 | 4 | - | - | - |
| 1/2 | Wood Form | - | - | - | 8 | 4,050 | 8 | - | - | - | 8 | 4,050 | 8 |
| | Upper flute | - | - | - | 8 | 4,050 | 8 | - | - | - | 8 | 4,050 | 8 |
| | Lower flute | - | - | - | 8 | 4,050 | 8 | - | - | - | 8 | 4,050 | 8 |

1 UL LLC Listing based on successful completion of testing in accordance with UL 203.
2 FM Approval based on successful completion of testing in accordance with FM 1952.

## INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) are included with each product package. They can also be viewed of downloaded online at www.hilti.com and www.hilti.ca. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the IFU.

## ORDERING INFORMATION

### KCC-WF and KCC-MD Short Plate and Long Plate cast-in anchors for use in metal deck[1]

| Description | Anchor color [2] | Qty / box | Hole saw diameter |
|---|---|---|---|
| KCC-WF 3/8" | Dark Green | 150 | N/A |
| KCC-WF 1/2" | Dark Orange | 100 | N/A |
| KCC-MD SP 3/8" | Dark Green | 75 | 11/16" |
| KCC-MD SP 1/2" | Dark Orange | 45 | 13/16" |
| KCC-MD LP 3/8" | Dark Green | 20 | 5/8" |
| KCC-MD LP 1/2" | Dark Orange | 15 | 3/4" |

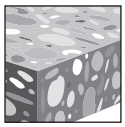
1 All dimensions in inches
2 Identifies anchor size

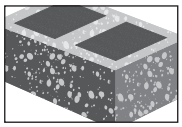
# 3.3.18 HLC SLEEVE ANCHOR

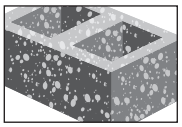
## PRODUCT DESCRIPTION

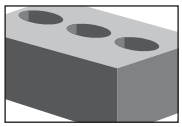
**HLC Sleeve anchors**

| Anchor System | | Features and Benefits |
|---|---|---|
|  | Bolt head — HLC-H | • Anchor suitable for through-hole installation<br>• Anchor and masonry bit are the same diameter<br>• Good selection of anchor diameters, lengths and head configurations offer versatility<br>• Load data for concrete, hollow masonry, solid masonry and brick<br>• Extrusions on sleeve prevent the anchor from spinning in hole during installation or dropping out of overhead hole prior to applying installation torque. |
|  | Hex Nut — HLC-HX | |
|  | Flat Phillips Head — HLC-FPH | |
|  | Tie-Wire Head — HLC-T | |
|  | Acorn Nut — HLC-AC | |
|  | Round Head Slotted — HLC-RS | |
|  | Rod Coupling — HLC-RC | |


Uncracked concrete


Grout-filled concrete masonry


Ungrouted concrete masonry


Hollow brick

## MATERIAL SPECIFICATIONS

| |
|---|
| Carbon steel epansion sleeves and spacer sleeves are manufactured from cold rolled steel. |
| Carbon steel anchors are zinc plated in accordance with ASTM B633, SC 1, TYPE III. |
| Stainless steel anchor components are manufactured from AISI Type 304 stainless steel. |

**Table 1 — Hilti HLC Sleeve anchor specification table**

| Setting information | Symbol | | Nominal anchor diameter | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1/4 | 5/16 | 3/8 | 1/2 | 5/8 | 3/4 |
| Thread size | UNC | in. | 3/16-24 | 1/4-20 | 5/16-18 | 3/8-16 | 1/2-13 | 5/8-11 |
| Nominal bit diameter | $d_{bit}$ | in. | 1/4 | 5/16 | 3/8 | 1/2 | 5/8 | 3/4 |
| Minimum nominal embedment | $h_{nom}$ | in.<br>(mm) | 1<br>(25) | 1<br>(25) | 1-1/4<br>(32) | 1-1/2<br>(38) | 2<br>(51) | 2<br>(51) |
| Minimum hole depth | $h_o$ | in.<br>(mm) | 1-3/8<br>(35) | 1-3/8<br>(35) | 1-3/4<br>(45) | 2-1/8<br>(54) | 2-5/8<br>(67) | 2-5/8<br>(67) |
| Installation torque | $T_{inst}$ [1] | ft-lb<br>(Nm) | -<br>- | 12<br>(16) | 18<br>(24) | 35<br>(47) | -<br>- | -<br>- |
| | $T_{inst}$ [2] | ft-lb<br>(Nm) | 2<br>(3) | 5<br>(7) | 10<br>(14) | 15<br>(20) | 60<br>(81) | 90<br>(122) |

1 HLC-H Bolt Head model.
2 HLC-HX, HLC-FPH, HLC-AC, HLC-RS and HLC-RC models.

## Table 2 — Carbon steel sleeve anchor allowable loads in concrete[1]

| Nominal anchor diameter | Bolt diameter in. | Nominal embedment in. (mm) | $f'_c$ = 2,000 psi | | | | $f'_c$ = 4,000 psi | | | | $f'_c$ = 6,000 psi | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tension | | Shear [2] | | Tension | | Shear [2] | | Tension | | Shear [2] | |
| | | | lb | (kN) | lb | (kN) | lb | (kN) | lb | (kN) | lb | (kN) | lb | (kN) |
| 1/4 | 3/16 | 1 (25) | 225 | (1.0) | 305 | (1.4) | 250 | (1.1) | 305 | (1.4) | 250 | (1.1) | 305 | (1.4) |
| 5/16 | 1/4 | 1 (25) | 350 | (1.5) | 560 | (2.5) | 450 | (2.0) | 560 | (2.5) | 500 | (2.2) | 560 | (2.5) |
| 3/8 | 5/16 | 1-1/4 (32) | 450 | (2.0) | 870 | (3.9) | 565 | (2.5) | 870 | (3.9) | 700 | (3.1) | 890 | (4.4) |
| 1/2 | 3/8 | 1-1/2 (38) | 675 | (3.0) | 1,250 | (5.6) | 925 | (4.1) | 1,325 | (5.9) | 1,100 | (4.9) | 1,325 | (5.9) |
| 5/8 | 1/2 | 2 (51) | 1,035 | (4.6) | 1,750 | (7.8) | 1,500 | (6.7) | 2,295 | (10.2) | 1,950 | (8.7) | 2,295 | (10.2) |
| 3/4 | 5/8 | 2 (51) | 1,125 | (5.0) | 1,750 | (7.8) | 1,500 | (6.7) | 3,000 | (13.3) | 1,950 | (8.7) | 3,010 | (13.4) |

1 Based on a safety factor of 4.0.

2 For 1/4- and 3/8-in. flat phillips and round head anchors, shear values should be reduced by 57% due to the potential of the shear acting through the hollow portion of the head.

## Table 3 — Stainless steel sleeve anchor allowable loads[1]

| Nominal anchor diameter | Nominal embedment in. (mm) | $f'_c$ = 2,000 psi | | | | $f'_c$ = 4,000 psi | | | | Hollow C-90 concrete block[2] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tension | | Shear | | Tension | | Shear | | Tension | | Shear | |
| | | lb | (kN) | lb | (kN) | lb | (kN) | lb | (kN) | lb | (kN) | lb | (kN) |
| 1/4 | 1-1/8 (29) | 235 | (1.0) | 450 | (2.0) | 300 | (1.3) | 450 | (2.0) | 200 | (0.9) | 400 | (1.8) |
| 5/16 | 1-1/4 (32) | 310 | (1.4) | 675 | (3.0) | 410 | (1.8) | 675 | (3.0) | 335 | (1.5) | 600 | (2.7) |
| 3/8 | 1-1/2 (38) | 450 | (2.0) | 1,000 | (4.4) | 600 | (2.7) | 1,000 | (4.4) | 470 | (2.1) | 890 | (4.0) |

1 Based on using a safety factor of 4.
2 ASTM Specification C90, Type II.

## Table 4 — Carbon steel sleeve anchor allowable loads in grout-filled block[1,2,3,4,5,6,7]

| Nominal anchor diameter | Nominal embedment in. (mm) | Edge distance in. (mm) | Tension lb (kN) | Shear lb (kN) |
|---|---|---|---|---|
| 1/4 | 1 (25) | 4 (101) | 290 (1.3) | 305 (1.4) |
| | | ≥ 12 (305) | | |
| 5/16 | 1 (25) | 4 (101) | 385 (1.7) | 500 (2.2) |
| | | ≥ 12 (305) | | |
| 3/8 | 1-1/4 (32) | 4 (101) | 435 (1.9) | 725 (3.2) |
| | | ≥ 12 (305) | | |
| 1/2 | 1-1/2 (38) | 4 (101) | 605 (2.7) | 865 (3.8) |
| | | ≥ 12 (305) | | 1,145 (5.1) |
| 5/8 | 2 (51) | 4 (101) | 710 (3.2) | 1,050 (4.7) |
| | | ≥ 12 (305) | | 1,815 (8.1) |
| 3/4 | 2 (51) | 4 (101) | 840 (3.7) | 1,050 (4.7) |
| | | ≥ 12 (305) | | 1,970 (8.8) |

1 Values are for lightweight, medium-weight or normal-weight concrete masonry units conforming to ASTM C90 with 2,000 psi grout conforming to ASTM C474.
2 Embedment depth is measured from the outside face of the concrete masonry unit.
3 Values are for anchors located in the grouted cell, bed joint, cross web or any combination of the above.
4 For anchors installed in the T joint or head joint reduce tension values by 20%.
5 Values for edge distances between 4 inches and 12 inches may be calculated by linear interpolation.
6 Anchors are limited to one per unit cell.
7 Based on using a safety factor of 4.

## Table 5 — Carbon steel sleeve anchor allowable loads in hollow concrete block[1,2,3,4]

| Nominal Anchor Diameter | Nominal embedment in. (mm) | Tension lb (kN) | Shear lb (kN) |
|---|---|---|---|
| 1/4 | 1 (25) | 350 (1.5) | 305 (1.4) |
| 5/16 | 1 (25) | 375 (1.7) | 560 (2.5) |
| 3/8 | 1-1/4 (32) | 435 (1.9) | 800 (3.5) |
| 1/2 | 1-1/2 (38) | 565 (2.5) | 1,125 (5.0) |

1 Based on using a safety factor of 4.
2 ASTM Specification C90, Type II.
3 Installation in the mortar joints is outside the scope of the published data.
4 Anchors are limited to one per unit cell with a minimum edge distance of 12 inches.

## Table 6 — Carbon steel sleeve anchor allowable loads in clay brick[1,2,3,4]

| Nominal Anchor Diameter | Nominal embedment in. (mm) | Tension lb (kN) | Shear lb (kN) |
|---|---|---|---|
| 1/4 | 1 (25) | 350 (1.5) | 305 (1.4) |
| 5/16 | 1 (25) | 345 (1.5) | 530 (2.3) |
| 3/8 | 1-1/4 (32) | 375 (1.7) | 850 (3.8) |
| 1/2 | 1-1/2 (38) | 435 (1.9) | 1,230 (5.5) |

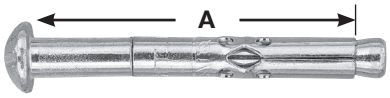
1 Based on using a safety factor of 4.
2 Due to wide strength variations encountered in masonry, these values should be considered as guide values.
3 Installation in the mortar joints is outside the scope of the published data.
4 Minimum anchor spacing shall be two (2) complete bricks in any direction. Minimum edge distance shall be the lesser of two (2) complete bricks or 16 inches in any direction.

## INSTALLATION INSTRUCTIONS

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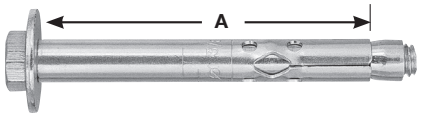
## ORDERING INFORMATION[1]

### Round head slotted (RS)



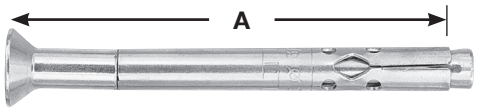

| Description | Nominal bit diameter | Bolt thread | Minimum embedment | Fastens materials up to | Qty / box |
|---|---|---|---|---|---|
| HLC-RS 1/4 x 1-1/4 | 1/4 | 3/16-24 | 1 | 1/4 | 100 |
| HLC-RS 1/4 x 2 | 1/4 | 3/16-24 | 1 | 1 | 100 |
| HLC-RS 1/4 x 4 | 1/4 | 3/16-24 | 1 | 3 | 100 |

### Bolt head (H)




| Description | Nominal bit diameter | Bolt thread | Minimum embedment | Fastens materials up to | Qty / box |
|---|---|---|---|---|---|
| HLC-H 5/16 x 1-5/8 | 5/16 | 1/4-20 | 1 | 5/8 | 100 |
| HLC-H 5/16 x 2-5/8 | 5/16 | 1/4-20 | 1 | 1-5/8 | 100 |
| HLC-H 3/8 x 1-7/8 | 3/8 | 5/16-18 | 1-1/4 | 5/8 | 50 |
| HLC-H 3/8 x 3 | 3/8 | 5/16-18 | 1-1/4 | 1-3/4 | 50 |
| HLC-H 1/2 x 2-1/4 | 1/2 | 3/8-16 | 1-1/2 | 3/4 | 50 |
| HLC-H 1/2 x 3 | 1/2 | 3/8-16 | 1-1/2 | 1-1/2 | 25 |
| HLC-H 1/2 x 4 | 1/2 | 3/8-16 | 1-1/2 | 2-1/2 | 25 |

### Flat phillips head (FPH)




| Description | Nominal bit diameter | Bolt thread | Minimum embedment | Fastens materials up to | Qty / box |
|---|---|---|---|---|---|
| HLC-FPH 1/4 x 1-3/8 | 1/4 | 3/16-24 | 1 | 3/8 | 100 |
| HLC-FPH 1/4 x 2 | 1/4 | 3/16-24 | 1 | 1 | 100 |
| HLC-FPH 1/4 x 3 | 1/4 | 3/16-24 | 1 | 2 | 100 |
| HLC-FPH 1/4 x 4 | 1/4 | 3/16-24 | 1 | 3 | 100 |
| HLC-FPH 3/8 x 2-7/8 | 3/8 | 5/16-18 | 1-1/4 | 1-1/2 | 50 |
| HLC-FPH 3/8 x 4 | 3/8 | 5/16-18 | 1-1/4 | 2-3/4 | 50 |
| HLC-FPH 3/8 x 5 | 3/8 | 5/16-18 | 1-1/4 | 3-3/4 | 25 |
| HLC-FPH 3/8 x 6 | 3/8 | 5/16-18 | 1-1/4 | 4-3/4 | 25 |

1 All dimensions in inches

### Definition of nomenclature

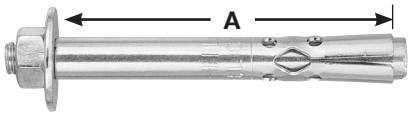
Outside diameter of sleeve, see tables for threaded bolt diameter

**HLC-AC 1/4 X 1-3/8**

Nut configuration

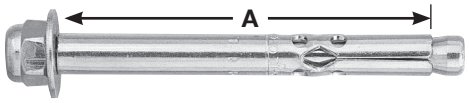
The overall length from bottom of washer to end of sleeve

## Hex nut (HX)



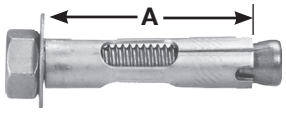

| Description | Nominal bit diameter | Bolt thread | Minimum embedment | Fastens materials up to | Qty / box |
|---|---|---|---|---|---|
| HLC-HX 5/16 x 1-5/8 | 5/16 | 1/4-20 | 1 | 1/2 | 100 |
| HLC-HX 5/16 x 2-5/8 | 5/16 | 1/4-20 | 1 | 1 -1/2 | 100 |
| HLC-HX 3/8 x 1-7/8 | 3/8 | 5/16-18 | 1-1/4 | 5/8 | 50 |
| HLC-HX 3/8 x 3 | 3/8 | 5/16-18 | 1-1/4 | 1-3/4 | 50 |
| HLC-HX 1/2 x 2-1/4 | 1/2 | 3/8-16 | 1-1/2 | 3/4 | 25 |
| HLC-HX 1/2 x 3 | 1/2 | 3/8-16 | 1-1/2 | 1-1/2 | 25 |
| HLC-HX 1/2 x 4 | 1/2 | 3/8-16 | 1-1/2 | 2-1/2 | 25 |
| HLC-HX 1/2 x 6 | 1/2 | 3/8-16 | 1-1/2 | 4-1/2 | 15 |
| HLC-HX 5/8 x 2-1/4 | 5/8 | 1/2-13 | 2 | 1/4 | 25 |
| HLC-HX 5/8 x 4-1/4 | 5/8 | 1/2-13 | 2 | 2-1/4 | 10 |
| HLC-HX 5/8 x 6 | 5/8 | 1/2-13 | 2 | 4 | 10 |
| HLC-HX 3/4 x 2-1/2 | 3/4 | 5/8-11 | 2 | 1/2 | 10 |
| HLC-HX 3/4 x 4-1/4 | 3/4 | 5/8-11 | 2 | 1-3/4 | 10 |
| HLC-HX 3/4 x 6-1/4 | 3/4 | 5/8-11 | 2 | 3-3/4 | 10 |

## Acorn head (AC)



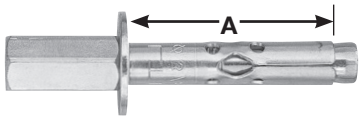

| Description | Nominal bit diameter | Bolt thread | Minimum embedment | Fastens materials up to | Qty / box |
|---|---|---|---|---|---|
| HLC-AC 1/4 x 1-3/8 | 1/4 | 3/16-24 | 1 | 3/8 | 100 |
| HLC-AC 1/4 x 2-1/4 | 1/4 | 3/16-24 | 1 | 1-1/4 | 100 |

## 304SS sleeve anchors



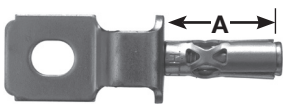

| Description | Nominal bit diameter | Bolt thread | Minimum embedment | Fastens materials up to | Qty / box |
|---|---|---|---|---|---|
| HLC-HX 304SS 1/4 x 2-1/4 | 1/4 | 3/16-24 | 1-1/8 | 1-1/8 | 100 |
| HLC-HX 304SS 5/16 x 1-1/2 | 5/16 | 1/4-20 | 1-1/4 | 1/4 | 100 |
| HLC-HX 304SS 5/16 x 2-1/2 | 5/16 | 1/4-20 | 1-1/4 | 1-1/4 | 100 |
| HLC-HX 304SS 3/8 x 1-7/8 | 3/8 | 5/16-18 | 1-1/2 | 3/8 | 50 |
| HLC-HX 304SS 3/8 x 3 | 3/8 | 5/16-18 | 1-1/2 | 1-1/2 | 50 |

## Rod coupling (RC)




| Description | Nominal bit diameter | Bolt thread | Minimum embedment | Fastens materials up to | Qty / box |
|---|---|---|---|---|---|
| HLC-RC 3/8 x 1-7/8 | 3/8 | 5/16-18 | 1-1/4 | 5/16 x 3/8 | 50 |
| HLC-RC 1/2 x 2-1/4 | 1/2 | 3/8-16 | 1-1/2 | 3/8 x 1/2 | 25 |

## Tie-wire head (T)




| Description | Nominal bit diameter | Bolt thread | Minimum embedment | Qty / box |
|---|---|---|---|---|
| HLC-T 1/4 x 1-3/8 | 1/4" | 3/16-24 | 1-3/8 | 50 |

1 All dimensions in inches

**Definition of nomenclature**

Outside diameter of sleeve, see tablesfor threaded bolt diameter

**HLC-AC 1/4 X 1-3/8**

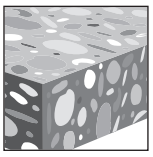
Nut configuration — The overall length from bottom of washer to end of sleeve

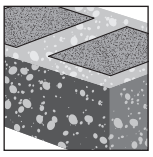
# 3.3.19 KWIK-CON+ CONCRETE AND MASONRY SCREW

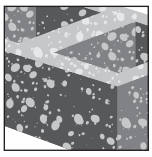
## PRODUCT DESCRIPTION

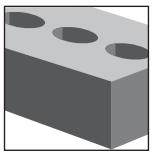
**KWIK-CON+ concrete and masonry screw anchors**

| Anchor System | | Features and Benefits |
|---|---|---|
|  | KWIK-CON+ fastener | • Zinc coating with proprietary finish that exceeds 1000 hours of protection from red rust per ASTM B117<br>• Salt spray testing per ASTM G85<br>• Coating is more durable than zinc plating alone<br>• Base material specific carbide tipped bits optimize performance in concrete or masonry<br>• Torx Hex washer head for fast secure installations into base material<br>• Torx or Phillips flat head for countersunk applications<br>• Load data available for installations in concrete, grout-filled and hollow concrete masonry units (CMU) and brick<br>• Available in AISI Type 410 Stainless Steel |
|  | KWIK-CON+ drive tool and installation accessories | |


Uncracked concrete


Grout-filled concrete masonry


Ungrouted concrete masonry


Brick

| Approvals/Listings | |
|---|---|
| **Metro-Dade County** | NOA 19-1113.04 |

## Table 1 — Material Properties

| Property | Carbon Steel | | Stainless Steel | |
|---|---|---|---|---|
| | Fastener Diameter (inches) | | Fastener Diameter (inches) | |
| | 3/16 | 1/4 | 3/16 | 1/4 |
| Minimum Tensile Strength (ksi) | 150 | | 130 | |
| Minimum Yield Strength (ksi) | 120 | | 105 | |
| Coating | Zinc with organic top coat | | N/A | |

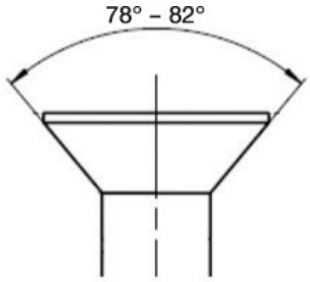



**Figure 1 — Flathead KWIK CON+ Head Angle**

## Table 2 — Physical Dimensions

| Characteristic | Nominal anchor diameter (inches) | | | | | |
|---|---|---|---|---|---|---|
| | 3/16 | | | 1/4 | | |
| Head Style | Tapered Flat Head | Tapered Flat Head | 5/16-in. Hex Washer | Tapered Flat Head | Tapered Flat Head | 5/16-in. Hex Washer |
| Internal recess | #3 Phillips | T-25 TORX | T-25 TORX | #3 Phillips | T-27 TORX | T-25 TORX |
| Maximum Head Diameter (inches) | 0.507 | 0.385 | 0.433 | 0.507 | 0.507 | 0.433 |
| Major Thread Diameter (inches) | 0.217 | | | 0.283 | | |
| Minor Diameter (inches) | 0.145 | | | 0.190 | | |
| Shank Diameter (inches) | 0.170 | | | 0.224 | | |

# INSTALLATION

## Table 3 — KWIK CON+ Installation Specifications

| Setting information | Symbol | Nominal anchor diameter (inches) | | | |
|---|---|---|---|---|---|
| | | 3/16 | | 1/4 | |
| Embedment (inches) | $h_{nom}$ | 1 | 1-3/4 | 1 | 1-3/4 |
| Nominal drill bit diameter (inches)[1] | $d_{bit}$ | 3/16 | | 1/4 | |
| Minimum fixture hole diameter (inches) | $d_h$ | 1/4 | | 5/16 | |
| Minimum hole depth (inches) | $h_o$ | 1-1/4 | 2 | 1-1/4 | 2 |
| Minimum member thickness (inches) | $h_{min}$ | 2-1/2 | 3-1/4 | 2-1/2 | 3-1/4 |
| Minimum anchor spacing (inches) | $s_{min}$ | 2-1/4 | | 2-1/2 | |
| Critical anchor spacing (inches) | $s_{cr}$ | 3 | 4 | 3 | 4 |
| Minimum edge distance (inches) | $c_{min}$ | 1-1/8 | | 1-1/2 | |
| Critical edge distance (inches) | $c_{cr}$ | 2-1/2 | 3-1/2 | 2-1/2 | 3-1/2 |

1 Requires matched tolerance drill bit from Hilti, TKC drill bits for concrete, TKB drill bits for other materials.

## Table 4 — Load adjustment factors for Hilti KWIK CON+ screw anchors in concrete

| Load adjustment factors for anchor spacing $f_A$ | | | | | | Load adjustment factors for edge distance $f_R$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tension/Shear loads | | | | | | Tension | | | | | | Shear | | | |
| Embedment (inches) | | 1 | 1-3/4 | 1 | 1-3/4 | Embedment (inches) | | 1 | 1-3/4 | 1 | 1-3/4 | 1 | 1-3/4 | 1 | 1-3/4 |
| Spacing (s) | | Anchor diameter | | | | Edge Distance | | Anchor Diameter | | | | Anchor Diameter | | | |
| in. | (mm) | 3/16 | | 1/4 | | in. | (mm) | 3/16 | | 1/4 | | 3/16 | | 1/4 | |
| 2-1/4 | (57) | 0.80 | 0.80 | | | 1-1/8 | (29) | 0.80 | 0.80 | | | 0.30 | 0.30 | | |
| 2-1/2 | (64) | 0.87 | 0.83 | 0.80 | 0.80 | 1-1/4 | (32) | 0.82 | 0.81 | | | 0.36 | 0.34 | | |
| 2-3/4 | (70) | 0.93 | 0.86 | 0.90 | 0.86 | 1-1/2 | (38) | 0.85 | 0.83 | 0.80 | 0.80 | 0.49 | 0.41 | 0.30 | 0.30 |
| 3 | (76) | 1.00 | 0.89 | 1.00 | 0.89 | 1-3/4 | (44) | 0.89 | 0.85 | 0.85 | 0.83 | 0.62 | 0.48 | 0.48 | 0.39 |
| 3-1/4 | (83) | | 0.91 | | 0.91 | 2 | (51) | 0.93 | 0.87 | 0.90 | 0.85 | 0.75 | 0.56 | 0.65 | 0.48 |
| 3-1/2 | (89) | | 0.94 | | 0.94 | 2-1/4 | (57) | 0.96 | 0.89 | 0.95 | 0.88 | 0.87 | 0.63 | 0.83 | 0.56 |
| 3-3/4 | (95) | | 0.97 | | 0.97 | 2-1/2 | (64) | 1.00 | 0.92 | 1.00 | 0.90 | 1.00 | 0.71 | 1.00 | 0.65 |
| 4 | (102) | | 1.00 | | 1.00 | 3 | (76) | | 0.96 | | 0.95 | | 0.85 | | 0.83 |
| | | | | | | 3-1/2 | (89) | | 1.00 | | 1.00 | | 1.00 | | 1.00 |

1 Reduction factors are multiplicative and linear interpolation between $s_{cr}$ and $s_{min}$, $c_{cr}$ and $c_{min}$ is permitted.

# DESIGN INFORMATION IN CONCRETE PER ALLOWALBLE STRESS DESIGN

### Table 5 — Tension and shear allowable loads in concrete [1, 2,3]

| Nominal anchor diameter (in.) | Nominal embedment in. (mm) | $f'_c$ = 2,000 psi | | $f'_c$ = 4,000 psi | | $f'_c$ = 6,000 psi | |
|---|---|---|---|---|---|---|---|
| | | Tension lb (kN) | Shear lb (kN) | Tension lb (kN) | Shear lb (kN) | Tension lb (kN) | Shear lb (kN) |
| 3/16 | 1 (25) | 100 (0.4) | 260 (1.2) | 125 (0.6) | 260 (1.2) | 185 (0.8) | 280 (1.3) |
| 3/16 | 1-3/4 (44) | 275 (1.2) | 260 (1.2) | 295 (1.3) | 265 (1.2) | 325 (1.5) | 300 (1.3) |
| 1/4 | 1 (25) | 190 (0.9) | 325 (1.4) | 240 (1.1) | 390 (1.7) | 275 (1.2) | 540 (2.4) |
| 1/4 | 1-3/4 (44) | 425 (1.9) | 560 (2.5) | 475 (2.1) | 600 (2.8) | 525 (2.3) | 600 (2.7) |

1 Screws installed in holes drilled with Hilti TKC carbide bits.
2 Allowable loads are based on a factor of safety of 4.
3 Apply spacing and edge distance reduction factors in Table 4 as needed.

### Table 6 — Tension and shear ultimate loads in concrete[1]

| Nominal anchor diameter (in.) | Nominal embedment in. (mm) | $f'_c$ = 2,000 psi | | $f'_c$ = 4,000 psi | | $f'_c$ = 6,000 psi | |
|---|---|---|---|---|---|---|---|
| | | Tension lb (kN) | Shear lb (kN) | Tension lb (kN) | Shear lb (kN) | Tension lb (kN) | Shear lb (kN) |
| 3/16 | 1 (25) | 400 (1.8) | 1,050 (4.7) | 500 (2.2) | 1,050 (4.7) | 750 (3.3) | 1,150 (5.1) |
| 3/16 | 1-3/4 (44) | 1,100 (4.9) | 1,050 (4.7) | 1,180 (5.3) | 1,070 (4.8) | 1,300 (5.8) | 1,200 (5.3) |
| 1/4 | 1 (25) | 760 (3.4) | 1,300 (5.8) | 970 (4.3) | 1,575 (7.0) | 1,100 (4.9) | 2,175 (9.7) |
| 1/4 | 1-3/4 (44) | 1,700 (7.6) | 2,250 (10.0) | 1,900 (8.5) | 2,400 (11.3) | 2,100 (9.34) | 2,400 (10.7) |

1 Screws installed in holes drilled with TKC bits.

### Table 7 — Tension and shear allowable loads in grout-filled and hollow concrete masonry units (CMU)[1,2,3,4,5]

| Nominal anchor diameter (in.) | Nominal embedment in. (mm) | Tension lb (kN) | Shear lb (kN) |
|---|---|---|---|
| 3/16 | 1 (25) | 150 (0.7) | 225 (1.0) |
| 3/16 | 1-3/4 (44) | 290 (1.3) | 300 (1.3) |
| 1/4 | 1 (25) | 165 (0.7) | 275 (1.2) |
| 1/4 | 1-3/4 (44) | 310 (1.4) | 400 (1.8) |

1 All values for anchors installed in grout-filled or hollow concrete masonry (CMU) with a minimum prism strength of 1,500 psi. CMU may be lightweight, medium-weight or normal-weight conforming to ASTM C90.
2 Screws installed in holes drilled with TKB bits.
3 Allowable loads calculated using a factor of safety of 4.
4 Installation in the mortar joints is outside the scope of the published data.
5 $C_{min}$, $S_{min}$ equals 4 inches

### Table 8 — Tension and shear allowable loads in brick[1,2,3,4,5]

| Nominal anchor diameter (in.) | Nominal embedment in. (mm) | Tension lb (kN) | Shear lb (kN) |
|---|---|---|---|
| 3/16 | 1 (25) | 125 (0.6) | 235 (1.0) |
| 3/16 | 1-3/4 (44) | 350 (1.6) | 300 (1.3) |
| 1/4 | 1 (25) | 205 (0.9) | 415 (1.8) |
| 1/4 | 1-3/4 (44) | 350 (1.6) | 500 (2.2) |

1 This test was performed on individual specimens of ASTM C62 common brick. Due to the wide variations encountered in the compressive strength of brick, these values should be considered guide values.
2 Allowable loads are based on a factor of safety of 4.
3 Installation in the mortar joints is outside the scope of the published data.
4 KWIK CON+ installed with TKB bits.
5 $C_{min}$, $S_{min}$ equals 4 inches

Load values are for anchors installed a minimum of sixteen diameters on center and a minimum edge distance of sixteen diameters. Anchor spacing may be reduced to twelve diameters provided loads are reduced by 20 percent. Edge distance may be reduced to six diameters provided loads are reduced by 20 percent in tension and 70 percent in shear.

### Combined shear and tension loading

$$\left(\frac{N_d}{N_{rec}}\right) + \left(\frac{V_d}{V_{rec}}\right) \leq 1.0$$



# INSTALLATION INSTRUCTIONS

Installation Instructions For Use (IFU) / Operating Instructions (OI) throughout the document are included with each product package. They can also be viewed or downloaded online at www.hilti.com. Because of the possibility of changes, always verify that downloaded IFU are current when used. Proper installation is critical to achieve full performance. Training is available on request. Contact Hilti Technical Services for applications and conditions not addressed in the (IFU)/Operating Instructions (OI).

# ORDERING INFORMATION[1]

## KWIK-CON+ fasteners



**5/16 - in. Magnetic nut setter or T-25 TORX bit**

| Description | Diameter | Total length | Thread length | Shank length |
|---|---|---|---|---|
| KWIK-CON+ 3/16 X 1-1/4 THH | 3/16 | 1-1/4 | 1-1/4 | 0 |
| KWIK-CON+ 3/16 X 1-3/4 THH | 3/16 | 1-3/4 | 1-3/4 | 0 |
| KWIK-CON+ 3/16 X 2-1/4 THH | 3/16 | 2-1/4 | 1-3/4 | 1/2 |
| KWIK-CON+ 3/16 X 2-3/4 THH | 3/16 | 2-3/4 | 1-3/4 | 1 |
| KWIK-CON+ 3/16 X 3-1/4 THH | 3/16 | 3-1/4 | 1-3/4 | 1-1/2 |



**5/16 - in. Magnetic nut setter or T-25 TORX bit**

| Description | Diameter | Total length | Thread length | Shank length |
|---|---|---|---|---|
| KWIK CON+ 1/4 X 1-1/4 THH | 1/4 | 1-1/4 | 1-1/4 | 0 |
| KWIK CON+ 1/4 X 1-3/4 THH | 1/4 | 1-3/4 | 1-3/4 | 0 |
| KWIK CON+ 1/4 X 2-1/4 THH | 1/4 | 2-1/4 | 1-3/4 | 1/2 |
| KWIK CON+ 1/4 X 2-3/4 THH | 1/4 | 2-3/4 | 1-3/4 | 1 |
| KWIK CON+ 1/4 X 3-1/4 THH | 1/4 | 3-1/4 | 1-3/4 | 1-1/2 |
| KWIK CON+ 1/4 X 3-3/4 THH | 1/4 | 3-3/4 | 1-3/4 | 2 |
| KWIK CON+ 1/4 X 4 THH | 1/4 | 4 | 1-3/4 | 2-1/4 |
| KWIK CON+ 1/4 X 1-1/4 THH SS | 1/4 | 1-1/4 | 1-1/4 | 0 |
| KWIK CON+ 1/4 X 2-1/4 THH SS | 1/4 | 2-1/4 | 1-3/4 | 1/2 |



**T-25 TORX bit**

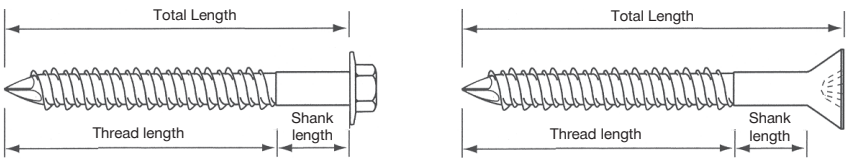
| Description | Diameter | Total length | Thread length | Shank length |
|---|---|---|---|---|
| KWIK-CON+ 3/16 X 1-1/4 TFH | 3/16 | 1-1/4 | 1-1/8 | 0 |
| KWIK-CON+ 3/16 X 1-3/4 TFH | 3/16 | 1-3/4 | 1-5/8 | 0 |
| KWIK CON+ 3/16 X 2-1/4 TFH | 3/16 | 2-1/4 | 1-3/4 | 1/2 |
| KWIK-CON+ 3/16 X 2-3/4 TFH | 3/16 | 2-3/4 | 1-3/4 | 7/8 |
| KWIK-CON+ 3/16 X 3-1/4 TFH | 3/16 | 3-1/4 | 1-3/4 | 1-3/8 |
| KWIK-CON+ 3/16 X 3-3/4 TFH | 3/16 | 3-3/4 | 1-3/4 | 1-7/8 |



**T-27 TORX bit**

| Description | Diameter | Total length | Thread length | Shank length |
|---|---|---|---|---|
| KWIK CON+ 1/4 X 1-1/4 TFH | 1/4 | 1-1/4 | 1-1/4 | 0 |
| KWIK CON+ 1/4 X 1-3/4 TFH | 1/4 | 1-3/4 | 1-3/4 | 0 |
| KWIK CON+ 1/4 X 2-1/4 TFH | 1/4 | 2-1/4 | 1-3/4 | 1/2 |
| KWIK CON+ 1/4 X 2-3/4 TFH | 1/4 | 2-3/4 | 1-3/4 | 1 |
| KWIK CON+ 1/4 X 3-1/4 TFH | 1/4 | 3-1/4 | 1-3/4 | 1-1/2 |
| KWIK CON+ 1/4 X 4 TFH | 1/4 | 4 | 1-3/4 | 2-1/4 |

1 All dimensions in inches





#3 Phillips bit

| Description | Diameter | Total length | Thread length | Shank length |
|---|---|---|---|---|
| KWIK CON+ 3/16 X 1-1/4 PFH | 3/16 | 1-1/4 | 1-1/4 | 0 |
| KWIK CON+ 3/16 X 2-1/4 PFH | 3/16 | 2-1/4 | 1-3/4 | 1/2 |
| KWIK CON+ 3/16 X 3-1/4 PFH | 3/16 | 2-3/4 | 1-3/4 | 1 |
| KWIK CON+ 3/16 X 2-3/4 PFH | 3/16 | 3-1/4 | 1-3/4 | 1-1/2 |
| KWIK CON+ 3/16 X 2-3/4 PFH SS | 3/16 | 1-1/4 | 1-1/4 | 0 |
| KWIK CON+ 3/16 X 1-1/4 PFH SS | 3/16 | 2-3/4 | 1-3/4 | 1 |



#3 Phillips bit

| Description | Diameter | Total length | Thread length | Shank length |
|---|---|---|---|---|
| KWIK CON+ 1/4 X 1-1/4 PFH | 1/4 | 1-1/4 | 1-1/4 | 0 |
| KWIK CON+ 1/4 X 2-1/4 PFH | 1/4 | 2-1/4 | 1-3/4 | 1/2 |
| KWIK CON+ 1/4 X 2-3/4 PFH | 1/4 | 2-3/4 | 1-3/4 | 1 |
| KWIK CON+ 1/4 X 3-1/4 PFH | 1/4 | 3-1/4 | 1-3/4 | 1-1/2 |
| KWIK CON+ 1/4 X 3-3/4 PFH | 1/4 | 3-3/4 | 1-3/4 | 2 |

## KWIK-CON+ hex driver system

| Description | Qty / pack |
|---|---|
| KWIK-CON Hex Driver Deluxe Kit | 1 |
| KWIK-CON Hex Driver | 1 |
| 5/16-in. Hex Driver for all THH | 1 |
| 5/16-in. Hex Nut Setter/Depth Locator | 1 |
| Insert Bit Holder/Depth Locator | 1 |
| #3 Phillips Driver for all PFH | 1 |
| T-25 TORX Driver for 3/16-in. TFH | 1 |

## KWIK-CON+ matched tolerance drill bits

| Description |
|---|
| **For 1/4-in. KWIK-CON+ Applications in normal-weight concrete** |
| TKC Large Concrete Bit SDS+ Hex |
| TKC Large Concrete Bit Smooth Shank |
| **For 1/4-in. KWIK-CON+ Applications in lightweight concrete, brick or CMU** |
| TKB Large CMU Bit SDS+ Hex |
| TKB Large CMU Bit Smooth Shank |
| **For 3/16-in. KWIK-CON+ Applications in normal-weight concrete** |
| TKC Small Concrete Bit SDS+ Hex |
| TKC Small Concrete Bit Smooth Shank |
| **For 3/16-in. KWIK-CON+ Applications in lightweight concrete, brick or CMU** |
| TKB Small CMU Bit SDS+ Hex |
| TKB Small Block Bit Smooth Shank |

# 4.0 REFERENCE

## 4.1 REFERENCE STANDARDS

### 4.1.1 ASTM STANDARDS FOR MATERIALS

| Standard | Title |
|---|---|
| A36 | Standard Specification for Structural Steel |
| A193 | Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| A307 | Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength |
| A370 | Standard Test Methods and Definitions for Mechanical Testing of Steel Products |
| A563 | Standard Specification for Carbon and Alloy Steel Nuts |
| A615 | Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| A653 | Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| B117 | Standard Practice for Operating Salt Spray (Fog) Apparatus |
| B695 | Specifications for Coatings of Zinc Mechanically Deposited on Iron and Steel |
| C31 | Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| C33 | Standard Specification for Concrete Aggregates |
| C34 | Standard Specification for Structural Clay Load-Bearing Wall Tile |
| C39 | Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| C42 | Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| C62 | Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale) |
| C90 | Standard Specification for Load-Bearing Concrete Masonry Units |
| C150 | Standard Specification for Portland Cement |
| C270 | Standard Specification for Mortar for Unit Masonry |
| C330 | Standard Specification for Lightweight Aggregates for Structural Concrete |
| C332 | Standard Specification for Lightweight Aggregates for Insulating Concrete |
| C652 | Standard Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale) |
| C881 | Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete |
| C882 | Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear |
| C942 | Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory |
| D638 | Standard Test Method for Tensile Properties of Plastics |
| D648 | Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position |
| D695 | Standard Test Method for Compressive Properties of Rigid Plastics |
| E8 | Standard Test Methods for Tension Testing of Metallic Materials |
| E119 | Standard Test Methods for Fire Tests of Building Construction and Materials |
| E488 | Standard Test Methods for Strength of Anchors in Concrete Elements |
| E1190 | Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members |
| E1512 | Standard Test Methods for Testing Bond Performance of Bonded Anchors |
| F436 | Standard Specification for Hardened Steel Washers |
| F593 | Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs |
| F594 | Standard Specification for Stainless Steel Nuts |
| F606 | Standard Test Methods for Determining the Mechanical Properties of Externally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets |
| F844 | Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use |
| F1554 | Standard Specification for Anchor Bolts, 36, 55, and 105-ksi Yield Strength |
| F1941-16 | Electrodeposited Coatings on Mechanical Fasteners |
| G85 | Standard Practice for Modified Salt Spray (Fog) Testing |

### 4.1.2 ASTM PLATING STANDARDS

| Standard | Title |
|---|---|
| A153 | Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| B633 | Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel |
| B695 | Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel |

## 4.1.3 FEDERAL SPECIFICATIONS

| Standard | Title |
|---|---|
| A-A-1922A | Shield, Expansion (Caulking Anchors, Single Lead) |
| A-A-1923A | Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors) |
| A-A-1924A | Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors) |
| A-A-55615 | Shield, Expansion (Wood Screw and Lag Bolt Self-Threading Anchors) |
| A-A-55614 | Shield, Expansion (Non-drilling Expansion Anchors) |

## 4.1.4 ANSI STANDARDS

| Standard | Title |
|---|---|
| B18.2.2 | Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series) |
| B18.22.1 | Plain Washers (Inch Series) |
| B212.15 | Carbide-Tipped Masonry Drills and Blanks for Carbide – Tipped Masonry Drills |
| Standard 61 | Drinking Water System Components – Health Effects |

# 4.2 TECHNICAL REFERENCES

## 4.2.1 METRIC CONVERSIONS AND EQUIVALENTS

The Metric Conversion Act of 1975, as amended by the Omnibus Trade and Competitiveness Act of 1988, establishes the SI or System International metric system as the preferred system of measurement in the United States.

Many products are currently manufactured and supplied in SI or hard metric sizes such as anchor bolts of 10 mm, 12 mm, 26 mm, etc. diameter. Where the inch-pound system is given or used, soft metric conversion can sometimes be used. This is not the case when selecting a drill bit for installing mechanical anchors, where it is critical to only use the specified Imperial or Metric diameter bit. The soft conversion diameters for anchor bolts is given by Table 1. Standard metric conversion factors commonly used for fastening products are given in Tables 2 and 3.

**Table 1— Diameters**

| in. | Hard metric conversion mm | Use for soft metric mm |
|---|---|---|
| 1/4 | 6.35 | 6 |
| 5/16 | 7.94 | 8 |
| 3/8 | 9.52 | 10 |
| 1/2 | 12.70 | 12 |
| 5/8 | 15.88 | 16 |
| 3/4 | 19.05 | 20 |
| 1 | 25.40 | 25 |
| 1-1/4 | 31.75 | 32 |

**Table 2 — Imperial units to SI units**

| To convert | Into | Multiply by |
|---|---|---|
| Length | | |
| inch (in.) | millimeter (mm) | 25.4000 |
| foot (ft) | meter (m) | 0.3048 |
| Area | | |
| square inch ($in^2$) | square millimeter ($mm^2$) | 645.1600 |
| square inch ($in^2$) | square centimeter ($cm^2$) | 6.4516 |
| square foot ($ft^2$) | square meter ($m^2$) | 0.0929 |
| Volume | | |
| cubic inch ($in^3$) | cubic centimeter ($cm^3$) | 16.3871 |
| cubic foot ($ft^3$) | cubic meter ($m^3$) | 0.0283 |
| gallon (US gal) | liter (L) | 3.7854 |
| Force | | |
| pound force (lbf) | newton (N) | 4.4482 |
| pound force (lbf) | kilonewton (kN) | 0.0044 |
| Pressure | | |
| pound/square inch (psi) | newton/square millimeter ($N/mm^2$) | 0.0069 |
| pound/square inch (psi) | mega pascal (MPa) | 0.0069 |
| Kip/square inch (ksi) | mega pascal (MPa) | 6.8946 |
| pounds/square foot (psf) | newton/square meter ($N/m^2$) | 47.8801 |
| Torque or Bending Moment | | |
| foot pound (ft-lb) | newton meter (N/m) | 1.3558 |
| inch pound (in-lb) | newton meter (N/m) | 0.1130 |
| Diaphragm Shear | | |
| pounds/foot (plf) | newton/meter (N/m) | 14.5939 |

**Table 3 — SI units to Imperial units**

| To convert | Into | Multiply by |
|---|---|---|
| Length | | |
| millimeter (mm) | inch (in.) | 0.0394 |
| meter (m) | foot (ft) | 3.2808 |
| Area | | |
| square millimeter ($mm^2$) | square inch ($in^2$) | 0.0016 |
| square centimeter ($cm^2$) | square inch ($in^2$) | 0.1550 |
| square meter ($m^2$) | square foot ($ft^2$) | 10.7639 |
| Volume | | |
| cubic centimeter ($cm^3$) | cubic inch ($in^3$) | 0.0610 |
| cubic meter ($m^3$) | cubic foot ($ft^3$) | 35.3147 |
| liter (L) | gallon (US gal) | 0.2642 |
| Force | | |
| newton (N) | pound force (lbf) | 0.2248 |
| kilonewton (kN) | pound force (lbf) | 224.8089 |
| Pressure | | |
| newton/square millimeter ($N/mm^2$) | pound/square inch (psi) | 145.0400 |
| mega pascal (MPa) | pound/square inch (psi) | 145.0400 |
| mega pascal (MPa) | Kip/square inch (ksi) | 0.1450 |
| newton/square meter ($N/m^2$) | pounds/square foot (psf) | 0.0209 |
| Torque or Bending Moment | | |
| newton meter (N/m) | foot pound (ft-lb) | 0.7376 |
| newton meter (N/m) | inch pound (in-lb) | 8.8496 |
| Diaphragm Shear | | |
| newton/meter (N/m) | pounds/lineal foot (plf) | 0.0685 |

# 4.2.2 MECHANICAL PROPERTIES OF MATERIALS

**Table 4 — Mechanical properties of carbon steel**

| Grade designation | Nominal size in. | Min. yield strength ksi | (MPa) | Min. ultimate strength ksi | (MPa) |
|---|---|---|---|---|---|
| ASTM A36 | All | 36 | (248) | 58 | (400) |
| ASTM A193, B7 | 1/4 thru 2-1/2 | 105 | (724) | 125 | (862) |
| AISI 1038 (As Rec'd) | 1/4 thru 1-1/4 | 41 | (282) | 75 | (517) |
| AISI 11L41 | over 5/8 thru 1 | 75 | (517) | 90 | (620) |
| AISI 1110 M (As Rec'd) | 1/4 thru 5/8 | 44 | (303) | 53 | (365) |
| AISI 12L14 | 5/8 thru 1-1/2 | 60 | (414) | 78 | (538) |
| AISI 1010 (As Rec'd) | 1/4 thru 3/4 | 44 | (303) | 53 | (365) |
| ASTM A307 | 1/4 thru 4 | – | – | 60 | (414) |
| ASTM A325 | 1/2 thru 1 | 92 | (634) | 120 | (827) |
| | over 1 thru 1-1/2 | 81 | (558) | 105 | (724) |
| ASTM A449 | 1/4 thru 1 | 92 | (634) | 120 | (827) |
| | over 1 thru 1-1/2 | 81 | (558) | 105 | (724) |
| ASTM A510 | 3/8 thru 3/4 | 70 | (480) | 87 | (600) |
| SAE Grade 2 | 1/4 thru 3/4 | 57 | (393) | 74 | (510) |
| | over 3/4 thru 1-1/2 | 36 | (248) | 60 | (414) |
| SAE Grade 5 | 1/4 thru 1 | 92 | (634) | 120 | (827) |
| | over 1 thru 1-1/2 | 81 | (558) | 105 | (724) |
| SAE Grade 8 | 1/4 thru 1-1/2 | 130 | (896) | 150 | (1034) |
| ISO 898-1 Class 5.8 | All | 58 | (400) | 72.5 | (500) |
| ISO 898-1 Class 8.8 | All | 92.8 | (640) | 116 | (800) |

**Table 5 — Mechanical properties of stainless steel**

| Grade ASTM/AISI | Nominal size in. | Yield strength ksi | (MPa) | Ultimate strength ksi | (MPa) |
|---|---|---|---|---|---|
| F593 / 304 / 316 | 1/4 thru 5/8 | 65 | (448) | 100 | (689) |
| | 3/4 thru 1-1/2 | 45 | (310) | 85 | (586) |
| A193, B8 / 304 / 316 | 1/4 thru 1-1/2 | 30 | (205) | 75 | (515) |
| A276 / 304 | 1/4 thru 9/16 | 76 | (524) | 90 | (620) |
| | Larger than 9/16 | 64 | (441) | 75 | (524) |
| A276 / 316 | 1/4 thru 9/16 | 76 | (524) | 90 | (620) |
| | Larger than 9/16 | 64 | (441) | 75 | (524) |
| A493 / 304 | All | 60 | (414) | 90 | (627) |
| A582 / 303 | All | 60 | (414) | 100 | (689) |
| DIN 267 Part 11, A4-70 | All | 65.3 | (450) | 101.5 | (700) |

# 4.2.3 BOLT THREAD DATA

**Table 6 — Basic dimensions for UNC Coarse Thread Series—ANSI B1.1-1982**

| Nominal size | Basic diameter | | Threads per Inch (n) | Area | | |
|---|---|---|---|---|---|---|
| | Major in. (D) | Minor in. | | Nominal $in^2$ | Minor[1] $in^2$ | Tensile stress[2] $in^2$ |
| No. 10 | 0.1900 | 0.1449 | 24 | 0.0284 | 0.0145 | 0.0175 |
| No. 12 | 0.2160 | 0.1709 | 24 | 0.0366 | 0.0206 | 0.0242 |
| 1/4 | 0.2500 | 0.1959 | 20 | 0.0491 | 0.0269 | 0.0318 |
| 5/16 | 0.3125 | 0.2524 | 18 | 0.0767 | 0.0454 | 0.0524 |
| 3/8 | 0.3750 | 0.3073 | 16 | 0.1104 | 0.0678 | 0.0775 |
| 7/16 | 0.4375 | 0.3602 | 14 | 0.1503 | 0.0933 | 0.1063 |
| 1/2 | 0.5000 | 0.4167 | 13 | 0.1963 | 0.1257 | 0.1419 |
| 9/16 | 0.5625 | 0.4723 | 12 | 0.2485 | 0.1620 | 0.1819 |
| 5/8 | 0.6250 | 0.5266 | 11 | 0.3068 | 0.2017 | 0.2260 |
| 3/4 | 0.7500 | 0.6417 | 10 | 0.4418 | 0.3019 | 0.3345 |
| 7/8 | 0.8750 | 0.7547 | 9 | 0.6013 | 0.4192 | 0.4617 |
| 1 | 1.0000 | 0.8647 | 8 | 0.7854 | 0.5509 | 0.6057 |
| 1-1/8 | 1.1250 | 0.9704 | 7 | 0.9940 | 0.6929 | 0.7633 |
| 1-1/4 | 1.2500 | 1.0954 | 7 | 1.2272 | 0.8896 | 0.9691 |

1 Minor area = $0.7854 (D - 1.3/n)^2$
2 Tensile stress area = $0.7854 (D - 0.9743/n)^2$

**Figure 1 - Basic profile for screw threads**

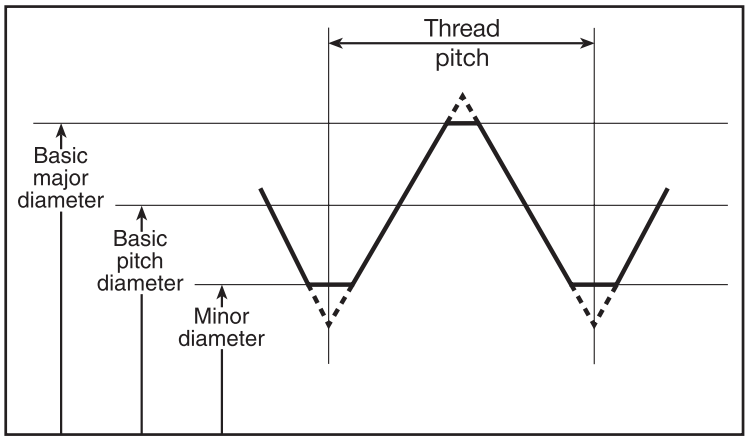



**Table 7 — Basic dimensions for M profile metric thread series – ANSI B1.13M-1979**

| Nominal size | Basic diameter | | Thread pitch mm (P) | Area | |
|---|---|---|---|---|---|
| | Major mm (D) | Minor mm | | Nominal $mm^2$ | Tensile stress[1] $mm^2$ |
| M8 | 8 | 6.62 | 1.25 | 50.3 | 36.6 |
| M10 | 10 | 8.34 | 1.50 | 78.5 | 58.0 |
| M12 | 12 | 10.07 | 1.75 | 113.1 | 84.3 |
| M16 | 16 | 13.80 | 2.00 | 201.1 | 157.0 |
| M20 | 20 | 17.25 | 2.50 | 314.2 | 245.0 |
| M24 | 24 | 20.70 | 3.00 | 452.4 | 353.0 |

1 Tensile stress area = $0.7854 (D - 0.9382 P)^2$

# 4.2.4 CONCRETE REINFORCING BAR DATA

**Table 8 — ASTM basic dimensions for deformed steel bars for concrete reinforcement, Imperial units**

| Bar designation No.[1] | Nominal weight lb/ft | Nominal dimensions[2] | | |
|---|---|---|---|---|
| | | Diameter in. | Area $in^2$ | Perimeter in. |
| 3 | 0.376 | 0.375 | 0.11 | 1.178 |
| 4 | 0.668 | 0.500 | 0.20 | 1.571 |
| 5 | 1.043 | 0.625 | 0.31 | 1.963 |
| 6 | 1.502 | 0.750 | 0.44 | 2.356 |
| 7 | 2.044 | 0.875 | 0.60 | 2.749 |
| 8 | 2.670 | 1.000 | 0.79 | 3.142 |
| 9 | 3.400 | 1.128 | 1.00 | 3.544 |
| 10 | 4.303 | 1.270 | 1.27 | 3.990 |
| 11 | 5.313 | 1.410 | 1.56 | 4.430 |
| 14 | 7.65 | 1.693 | 2.25 | 5.32 |
| 18 | 13.60 | 2.257 | 4.00 | 7.09 |

1 Bar designation numbers are based on the number of eighths of an inch included in the nominal diameter.
2 The nominal dimensions of a deformed bar are approximate, being shown as equivalent to those of a plain round bar having the same weight per foot as the deformed bar.

**Table 9 — ASTM basic dimensions for deformed steel bars for concrete reinforcement, SI units**

| Bar designation No.[1] | Nominal mass kg/m | Nominal dimensions[2] | | |
|---|---|---|---|---|
| | | Diameter mm | Area $mm^2$ | Perimeter mm |
| 10 | 0.560 | 9.5 | 71 | 29.9 |
| 13 | 0.994 | 12.7 | 129 | 39.9 |
| 16 | 1.552 | 15.9 | 199 | 49.9 |
| 19 | 2.235 | 19.1 | 284 | 59.8 |
| 22 | 3.042 | 22.2 | 387 | 69.8 |
| 25 | 3.973 | 25.4 | 510 | 79.8 |
| 29 | 5.060 | 28.7 | 645 | 90.0 |
| 32 | 6.404 | 32.3 | 819 | 101.3 |
| 36 | 7.907 | 35.8 | 1006 | 112.5 |
| 43 | 11.38 | 43.0 | 1452 | 135.1 |
| 57 | 20.24 | 57.3 | 2581 | 180.0 |

1 Bar designation numbers approximate the number of millimeters of the nominal diameter of the bar.
2 The nominal dimensions of a deformed bar are approximate, being shown as equivalent to those of a plain round bar having the same mass per meter as the deformed bar.

**Table 10 — CSA G30.12 & G30.16 basic dimensions for deformed steel bars for concrete reinforcement, SI units (Canada only)**

| Bar number[1] | Nominal mass kg/m | Nominal dimensions[2] | | |
|---|---|---|---|---|
| | | Diameter mm | Area $mm^2$ | Perimeter mm |
| 10M | 0.785 | 11.3 | 100 | 36 |
| 15M | 1.570 | 16.00 | 200 | 50 |
| 20M | 2.355 | 19.5 | 300 | 61 |
| 25M | 3.925 | 25.2 | 500 | 79 |
| 30M | 5.495 | 29.9 | 700 | 94 |
| 35M | 7.850 | 35.7 | 1000 | 112 |
| 45M | 11.775 | 43.7 | 1500 | 137 |
| 55M | 19.625 | 56.4 | 2500 | 177 |

1 Bar numbers are based on the rounded off nominal diameter of the bars.
2 Nominal dimensions are equivalent to those of a plain round bar having the same mass per meter as the deformed bar.

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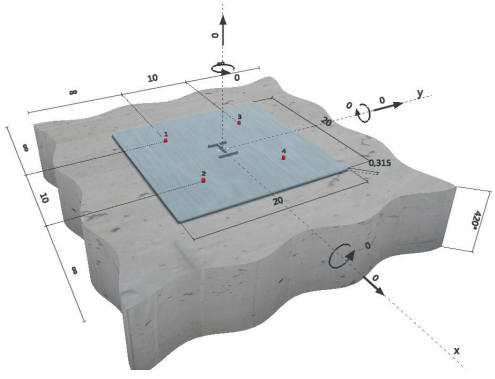
**Table 1 — HIT-HY 200 V3 Design Strength (Factored Resistance) for HIT-Z(-R) Rods in Uncracked Concrete[1,2,3,4,5,6,7,8]**

| Anchor Diameter in. (mm) | Effective Embed. Depth in. (mm) | Tension – $\Phi N_n$ or $N_r$ | | | | Shear – $\Phi V_n$ or $V_r$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 2,500 psi (17.2 MPa) lb (kN) | $f'_c$ = 3,000 psi (20.7 MPa) lb (kN) | $f'_c$ = 4,000 psi (27.6 MPa) lb (kN) | $f'_c$ = 6,000 psi (41.4 MPa) lb (kN) | $f'_c$ = 8,000 psi (55.2 MPa) lb (kN) |
| 3/8 (9.5) | 2-3/8 (60) | 2,855 (12.7) | 3,125 (13.9) | 3,610 (16.1) | 4,425 (19.7) | 3,075 (13.7) | 3,370 (15.0) | 3,890 (17.3) | 4,765 (21.2) | 5,500 (24.5) |
| | 4-1/2 (114) | 5,560 (24.7) | 5,560 (24.7) | 5,560 (24.7) | 5,560 (24.7) | 16,035 (71.3) | 17,570 (78.2) | 20,285 (90.2) | 24,845 (110.5) | 26,690 (127.6) |
| 1/2 (12.7) | 2-3/4 (70) | 3,555 (15.8) | 3,895 (17.3) | 4,500 (20.0) | 5,510 (24.5) | 7,660 (34.1) | 8,395 (37.3) | 9,690 (43.1) | 11,870 (52.8) | 13,705 (61.0) |
| | 6 (152) | 7,935 (35.3) | 7,935 (35.3) | 7,935 (35.3) | 7,935 (35.3) | 24,690 (109.8) | 27,045 (120.3) | 31,230 (138.9) | 38,250 (170.1) | 44,170 (196.5) |
| 5/8 (15.9) | 3-3/4 (95) | 5,665 (25.2) | 6,205 (27.6) | 7,165 (31.9) | 8,775 (39.0) | 12,200 (54.3) | 13,365 (59.5) | 15,430 (68.6) | 18,900 (84.1) | 21,825 (97.1) |
| | 7-1/2 (191) | 14,950 (66.5) | 14,950 (66.5) | 14,950 (66.5) | 14,950 (66.5) | 34,505 (153.5) | 37,800 (168.1) | 43,650 (194.2) | 53,455 (237.8) | 61,725 (274.6) |

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