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HILTI

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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 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 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 5.3.1 Metric Conversions and Equivalents, provided in this product technical guide.

1.3 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.

1.4 Our Quality System

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.

Fastening Technology 2.0

2.1 Base Materials

2.1.1 Base Materials for Fastening

The design of modern buildings requires fastenings to be made in a variety of base materials. To meet this challenge, fastener manufacturers have developed many products specifically targeting certain types of base materials. The properties of the base material play a decisive role in the suitability and performance of a fastener. The designer must carefully match the type of fastener with the base material to obtain the desired results. There is hardly a base material in which a fastening cannot be made with a Hilti product.

2.1.2 Concrete

Concrete is a mineral building material which is made from three basic ingredients; cement, aggregate and water. 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 cast in concrete to carry the tensile forces, and this combination is referred to as reinforced concrete.

Cement is the binding agent which combines with water and aggregate and hardens through the process of hydration to form concrete. Portland cement is the most common cement and is available in several different types, as outlined in ASTM C 150, to meet specific design requirements.

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 create concrete with specific characteristics. Normal weight concrete is generally made from crushed stone or gravel. 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. Lightweight aggregates are made from expanded clay, shale, slate or blast-furnace slag. Lightweight insulating concrete is used when thermal insulating properties are a prime consideration. Lightweight insulating aggregates are manufactured from perlite, vermiculite, blast-furnace slag, clay or shale. Sand lightweight concrete is made from lightweight aggregate and natural sand. All concrete with a unit weight between 85 and 115 pcf is considered to be structural lightweight concrete. The ASTM specification and unit weight for each of these concretes is summarized as follows:

ASTM Concrete Type	Aggregate Grading Specification	Concrete Unit Weight pcf
Normal Weight	ASTM C 33	145-155
Sand Lightweight	ASTM C 330	105-115
All Lightweight	ASTM C 330	85-110
Lightweight	ASTM C 332	15-90
Insulating Concrete		

The type and mechanical properties of concrete aggregate have a major influence on the behavior of drill bits used to drill anchor holes. The harder aggregates 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, although in general harder/denser aggregates such as granite tend to result in higher concrete cone breakout loads, whereas lightweight aggregates produce lower tension and shear capacities.

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 which has cured for less than 28 days is referred to as green concrete. Aggregate type, cement replacements such as fly ash, and admixtures could have an effect on the capacity of some fasteners, and this may not be reflected in the concrete strength as measured in a uniaxial compression test. Generally, Hilti data reflects testing with common aggregates and cement types in plain, unreinforced concrete. In questionable cases, consult with Hilti Technical Support.

In view of the significantly lower strength of green concrete (less than 28-day cure), it is recommended that anchors and power-actuated fastenings not be made in cast-in-place concrete which has 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. Power-actuated fastening capacity should be based on the concrete strength at the time of installation.

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 Base Materials

2.1.3 Masonry Materials

Masonry is a heterogeneous building material consisting of brick, block or clay tile bonded together using joint mortar. The primary application for masonry is the construction of walls which are made by placing masonry components in horizontal rows (course) and vertical rows (wythe). Masonry components are 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 generally 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, holes should be drilled using rotation only (i.e. hammering action of the drill turned off).

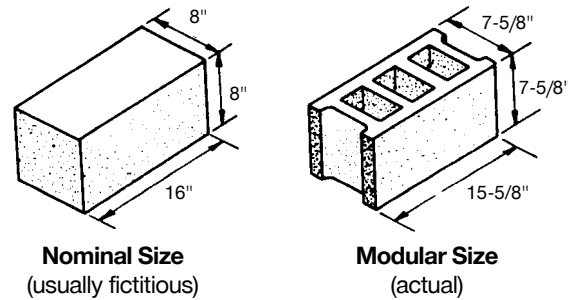
2.1.3.1 Concrete Block

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

Nominal Width of Unit in. (mm)	Minimum face-shell Thickness ^A in. (mm)	Minimum web Thickness ^A in. (mm)
3 (76) and 4 (102)	3/4 (19)	3/4 (19)
6 (152)	1 (25)	1 (25)
8 (203)	1-1/4 (32)	1 (25)
10 (254)	1-3/8 (35)	1-1/8 (29)
	1-1/4 (32) ^B	
≥12 (305)	1-1/2 (38)	1-1/8 (29)
	1-1/4 (32) ^B	

Adapted from ASTM C 90.

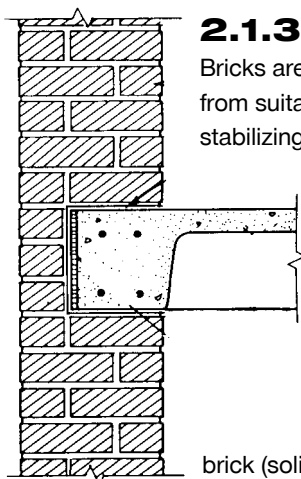
- A Average of measurements on three units taken at the thinnest point.
- B This face-shell thickness is applicable where the allowable design load is reduced in proportion to the reduction in thickness from the basic face-shell thickness shown.



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.

Concrete block construction can be reinforced, whereby reinforcing bars are placed vertically in the cells and those cells are 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 reinforcing may be placed in the 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 compressive strength of at least 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. In general, 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 be installed in conjunction with a screen tube to prevent uncontrolled flow of the bonding material. In hollow CMU, anchor strength is generally assumed to be derived from the face shell thickness, which can be variable.

Base Materials 2.1



**12" Brick
Bearing Walls**

2.1.3.2 Brick

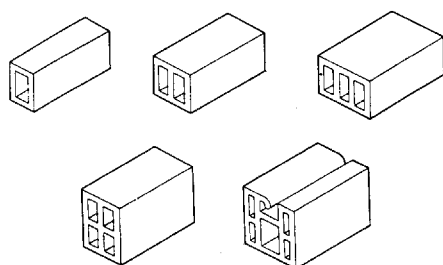
Bricks are prismatic masonry units made from suitable mixture of soil, clay and a stabilizing agent (emulsified asphalt). They are shaped by molding, pressing or extruding and are fired at elevated temperature to meet the strength and durability requirements of ASTM C62 for solid brick and C652 for hollow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

Depending upon the grade, brick (solid clay masonry) can have a compressive strength ranging from 1,250 to over 25,000 psi. Grouted multiwythe masonry construction typically consists of

two wythes, each one unit masonry in thickness, separated by a space 2" to 4-1/2" in width, which is 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.

2.1.3.3 Clay Tile

Structural clay load-bearing wall tile is made from clay or shale and heat treated (fired) at an elevated temperature to develop the strength and durability required by ASTM C34. These units are manufactured in a variety of shapes and sizes with one or more cavities and develop a compressive strength of 500 to 1000 psi depending upon the grade and type. These units typically have a 3/4" face shell thickness and 1/2" interior web thickness.



Clay tile as a base material is somewhat more difficult to fasten into because of its thin face shell and low compressive strength. Adhesive anchors such as the Hilti HIT-HY 20 with a wire screen are usually recommended because they spread the load over a larger area and do not produce expansion forces.

2.1.3.4 Mortar

Mortar is the product which is used in the construction of reinforced and non-reinforced masonry structures. The role of mortar when hardened in the finished structure is to transfer the compressive, tensile and shear stresses between the masonry units. Mortar consists of a mixture of cementitious material, aggregate and water combined in accordance with ASTM C270. Either a cement/lime mortar or a masonry mortar, each in four types, can be used under this specification.

Mortar	Type	Average Compressive Strength at 28 Days, Min 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. 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 the guide.

2.1.3.5 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). Grout is supplied in a pourable consistency where mortar is not. Grout fills voids while mortar bonds elements together.

Grout is used to fill space 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, in regards 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 to the jobsite conditions.

2.1 Base Materials

2.1.4 Autoclaved Aerated Concrete

Precast autoclaved aerated concrete (AAC) is a lightweight, precast building material of a uniform porous structure. Adding aluminum powder to a cement, lime, fine sand and water mixture causes it to expand dramatically. After mixing, the slurry is poured into a mold and allowed to "rise". The product is removed from its mold after a few hours and fed through a cutting machine, which sections the AAC into predetermined sizes. These AAC products are then placed into an autoclave and steam cured for 10 to 12 hours. Autoclaving initiates a second chemical reaction that transforms the material into a hard calcium silicate. AAC was developed in Europe and is currently being manufactured in the United States by licensed facilities.

Strength Class	Average Compressive Strength, psi (N/mm ²)	Average Comp. Str. Density lb/ft ³ (g/cm ³)
AAC - 2	360 (2.5)	32 (0.5)
AAC - 4	725 (5.0)	38 (0.6)
AAC - 6	1090 (7.5)	44 (0.7)

Due to the low compressive strength of AAC, anchors that spread the load over the entire embedded section are preferred (e.g., HUD, HRD, adhesives).

2.1.5 Pre-tensioned / Pre-stressed Concrete

Pre-tensioned concrete refers to a concrete member containing steel tendons that are pre-tensioned prior to placing the concrete.

Pre-tensioned concrete poses a unique problem when post-installed anchors and power-actuated fasteners are used. Drilling into the concrete is typically not recommended unless a precise knowledge of the location of the tendons is known. Since locating the tendons can be tedious and expensive other alternatives for post-installed anchors are needed. Typically, the clear cover over the tendons is known and can be used to provide connection points. Post-installed anchors and power-actuated fasteners with embedments on the magnitude of 3/4" to 1" are typically ideal and do not interfere with the tendons or strands.

2.1.6 Bonded Post-tensioned Concrete

Post-tensioned concrete refers to a concrete member containing steel tendons that are tensioned after placing the concrete. The same considerations for avoiding post-tensioning strands should be considered when using post-installed anchors and power-actuated fasteners.

2.1.7 Admixtures

Chemical admixtures are the ingredients in concrete other

than Portland cement, water and aggregate that are added to the mix 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, and improve the economy of the mixture.

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". Using the Strength Design method for anchorage into concrete, nominal strengths are calculated for possible anchor failure modes. Strength reduction factors are applied to each nominal strength to give a Design Strength. The controlling Design Strength is compared to a factored load. The provisions of ACI 318, Appendix D are used for Strength Design.

Strength Design data for Hilti mechanical anchors is derived from testing per the provisions of ACI 355.2 and ICC-ES AC193. Strength Design data for Hilti adhesive anchors is derived from testing per the provisions of 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 for post-installed anchors that have not been tested for use with Strength Design provisions. Sections 2.2.2 and 2.2.3 provide detailed explanations of the Allowable Stress Design provisions used by Hilti. Allowable Stress Design data for Hilti mechanical anchors is derived from testing per the provisions of ASTM E-488 and ICC-ES AC01. Allowable Stress Design data for Hilti adhesive anchors is derived from testing per the provisions of ASTM E-1512 and ICC-ES AC58.

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.

Evaluation of Test Data 2.2

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. This approach is characterized by Eq. 2.2.1.

$$\text{Eq. 2.2.1} \quad F_{\text{all}} = \frac{\bar{F}}{v}$$

Where:

\bar{F} = mean of test data (population sample)
 v = 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 variation in anchor performance from laboratory tests.

Note that global safety factors applied to the mean do not explicitly account for anchor 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.

One such technique is to adjust the mean such that the resulting resistance represents a so-called 5% fractile, or characteristic value. As commonly applied, the characteristic load, R_k , for a given test series is derived from the mean, \bar{F} , the standard deviation, s , and the sample size, n , such that, for a 90% probability (90% confidence) 95% of the loads are above the characteristic load. The characteristic load is calculated according to Eq. 2.2.2 whereby k is usually provided by a one-sided population limit for a standard distribution for sample size n .

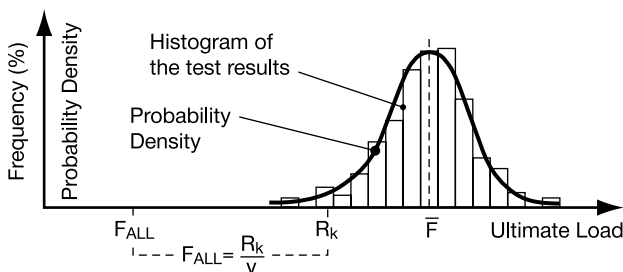


Fig. 2.2.1

Frequency distribution of fastener loads, demonstrating the significance of the 5% fractile and the allowable load

As applied to the characteristic resistance, the global safety factor, v , is not required to account for the variability of the system. This allows for a tighter definition of the components to be covered by the safety factor, such as concrete variability and the variability of lab test data with respect to field performance. (Taken together with an ultimate strength design method, whereby loading variability is accommodated via load factors, the partial safety factors associated with these effects can be converted into a strength reduction factor, ϕ , thus allowing for greater consistency in the safety factor). Fastening systems exhibiting tightly grouped test data are rewarded with a low standard deviation, s .

$$\text{Eq. 2.2.2} \quad F_{\text{all}} = \frac{R_k}{v} = \frac{\bar{F} - k \cdot s}{v} = \frac{\bar{F} (1 - k \cdot cv)}{v}$$

Where:

R_k = characteristic resistance of the tested anchor system
 \bar{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 = $\frac{s}{\bar{F}}$
 v = safety factor

Many of the allowable loads in this Technical Guide are based on the characteristic resistance. Unless stated otherwise, the following safety factors are applied to the characteristic resistance:

v = 3 for concrete and bond failure modes
 v = 5 for shallow anchors (due to the greater variability associated with cover concrete) and plastic anchors

These safety factors are intended to cover the following conditions, within reasonably expected variations:

1. variability of anchor performance in the field with respect to laboratory performance
2. variability of actual loading with respect to calculated loads
3. typical variability of base material (e.g., concrete) condition with respect to specified or laboratory conditions
4. reasonable installation deviations

Note that installation error, e.g., installation not in accordance with Hilti's installation instructions, is not covered by the safety factor. **It is the responsibility of the user or design engineer to examine all factors that could influence an anchorage and to adjust the design resistance accordingly.**

2.3 Corrosion

2.3.1 The Corrosion Process

Corrosion is defined as the chemical or electrochemical reaction between a material, usually a metal, and its environment that produces a deterioration of the material and its properties (ASTM G 15). The corrosion process can be very complex and have many contributing factors that lead to immediate or delayed destructive results. In anchorage and fastener design, the most common types of corrosion are direct chemical attack and electro-chemical contact.

2.3.2 Types of Corrosion

2.3.2.1 Direct Chemical Attack

Corrosion by direct chemical attack occurs when the base material is soluble in the corroding medium. One method of mitigating these effects is to select a fastener that is not susceptible to attack by the corroding chemical. Compatibility tables of various chemical compounds with Hilti adhesive and epoxy fastening systems are provided in this Product Technical Guide.

When selection of a base metal compatible with the corroding medium is not possible or economical, another solution is to provide a coating that is resistant to the corroding medium. These might include metallic coatings such as zinc or organic coatings such as epoxies or fluorocarbons.

2.3.2.2 Electrochemical Contact Corrosion

All metals have an electrical potential relative to each other and have been ranked accordingly to form the “electromotive force series” or galvanic series of metals. When metals of different potential come into contact in the presence of an electrolyte (moisture), the more active metal with more negative potential becomes the anode and corrodes, while the other metal becomes the cathode and is galvanically protected.

The severity and rate of attack will be influenced by:

- Relative position of the contacting metals in the galvanic series,
- Relative surface areas of the contacting materials and,
- Conductivity of the electrolyte.

The effects of electro-chemical contact corrosion may be mitigated by:

- Using similar metals close together in the electromotive force series,
- Separating dissimilar metals with gaskets, plastic washers or paint with low electrical conductivity. Materials typically used in these applications include:
 - High Density Polyethylene (HDPE)
 - Polytetrafluoroethylene (PTFE)
 - Polycarbonates
 - Neoprene/chloroprene
 - Cold galvanizing compound
 - Bituminous coatings or paint

Note: Specifiers must ensure that these materials are compatible with other anchorage components in the service environment.

- Selecting materials so that the fastener is the cathode, most noble or protected component,
- Providing drainage or weep holes to prevent entrapment of the electrolyte

Galvanic Series of Metals and Alloys

Corroded End (anodic, or least noble)

Magnesium
Magnesium alloys
Zinc

Aluminum 1100
Cadmium
Aluminum 2024-T4
Steel or Iron
Cast Iron
Chromium-iron (active)
Ni-Resist cast iron

Type 304 Stainless (active)
Type 316 Stainless (active)

Lead tin solders
Lead
Tin

Nickel (active)
Inconel nickel-chromium alloy (active)
Hastelloy Alloy C (active)

Brasses
Copper
Bronzes
Copper-nickel alloys
Monel nickel-copper alloy

Silver solder
Nickel (passive)
Inconel nickel-chromium alloy (passive)

Chromium-iron (passive)
Type 304 Stainless (passive)
Type 316 Stainless (passive)
Hastelloy Alloy C (passive)

Silver
Titanium
Graphite
Gold
Platinum

Protected End
(cathodic, or most noble)

Source: IFI Fastener Standards, 6th Edition

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2.3.2.3 Hydrogen Assisted Stress Corrosion Cracking

Often incorrectly referred to as hydrogen embrittlement, hydrogen assisted stress corrosion cracking (HASCC) is an environmentally induced failure mechanism that is sometimes delayed and most times occurs without warning. HASCC occurs when a hardened steel fastener is stressed (loaded) in a service environment which chemically generates hydrogen (such as when zinc and iron combine in the presence of moisture). The potential for HASCC is directly related to steel hardness. The higher the fastener hardness, the greater the susceptibility to stress corrosion cracking failures. Eliminating or reducing any one of these contributing factors (high steel hardness, corrosion or stress) reduces the overall potential for this type of fastener failure. Hydrogen embrittlement, on the other hand, refers to a potential damaging side effect of the steel fastener manufacturing process, and is unrelated to project site corrosion. Hydrogen embrittlement is neutralized by proper processing during fastener pickling, cleaning and plating operations, specifically by “baking” the fasteners after the application of the galvanic coating.

2.3.3 Corrosion Protection

The most common material used for corrosion protection of carbon steel fasteners is zinc. Zinc coatings can be uniformly applied by a variety of methods to achieve a wide range of coating thickness depending on the application. All things being equal, thicker coatings typically provide higher levels of protection.

An estimating table for the mean corrosion rate and service life of zinc coatings in various atmospheres is provided to the right. These values are for reference only, due to the large variances in the research findings and specific project site conditions, but they can provide the specifier with a better understanding of the expected service life of zinc coatings. In controlled environments where the relative humidity is low and no corrosive elements are present, the rate of corrosion of zinc coatings is approximately 0.15 microns per year.

Zinc coatings can be applied to anchors and fasteners by different methods. These include (in order of increasing coating thickness and corrosion protection):

- ASTM B 633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- ASTM B 695 – Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
- ASTM A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- Sherardizing Process – Proprietary Diffusion Controlled Zinc Coating Process

Atmosphere	Mean Corrosion Rate
Industrial	5.6 µm/year
Urban Non-Industrial or Marine	1.5 µm/year
Suburban	1.3 µm/year
Rural	0.8 µm/year
Indoors	Considerably less than 0.5 µm/year

Source: ASTM B 633 Appendix X1. Service Life of Zinc

2.3.3.1 Suggested Corrosion Resistance

Use of AISI 316 stainless steel in environments where pitting or stress corrosion is likely should be avoided due to the possibility of sudden failure without visual warning. Fastenings in these applications should be regularly inspected for serviceability condition. See chart 2.3.3.1 below.

Corrosion Resistance	Typical Conditions of Use
Phosphate and Oil Coatings (Black Oxide)	• Interior applications without any particular influence of moisture
Zinc electro-plated 5 – 10 µm (ASTM B 633, SC 1, Type III)	• Interior applications without any particular influence of moisture
Organic Coatings – KWIK Cote ≥ 17.8 µm	• If covered sufficiently by noncorrosive concrete
Mechanically deposited zinc coating 40 – 107 µm	• Interior applications in damp environments and near saltwater (ASTM B 695)
Hot-Dip Galvanizing (HDG) > 50 µm (ASTM A 153)	• Exterior applications in only slightly corrosive atmospheres
Sherardizing Process > 50 µm	
Stainless Steel (AISI 303 / 304)	• Interior applications where heavy condensation is present • Exterior applications in corrosive environments
Stainless Steel (AISI 316)	• Near saltwater • Exterior corrosive environments

2.3 Corrosion

2.3.4 Test Methods

Various test methods have been used in the development of Hilti fastening systems to predict performance in corrosive environments. Some of the internationally accepted standards and test methods used in these evaluations are:

- ASTM B 117 Standard Practice for Operating Salt Spray (Fog) Apparatus
- ASTM G 85 Standard Practice for Modified Salt Spray (Fog) Testing
- ASTM G 87 Standard Practice for Conducting Moist SO₂ Tests
- DIN 50021 – SS Salt Spray Testing (ISO 3768)
- DIN 50018 2,0 Kesternich Test (ISO 6988) Testing in a Saturated Atmosphere in the Presence of Sulfur Dioxide

2.3.5 Hilti Fastening Systems

2.3.5.1 Anchors

Most Hilti metal anchors are available in carbon steel with an electrodeposited zinc coating of at least 5 µm with chromate passivation. Chromate passivation reduces the

rate of corrosion for zinc coatings, maintains color, abrasion resistance and when damaged, exhibits a unique “self healing” property. This means that the chromium contained within the film on the anchor surface will repassivate any exposed areas and lower the corrosion rate.

Hilti Super HAS threaded rods in 7/8" diameter size and KWIK Bolt 3 mechanical anchors are zinc coated by the hot-dip galvanizing process. Other sizes may be available through special orders.

Stainless steel anchors should be considered as a fastening solution whenever the possibility for corrosion exists. It must be noted that under certain extreme conditions, even stainless steel anchors will corrode and additional protective measures will be needed. Stainless steels should not be used when the anchorage will be subjected to long term exposure, immersion in chloride solutions, or in corrosive environments where the average temperature is above 86° F. Hilti HCR High Corrosion Resistant threaded rod is available on a special order basis. It provides superior corrosion resistance to AISI 316 and is an alternative to titanium or other special stainless steels.

ACI 318, Chapter 4 provides additional information for concrete durability requirements.

2.3.6 Applications

It is difficult to offer generalized solutions to corrosion problems. An applications guide can be useful as a starting point for fastener material selection. The specifier should also consult:

- Local and national building code requirements (e.g., IBC, UBC)
- Standard practice manuals for specific types of construction (e.g., ACI, PCI, AISC, PCA, CRSI, AASHTO, NDS/APA)
- Manufacturers of structural components
- Hilti technical support

2.3.6.1 General Applications

These application charts are offered as general guidelines.⁴ Site specific conditions may influence the decision.

Application	Conditions	Fastener Recommendations
Structural steel components to concrete and masonry (interior connections within the building envelope not subjected to free weathering) ^{1,2}	Interior applications without condensation	Galvanic zinc plating
	Interior applications with occasional condensation	HDG or Sherardized
Structural steel components to concrete and masonry (exterior connections subjected to free weathering) ^{1,2}	Slightly corrosive environments	HDG or Sherardized
	Highly corrosive environments	Stainless steel
Temporary formwork, erection bracing and short-term scaffolding	Interior applications	Galvanic zinc plating
	Exterior applications	HDG or Sherardized
Parking garages / parking decks subject to periodic application of de-icers including chloride solutions ³	Non-safety critical	HDG, Sherardized
	Safety critical	Stainless steel ¹
Road / bridge decks subject to periodic application of de-icers including chloride solutions	Non-safety critical	HDG or Sherardized
	Safety critical	Stainless steel

¹ Refer to ACI 318 Chapter 4 – Durability

² Refer to ACI 530.1 Section 2.4F – Coatings for Corrosion Protection

³ Refer to PCI Parking Structures: Recommended Practice for Design and Construction – Chapters 3, 5 and Appendix

⁴ General guidelines address environmental corrosion (direct chemical attack). Additional considerations should be taken into account when using hardened steel fasteners susceptible to HASSC.

Corrosion 2.3

2.3.6.2 Special Applications

These application charts are offered as general guidelines.⁴ Site specific conditions may influence the decision.

Application	Conditions	Fastener Recommendations
Aluminum fastenings (flashing / roofing accessories, hand rails, grating panels, sign posts and miscellaneous fixtures)	Interior applications without condensation	Galvanic zinc plating
	Exterior applications with condensation	Stainless steel
Water treatment	Not submerged	HDG, Sherardized or Stainless steel
	Submerged	Stainless steel ²
Waste water treatment	Not submerged	HDG, Sherardized or Stainless steel
	Submerged	Stainless steel ²
Marine (salt water environments, shipyards, docks, off-shore platforms)	Non-safety critical or temporary connections	HDG, Sherardized
	High humidity with the presence of chlorides – splash zone	Stainless steel ¹
	On the off-shore platform or rig	Stainless steel
Indoor swimming pools	Non-safety critical	HDG or Sherardized
	Safety critical or subjected to high concentrations of soluble chlorides	Stainless steel ¹
Pressure / chemically treated wood ³	Above grade	HDG
	Below grade	Stainless steel
Power plant stacks / chimneys	Non-safety critical	HDG or Stainless steel
	Safety critical or subjected to high	Stainless steel
Tunnels (lighting fixtures, rails, guardposts)	Non-safety critical	HDG, Stainless steel
	Safety critical	Stainless steel ¹

¹ Steel selection depends on safety relevance

² Must electrically isolate fastener from contact with concrete reinforcement through use of adhesive or epoxy anchoring system, gasket or plastic washer with low electrical conductivity

³ Refer to APA Technical Note No. D485D and AF and PA Technical Report No. 7

⁴ General guidelines address environmental corrosion (direct chemical attack). Additional considerations should be taken into account when using hardened steel fasteners susceptible to HASCC.

3.0 Anchoring Systems

3.1 Anchor Principles and Design

3.1.1 Allowable Stress Design (ASD) Terminology

The following terminology is generally compliant with that used for Allowable Stress Design of anchors.

A_{nom}	= nominal bolt cross sectional area	h_{min}	= minimum member thickness
A_{sl}	= cross sectional area of anchor sleeve	h_{nom}	= dimension from base material surface to bottom of anchor (prior to setting is applicable)
A_{st}	= tensile stress area of threaded part	h_o	= depth of full diameter hole in base material
c	= distance from anchor centerline to free edge of base material	ℓ	= anchor embedded length
c_{cr}	= critical edge distance	ℓ_{th}	= anchor useable thread length
c_{min}	= minimum edge distance	$M_{UM,5\%}$	= characteristic flexural resistance of anchor bolt (5% fractile)
d	= anchor bolt diameter (shank diameter)	N_{allow}	= allowable load (based on mean value from tests and a global safety factor)
d_{bit}	= nominal drill bit diameter	N_d	= design tension load (unfactored)
d_h	= diameter of clearance hole in attachment (e.g. baseplate)	N_{rec}	= recommended tension load
d_{nom}	= nominal anchor diameter	s	= anchor axial spacing
d_o	= anchor O.D.	s_{cr}	= critical spacing between adjacent loaded anchors
d_w	= washer diameter	s_{min}	= minimum spacing between adjacent loaded anchors
f_a	= adjustment factor for anchor spacing	s	= elastic section modulus of anchor bolt
f_c	= concrete compressive strength as measured by testing of cylinders	s_w	= width of anchor nut across flats
f'_c	= specified concrete compressive strength	t_{fix}	= maximum thickness of attachment (e.g. baseplate) to be fastened
f_{RN}	= adjustment factor for edge distance, tension loading	T_{inst}	= recommended anchor installation torque
f_{RV1}	= adjustment factor for edge distance, shear loading perpendicular and towards free edge	T_{max}	= maximum tightening torque
f_{RV2}	= adjustment factor for edge distance, shear loading parallel to edge	V_{allow}	= allowable shear load (based on mean value from tests and a global safety factor)
f_{RV3}	= adjustment factor for edge distance, shear loading perpendicular and away from free edge	V_d	= design shear load (unfactored)
f_y	= specified reinforcing bar yield strength	V_{rec}	= recommended shear load
F_y	= specified bolt minimum yield strength		
F_u	= specified bolt minimum ultimate strength		
h	= thickness of member in which anchor is embedded as measured parallel to anchor axis		
h_{ef}	= effective anchor embedment		

Anchor Principles and Design 3.1

3.1.2 Strength Design (SD) Terminology

The following terminology is generally compliant with that used in Strength Design of anchors.

A_{Nc}	= projected failure area of a single anchor or group of anchors for calculating concrete breakout strength in tension	d_{nom}	= nominal anchor diameter
A_{Nco}	= projected failure area of a single anchor, not limited by edge distance or spacing, for calculating concrete breakout strength in tension	d_o	= anchor O.D.
$A_{se,N}$	= effective cross-sectional area of anchor in tension	e'_N	= distance between geometric centroid of a group of anchors loaded in tension, and the resultant tension load applied to the group
$A_{se,V}$	= effective cross-sectional area of anchor in shear	e'_V	= distance between geometric centroid of a group of anchors loaded in shear, and the resultant shear load applied to the group
A_{se}	= tensile stress area of threaded part	f'_c	= specified concrete compressive strength
A_{Vc}	= projected failure area of a single anchor or group of anchors for calculating concrete breakout strength in shear	f_{ya}	= specified bolt minimum yield strength
A_{Vco}	= projected failure area of a single anchor, not limited by corner influences, spacing, or member thickness for calculating concrete breakout strength in shear	f_{uta}	= specified bolt minimum ultimate strength
c	= distance from anchor centerline to free edge of base material	h	= thickness of member in which anchor is embedded as measured parallel to anchor axis
c_{ac}	= critical edge distance required to develop the basic concrete breakout strength of a post-installed anchor in uncracked concrete with out supplementary reinforcement to control splitting	h_{ef}	= effective anchor embedment
$c_{a,max}$	= maximum distance from the center of an anchor to the edge of concrete	h_{min}	= minimum member thickness
$c_{a,min}$	= minimum distance from the center of an anchor to the edge of concrete	h_0	= depth of full diameter hole in base material
c_{a1}	= distance from the center of an anchor to the edge of concrete in the direction of the applied shear load. Can also refer to the minimum edge distance in tension	k_{cr}	= coefficient for basic concrete strength in tension, cracked concrete
c_{a2}	= distance from center of anchor to edge of concrete in the direction perpendicular to c_{a1}	k_{un-cr}	= coefficient for basic concrete strength in tension, uncracked concrete
$c_{cr,Na}$	= edge distance in tension for adhesive anchors at which the anchor tension capacity is theoretically unaffected by the proximate edge	k_{cp}	= coefficient for pryout strength
d or d_a	= anchor bolt diameter (shank diameter)	ℓ_e	= load-bearing length of anchor for shear, not to exceed $8d_o$, in.
d_{bit}	= nominal drill bit diameter		= h_{ef} for anchors with a constant stiffness over the full length of the embedded section, such as headed studs or post-installed anchors with one tubular shell over the full length of the embedment depth
d_h	= diameter of clearance hole in attachment (e.g. baseplate)		= $2d_o$ for torque-controlled expansion anchors with a distance sleeve separated from the expansion sleeve
		ℓ_{th}	= anchor useable thread length
		M_s^O	= characteristic value for the bending moment corresponding to rupture
		n	= number of anchors in a group
		N_{aO}	= characteristic tension capacity of a single adhesive anchor in tension
		N_b	= basic concrete breakout strength in tension of a single anchor in cracked concrete
		N_{cb}	= nominal concrete breakout strength of a single anchor in tension

3.1 Anchor Principles and Design

3.1.2 Strength Design (SD) Terminology

N_a	= nominal bond strength of a single adhesive anchor in tension	$\psi_{c,N}$	= factor modifying the concrete breakout strength of anchors in tension based on whether the concrete is considered to be cracked or uncracked
N_{ag}	= nominal bond strength of a group of adhesive anchors in tension	$\psi_{c,p}$	= factor modifying the pullout strength of anchors in tension based on whether the concrete is considered to be cracked or uncracked for design purposes
N_{cbg}	= nominal concrete breakout strength of a group of anchors in tension	$\psi_{c,V}$	= factor modifying the shear strength of anchors based on whether the concrete is considered to be cracked or uncracked and whether supplementary reinforcement is present
N_n	= nominal strength in tension	$\psi_{cp,N}$	= factor modifying the tension strength of anchors in uncracked concrete where supplementary reinforcement is not present to control splitting
N_p	= pullout strength of a single headed stud or headed bolt in cracked concrete	$\psi_{ec,N}$	= factor modifying the tension strength of anchors subjected to eccentric tension loading
N_{pn}	= nominal pullout strength of a single cast-in-place anchor	$\psi_{ec,V}$	= factor modifying the shear strength of anchors subjected to eccentric shear loading
$N_{pn, f'c}$	= nominal pullout strength of a single mechanical anchor	$\psi_{ed,N}$	= factor modifying the tension strength of anchors based on proximity to near edges
N_{sa}	= nominal strength in tension of a single anchor as governed by steel strength	$\psi_{ed,V}$	= factor modifying the shear strength of anchors based on proximity to near edges
N_{sb}	= nominal side face blowout strength of a single anchor	$\psi_{ed,Na}$	= modification for edge effects for adhesive anchors loaded in tension
N_{sbg}	= nominal side face blowout strength of a group of anchors	$\psi_{g,Na}$	= modification factor for the influence of the failure surface on a group of adhesive anchors loaded in tension
N_{ua}	= factored tensile force applied to an anchor or group of anchors	$\psi_{ec,Na}$	= modification factor for adhesive anchor groups loaded eccentrically in tension
s	= anchor axial spacing	$\psi_{p,Na}$	= modification for splitting for adhesive anchors loaded in tension
$s_{cr,Na}$	= spacing in tension for adhesive anchors at which the anchor tension capacity is theoretically unaffected by the presence of the adjacent loaded anchor		
s_{min}	= minimum spacing between adjacent loaded anchors		
S	= elastic section modulus of anchor bolt		
t_{fix}	= maximum thickness of attachment (e.g. baseplate) to be fastened		
T_{inst}	= recommended anchor installation torque		
T_{max}	= maximum tightening torque		
V_b	= basic concrete breakout strength in shear of a single anchor in cracked concrete		
V_{cb}	= nominal concrete breakout strength of a single anchor in shear		
V_{cbg}	= nominal concrete breakout strength of a group of anchors in shear		
V_{cp}	= nominal pryout strength of a single anchor		
V_{cpg}	= nominal pryout strength of a group of anchors		
V_n	= nominal strength in shear		
V_{sa}	= nominal strength in shear of a single anchor or as governed by steel strength		
V_{ua}	= factored shear force applied to a single anchor or group of anchors		
Φ	= strength reduction factor		

3.1.3 Definitions

Adhesive Anchor System = a device for transferring tension and shear loads to structural concrete, consisting of an anchor element embedded with an adhesive compound in a cylindrical hole drilled in hardened concrete. The system includes the fastening itself and the necessary accessories to install it appropriately.

Anchor Category = 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 = a group of anchors of approximately equal embedment and stiffness where the maximum anchor spacing is less than the critical spacing

Anchor Principles and Design 3.1

Anchor Reinforcement = reinforcement that transfers the full design load from the anchors into the concrete member

Anchor Spacing = centerline to centerline distance between adjacent loaded anchors

Attachment = the structural assembly, external to the surface of the concrete, that transmits loads to or receives loads from the base material

Cast-In-Place Anchor = a headed bolt, headed stud or hooked bolt installed before placing concrete

Characteristic Capacity = a statistical term indicating 90 percent confidence that there is 95 percent probability of the actual strength exceeding the nominal strength

Concrete Breakout = failure of the anchor characterized by the formation of a conical fracture surface originating at or near the embedded end of the anchor element and projecting to the surface of the base material. An angle between the surface and the breakout of 35° (Strength Design) or 45° (ASD) can be assumed.

Cracked Concrete = condition of concrete in which the anchor is installed; concrete is assumed to be cracked ($f_t > f_r$) for anchor design purposes if cracks could form in the concrete at or near the anchor location over the service life of the anchor.

Critical Spacing = required spacing between adjacent loaded anchors to achieve full capacity

Critical Edge Distance = required edge distance to achieve full capacity

Cure Time = 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 loads can be applied.

Displacement Controlled Expansion Anchor = an expansion anchor designed to expand in response to driving a plug into the anchor body

Ductile Steel Element = an element with a tensile test elongation of at least 14% and corresponding reduction of area of at least 30% at failure

Expansion Anchor = a post-installed anchor that transfers loads into hardened concrete by direct bearing, friction or both.

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

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

Effective Embedment Depth = effective anchor embedment equal to distance from surface of base material to point of load introduction into the base material, for expansion anchors taken as distance from surface of base material to tip of expansion element(s)

Minimum Edge Distance = minimum edge distance to preclude splitting of the base material during anchor installation

Minimum Spacing = minimum spacing between adjacent loaded anchors to preclude splitting of the base material during anchor installation

Minimum Member Thickness = required thickness of member in which anchor is embedded to prevent splitting of the base material

Post-Installed Anchor = an anchor installed into hardened concrete

Projected Area = the area of influence defined by the base of a truncated pyramid which is assumed to act at the surface or at the edge of a concrete member

Side Face Blowout = failure mode characterized by blowout of side cover of an anchor loaded in tension

Supplementary Reinforcement = reinforcement that acts to restrain the potential concrete breakout area but not to transfer the full design load from the anchors into the concrete member

Torque Controlled Anchor = a post-installed anchor employing an element designed to generate expansion forces in response to tension loading

Undercut Anchor = a post-installed anchor that develops its tensile strength from the mechanical interlock provided by undercutting the concrete at the embedded end of the anchor

3.1.4 Anchors in Concrete and Masonry

Anchor bolts fulfill a variety of needs in construction, from securing column baseplates to supporting mechanical and electrical systems; from attaching facade panels to 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. The proper selection of a suitable anchor system and its incorporation in connection design requires an understanding of the fundamental principles of anchor function. An overview is provided here. Additional references are provided at the conclusion of this section.

3.1.5 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

3.1 Anchor Principles and Design

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 (preload) load level 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 applied tension. 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 condition and represent the most robust solution for most anchoring needs.

Bonding (Adhesion): Adhesive anchor systems utilize the bonding that takes place between the adhesive and the anchor element, and the adhesive and the concrete to transfer 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 150 MAX-SD offer unparalleled flexibility and high bond resistance for a wide variety of anchoring element options.

Hybrid anchor elements like the Hilti HIT-TZ 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 near the surface of the base material. Shear loading may cause surface spalling resulting in significant flexural stresses and secondary tension in the anchor body.

Independent of the anchor working principle, proper installation in accordance with Hilti's published installation instructions is required.

3.1.6 Anchor Behavior Under Load

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

- rupture of the anchor bolt or body;
- anchor pullout or pull-through whereby the anchor is extracted more or less intact from the hole;
- concrete breakout as characterized by the formation of a conical fracture surface;

- concrete splitting whereby the member in which the anchor is embedded fractures in a plane coincident with the anchor axis.
- * side-face blowout resulting from local stresses generated near the head of a cast-in-place anchor installed close to the edge of a concrete member

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

- shear/tension rupture of the anchor bolt or body;
- anchor pullout or pull-through whereby the anchor is extracted intact from the hole;
- concrete edge breakout as generated by near-edge anchors loaded in shear toward a free edge;
- pryout whereby a shear load causes the base plate to rotate such that a tension force is created on the anchors which results in a prying action on the concrete.

3.1.6.1 Pre-Stressing of Anchors

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

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 will show increased deflection corresponding to relative movement of the cone and expansion elements. Grouted anchors exhibit a change in stiffness corresponding to loss of adhesion between the grout and the base material whereby tension resistance at increasing displacement levels is provided by friction between the uneven hole wall and the grout plug. In all cases, increasing stress levels in the anchor bolt/body result in increased anchor displacements.

3.1.6.2 Long Term Behavior

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

Adhesive Anchoring Systems:

- | | |
|----------------------------------|---------------------|
| • Pretensioning relaxation | • Fatigue |
| • Chemical resistance/durability | • Concrete cracking |
| • Creep | • Corrosion |
| • Freeze/Thaw conditions | • Fire |
| • High temperature | • Seismic |

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Mechanical Anchoring Systems:

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

All Hilti adhesive anchor systems suitable for use with Strength Design have been tested for sustained loading conditions per the ICC-ES Acceptance Criteria AC308. Contact Hilti for additional information.

3.1.7 Anchor Design

The design of anchors is properly based on an assessment of the loading conditions and anchorage capacity. Both Allowable Stress Design (ASD) and Strength Design (SD), are currently in use in North America for the design of anchors.

Allowable Loads: Under the allowable stress design approach, the “allowable load”, or resistance, is based on the application of a global safety factor to the mean result of laboratory testing to failure, regardless of the controlling failure mode observed in the tests. The global safety factor is intended to account for reasonably expected variations in loading as well as resistance and, in many application codes, is traditionally set at 4 for inspected installations and 8 for uninspected work. Adjustments for anchor edge distance and spacing 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 3.1.8.

Strength Design: The Strength Design method for anchor design has been incorporated into several codes such as ACI 318. It 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 generally considered to result in a more consistent factor of safety and a more reliable estimate of anchor resistance as compared to the “allowable loads” approach (ASD). The Strength Design method, as incorporated in ACI 318 Appendix D, is discussed in 3.1.9. Strength Design is state of the art and Hilti recommends the use of Strength Design where applicable.

3.1.8 Allowable Stress Design (ASD)

3.1.8.1 Recommended Loads

The recommended allowable load for an anchor or group of anchors is obtained as follows:

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

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

where:

$$N_{\text{rec}} = \text{recommended tension load;}$$

$$N_{\text{allow}} = \text{allowable load (based on mean value from tests and a global safety factor);}$$

$$V_{\text{rec}} = \text{recommended shear load;}$$

$$V_{\text{allow}} = \text{allowable shear load (based on mean value from tests and a global safety factor);}$$

$$f_A = \text{adjustment factor for anchor spacing;}$$

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

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

$$f_{\text{RV2}} = \text{adjustment factor for edge distance, shear loading parallel to or away from the edge}$$

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

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

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

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

3.1.8.2 Critical and Minimum Spacing and Edge Distance

In all cases, the adjustment factors are applicable for cases where the anchor spacing is:

$$s_{\text{min}} \leq s < s_{\text{cr}}$$

where:

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

$$s_{\text{cr}} = \text{critical spacing between adjacent loaded anchors; anchor spacing equal to or greater than } s_{\text{cr}} \text{ requires no reduction factor.}$$

3.1 Anchor Principles and Design

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

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

where:

c_{\min} = minimum edge distance; and

c_{cr} = critical edge distance; anchor edge distance equal to or greater than requires no reduction factor.

3.1.8.3 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:

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

where:

N_d = design tension load (ASD);

V_d = design shear load (ASD); and

α = exponent, $1 \leq \alpha \leq 2$

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

3.1.8.4 Bolt Bending - ASD

When shear load is applied to a connection having stand-off, the anchor bolt will be subject 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:

$\alpha_M = 1$ standoff installation without rotational restraint

$\alpha_M = 2$ standoff installation with full rotational restraint, as shown in the illustration.

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

α_M = adjustment of bending moment associated with rotational restraint;

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

$$= 1.2 \cdot S \cdot f_{uM,5\%} \left(1 - \frac{N_d}{N_{rec}} \right)$$

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

S = elastic section modulus of anchor bolt at concrete surface (assumes uniform cross section)

ℓ = internal lever arm adjusted for spalling of the surface concrete as follows:

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

z = standoff distance

d = anchor outer 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);

$n = 0.5$ 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 in order to ensure proper anchor function.

3.1.8.5 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 with allowable stress design methodologies. 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.

Anchor Principles and Design 3.1

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.

3.1.9 Strength Design – SD (LRFD)

Strength Design of anchors is referenced in the provisions of ACI 355.2, ACI 318 Appendix D and the ICC-ES Acceptance Criteria AC193 (mechanical anchors) and AC308 (adhesive anchors). A summary of selected relevant design provisions, especially as they pertain to post-installed anchors, is provided here.

3.1.9.1 Load Distribution

Per ACI 318 Appendix D, Section D.3 – General requirements, 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, deformational compatibility must be checked.

Example of deformational incompatibility

For most cases, elastic analysis yields satisfactory results and is recommended. It should be noted, however, that an assumption that the anchor load is linearly proportional to the magnitude of the applied load and the distance from the neutral axis of the group also implies that 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: 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 simplified elastic load distribution in a beam-wall connection

3.1.9.2 General Requirements for Anchor Strength

In accordance with general LRFD principles and D.4.1 – General requirements for strength of anchors, the design of anchors must satisfy the following conditions:

$$\Phi N_n \geq N_{ua} \quad (D-1)$$

$$\Phi V_n \geq V_{ua} \quad (D-2)$$

whereby ΦN_n and ΦV_n are the controlling design strengths from all applicable failure modes and N_{ua} and V_{ua} are factored tension and shear loads resulting from the governing load combination. (The load combinations given in 9.2 – **Required Strength** conform generally with ASCE 7-05 load combinations.) For this assessment, the following possible failure modes are considered:

- a) steel rupture of the anchor bolt in tension
- b) steel rupture of the anchor bolt in shear
- c) concrete cone breakout in tension
- d) concrete edge breakout in shear
- e) anchor pullout in tension
- f) side-face blowout of the concrete
- g) pryout failure in shear

Note that per D.4.1.2, the strength reduction factors applicable for each failure mode must be applied prior to determining the controlling strength. Thus, for an anchor group, the controlling strength would be determined as follows:

$$\Phi N_n = \min | \Phi N_{sa}, \Phi N_{pn}, \Phi N_{sb}, \Phi N_{cbg} |$$

$$\Phi V_n = \min | \Phi V_{sa}, \Phi V_{cpg}, \Phi V_{cbg} |$$

3.1 Anchor Principles and Design

3.1.9.3 Strength Reduction Factors

Strength reduction factors are intended to account for possible reductions in resistance due to normally expected variations in material strengths, anchor installation procedures, etc. Relevant strength reduction factors as given in D.4.4 for load combinations in accordance with 9.2 –

Required Strength are provided below:

Steel failure of a ductile steel element:

Tension0.75

Shear0.65

Steel failure of a non-ductile steel element:

Tension0.65

Shear0.60

Refer to ACI 318-08, Part D.1 for definition of a ductile steel element.

Failure characterized by concrete breakout, side-face blowout, anchor pullout or anchor pryout:

Condition A Condition B

i) Shear 0.75 0.70

ii) Tension

Cast-in headed
studs and bolts,
or hooked bolts0.75 0.70

Post-installed anchors:

Category 1 0.75 0.65

Category 2 0.65 0.55

Category 3 0.55 0.45

Condition A applies where supplementary reinforcement is present, except for pullout and pryout strengths.

Condition B applies where supplementary reinforcement is not present, and for pullout and pryout strengths.

Anchor categories are determined via testing conducted in accordance with ACI 355.2, wherein the anchor sensitivity to variations in installation parameters and in the concrete condition is investigated.

3.1.9.4 Design Requirements for Tensile Loading

In accordance with D.5.1 – Steel strength of anchor in tension, anchor steel strength is determined as follows:

$$N_{sa} = n A_{se,N} f_{uta} \quad (D-3)$$

where $f_{uta} \leq 1.9 f_{ya} \leq 125,000$ psi (860 MPa)

For reference purposes, nominal minimum bolt steel strengths for selected Hilti anchors are tabulated below:

Hilti Anchor Designation	f_{ya}	f_{uta}
	ksi (MPa)	ksi (MPa)
HDA-T/-TF/-P/-PF	92.8 (640)	116 (800)
HSL-3	92.8 (640)	116 (800)
KB-TZ 3/8"Ø	100 (690)	125 (862)
KB-TZ > 3/8"Ø	84.8 (585)	106 (731)
SS KB-TZ < 3/4"Ø	92.0 (634)	115 (793)
SS KB-TZ 3/4"Ø	76.1 (525)	102 (700)
ASTM A193, B7	105 (724)	125 (862)

The concrete breakout strength of single anchors loaded in tension is determined in accordance with D.5.2 – Concrete breakout strength of an anchor in tension, as follows:

$$N_{cb} = \frac{A_{Nc}}{A_{Nco}} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \quad (D-4)$$

The concrete breakout strength of anchor groups is likewise determined as follows:

$$N_{cbg} = \frac{A_{Nc}}{A_{Nco}} \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \quad (D-5)$$

where:

$$A_{Nco} = 9h_{ef}^2$$

A_{Nc} = area defined by projecting from the centerlines of the anchor or from the centerline of anchor rows in each of two orthogonal directions.

$\psi_{ec,N}$ = modification factor for anchor groups loaded by an eccentric tension force

$$= \frac{1}{\left(1 + \frac{2e'_N}{3h_{ef}}\right)} \leq 1$$

$\psi_{ed,N}$ = modification factor for edge distances less than $1.5h_{ef}$

$$= 0.7 + 0.3 \frac{c_{a,min}}{1.5h_{ef}} \text{ if } c_{a,min} < 1.5h_{ef}$$

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$\Psi_{c,N}$ = Reference D.5.2.6 for cast-in-place anchors.
Reference ICC-ES Evaluation Service Report for post-installed anchors.

$\Psi_{cp,N}$ = modification factor for splitting
= $\frac{c_{a,min}}{c_{ac}} \geq \frac{1.5h_{ef}}{c_{ac}}$ if $c_{a,min} < c_{ac}$

N_b = basic concrete breakout strength of a single anchor in tension in cracked concrete
= $k_{cr} \lambda \sqrt{f'_c} h_{ef}^{1.5}$

Reference D.5.2.2 for k_c values for cast-in-place anchors.

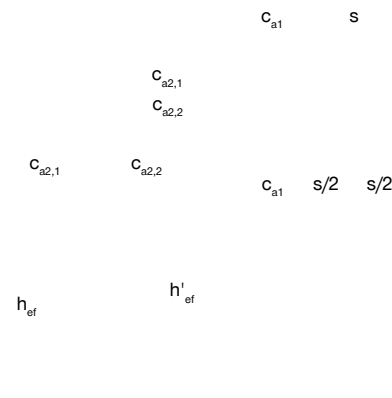
For post-installed anchors that have been tested in accordance with ACI 355.2, specific values of k_{cr} (cracked concrete) and k_{uncr} (uncracked concrete) are established in accordance with the provisions of that document or the relevant ICC-ES acceptance criteria. A summary of values for selected Hilti anchors is provided below:

Hilti Anchor Designation ¹	k_{cr}	k_{uncr}	$\Psi_{ec,N}$
HDA	24	30	1.25
HSL-3 > M8	24	24	1.00
KB-TZ Carbon Steel	17	24	1.41
HSL-3 M8	17	24	1.41

¹ These values supercede default values provided for post-installed anchors in ACI 318.

e'_N

Definition of e'_N for anchor groups



h

$c_{a,1}$ s_1 $1.5h_{ef}$

$$h'_{ef} = \max \left\{ \frac{c_{a1}}{1.5}, \frac{c_{a2,1}}{1.5}, \frac{c_{a2,2}}{1.5}, \frac{s}{3} \right\}$$

Example of determination of h'_{ef} in a stem wall

The pullout strength of anchors loaded in tension is determined in accordance with D.5.3 – Pullout strength of anchor in tension, as follows:

$$N_{pn} = \Psi_{c,P} N_p \quad (D-14)$$

where:

N_p = for post-installed anchors, pullout strength in cracked concrete as determined by tests in accordance with ACI 355.2 or the relevant ICC-ES acceptance criteria

$\Psi_{c,P}$ = modification factor for concrete that is anticipated to remain uncracked for the service life of the anchor (> 1)



Example of determination of A_{Nc}

3.1 Anchor Principles and Design

Pullout values are based on direct tension testing of anchors in cracks as well as on the results of the crack movement test. Additional pullout values associated with seismic testing may also be provided.

For deep headed anchors placed close to an edge ($c_{a1} < 0.4h_{ef}$), side-face blowout may control the design. In most cases, restrictions on the placement of post-installed anchors close to an edge will preclude this failure mode. For further information, see **D.5.4 – Concrete side-face blowout strength of a headed anchor in tension**.

3.1.9.5 Design Requirements for Shear Loading

In accordance with ACI 318 Appendix D, Section D.6.1 – Steel strength of anchor in shear, anchor steel strength for headed stud anchors is determined as follows:

$$V_{sa} = A_{se,V} f_{uta} \quad (D-19)$$

For post-installed anchors without a sleeve extending through the shear plane:

$$V_{sa} = n 0.6 A_{se,V} f_{uta} \quad (D-20)$$

where $f_{uta} \leq 1.9 f_y \leq 125,000$ psi (860 MPa).

For other post-installed anchors, the shear strength as controlled by steel failure must be determined by test in accordance with ACI 355.2 or the relevant ICC-ES acceptance criteria.

In accordance with D.6.1.3, the nominal steel strength of anchors used with built-up grout pads must be reduced by 20%.

The concrete breakout strength of a single anchor loaded in shear is determined in accordance with D.6.2 – **Concrete breakout strength of anchor in shear**, as follows:

$$V_{cb} = \frac{A_{Vc}}{A_{Vco}} \psi_{ed,N} \psi_{c,V} V_b \quad (D-21)$$

The concrete breakout strength of anchor groups is likewise determined as follows:

$$V_{cbg} = \frac{A_{Vc}}{A_{Vco}} \psi_{ec,V} \psi_{ed,V} \psi_{c,V} V_b \quad (D-22)$$

where:

$$A_{Vco} = 4.5 c_{a1}^2$$

A_{Vc} = area defined by projecting $1.5 c_{a1}$ from the centerlines of the anchor or from the centerline of anchor rows to the face of the free edge being considered.

$\psi_{ec,V}$ = modification factor for anchor groups loaded by an eccentric shear force

$$= \frac{1}{\left(1 + \frac{2e'_V}{3c_{a1}}\right)} \leq 1$$

$\psi_{ed,V}$ = modification factor for edge distances less than $1.5c_{a1}$

$$= 0.7 + 0.3 \frac{c_{a2}}{1.5c_{a1}} \text{ if } c_{a,\min} < 1.5h_{ef}$$

$\psi_{c,V}$ = modification factor for concrete that is anticipated to remain uncracked for the service life of the anchor

$$= 1.4$$

$\psi_{h,V}$ = modification factor for anchors located in a thin slab

$$= \sqrt{1.5c_{a1}} / h_a$$

V_b = basic concrete breakout strength of a single anchor in shear in cracked concrete

$$= 7 \left(\frac{\ell_e}{d_o} \right)^{0.2} \sqrt{d_o} \lambda \sqrt{f'_c} (c_{a1})^{1.5}$$

The concrete pryout strength of single anchors loaded in shear is determined in accordance with D.6.3 – **Concrete pryout strength of anchor in shear**, as follows:

$$V_{cp} = k_{cp} N_{cb} \quad (D-29)$$

Likewise, for anchor groups, the pryout strength is determined as follows:

$$V_{cpg} = k_{cp} N_{cbg} \quad (D-30)$$

where:

$$k_{cp} = 1.0 \quad \text{for } h_{ef} < 2.5 \text{ in.}$$

$$k_{cp} = 2.0 \quad \text{for } h_{ef} \geq 2.5 \text{ in.}$$

3.1.9.6 Interaction – Strength Design (LRFD)

Where anchors are loaded simultaneously in tension and shear, interaction must be considered. In accordance with **D.7 – Interaction of tensile and shear forces**, interaction may be checked as follows:

$$\text{If } V_{ua} \leq 0.2 \Phi V_n \quad \Phi N_n \geq N_{ua}$$

$$\text{If } N_{ua} \leq 0.2 \Phi N_n \quad \Phi V_n \geq V_{ua}$$

$$\text{If } N_{ua} > 0.2 \Phi N_n \quad \text{and} \quad \left[\frac{N_{ua}}{\Phi N_n} \right] + \left[\frac{V_{ua}}{\Phi V_n} \right] \leq 1.2$$

$$V_{ua} > 0.2 \Phi V_n$$

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Alternatively, ACI 318 permits the use of an interaction expression of the form:

$$\left[\frac{N_{ua}}{\Phi N_n} \right]^\alpha + \left[\frac{V_{ua}}{\Phi V_n} \right]^\alpha \leq 1.0$$

with $\alpha = 5/3$.

3.1.9.7 Required Edge Distances, Anchor Spacing and Member Thickness - Strength Design (LRFD)

Refer to ACI 318 Appendix D Section D.8 for the geometry requirements for cast-in-place anchors.

Refer to ICC-ES Evaluation Service Report for the geometry requirements for post-installed anchors.

3.1.9.8 Bolt Bending - Strength Design (LRFD)

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:

α_M = adjustment of bending moment associated with rotational restraint

M_s = resultant flexural resistance of anchor

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

M_s^0 = characteristic flexural resistance of anchor

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

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

S = elastic section modulus of anchor bolt at concrete surface (assumes uniform cross section)

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

ℓ = 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

d_o = anchor outer 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)

$n = 0.5$ 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 in order to ensure proper anchor function and to properly resist compression loads.

M_s^0

Determination of bolt bending – strength design

3.1 Anchor Principles and Design

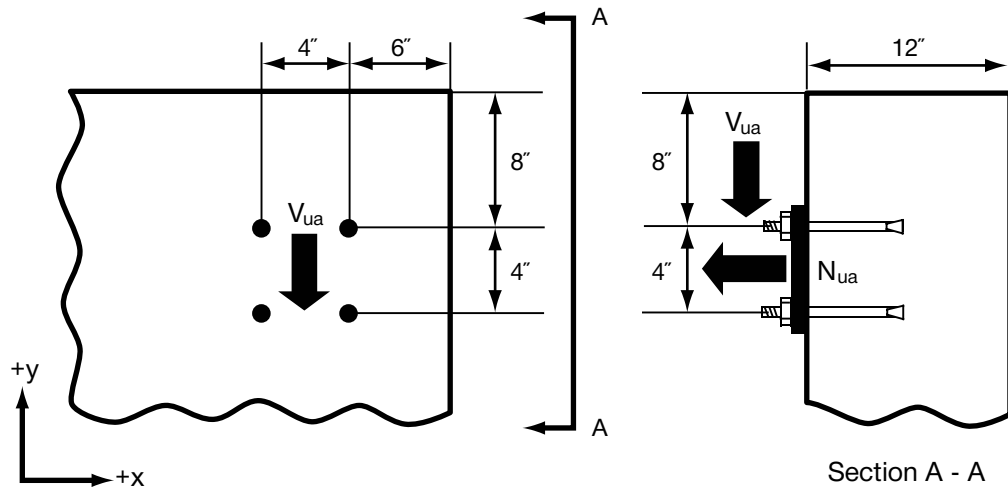
3.1.9.9 Design Examples

Strength Design Example, Mechanical Anchors, KWIK BOLT-TZ

Objective:

Determine the controlling design strength in tension and shear.

Check the controlling design strength in tension and shear against the factored service load in tension and shear.


Dimensional
Parameters:

d_0	=	5/8 in
h_{nom}	=	4.75 in
h_{ef}	=	4 in
$t_{fixture}$	=	1/2 in
h	=	12 in
s_x	=	4 in
s_y	=	4 in
c_{+x}	=	6 in
c_{+y}	=	8 in

Given:

Normal weight concrete, $f'_c = 4,000$ psi
 Cracked concrete conditions assumed
 Seismic design category (SDC) C
 Reference ACI 318-08, Ch. 9 and ICC-ES ESR-1917 for L/R factors
 => Assume Condition B for all Φ factors
 Carbon Steel 5/8" x 6" KWIK BOLT-TZ anchors
 Anchors are considered ductile steel elements
 4 – anchors in tension
 No tension eccentricity
 4 – anchors in shear
 No shear eccentricity
 $N_{ua} = 1500$ lb $V_{ua} = 5000$ lb

Things to check:

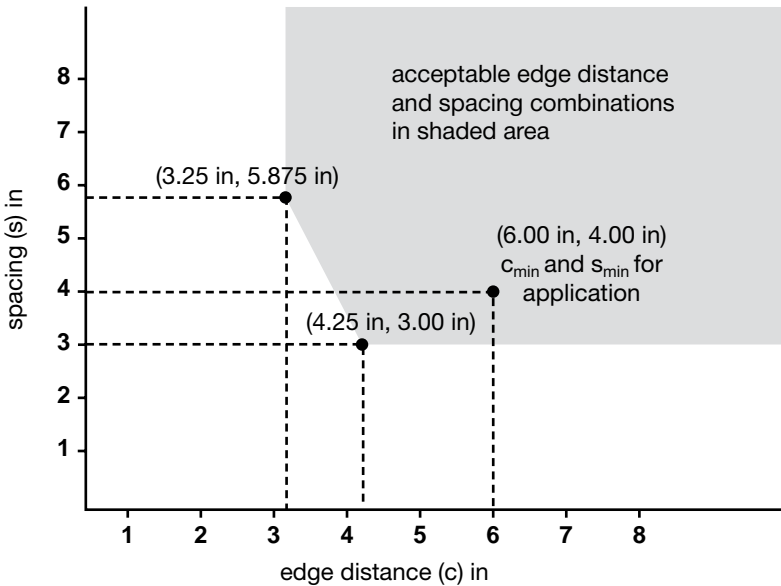
- Geometry requirements
- Tension Design Strengths
- Shear Design Strengths
- Tension/Shear Interaction

References:

- Mechanical Anchor – KWIK BOLT-TZ
- ACI 318-08, Appendix D
- ICC-ES ESR-1917

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3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-1917, KWIK BOLT-TZ	ACI 318 Ref.	ESR Ref.
Check Minimum Anchor Spacing, Edge Distance, Concrete Member Thickness.		
$c_{min} = 3.25 \text{ in}$ when $s \geq 5.875 \text{ in}$ $s_{min} = 3 \text{ in}$ when $c \geq 4.25 \text{ in}$		
 <p>acceptable edge distance and spacing combinations in shaded area</p> <p>(3.25 in, 5.875 in)</p> <p>(4.25 in, 3.00 in)</p> <p>(6.00 in, 4.00 in) c_{min} and s_{min} for application</p> <p>spacing (s) in</p> <p>edge distance (c) in</p>	D.8.1 D.8.2 RD 8	Section 4.1.9 Table 3 Figure 4
NOTES ON TENSION PARAMETERS: Anchors spaced $> 3h_{ef}$ are not assumed to act as a group in tension. $3h_{ef} = (3)(4 \text{ in}) = 12 \text{ in}$ $4 \text{ in} < 12 \text{ in}$ consider group action		
If an edge distance is $> 1.5h_{ef}$, the edge is not assumed to influence the tension anchor capacity unless splitting is considered. $1.5h_{ef} = (1.5)(4 \text{ in}) = 6 \text{ in}$ $c_{min} = 6 \text{ in}$ no edge influence in tension		

3.1 Anchor Principles and Design

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-1917, KWIK BOLT-TZ	ACI 318 Ref.	ESR Ref.
<p>NOTES ON SHEAR PARAMETERS:</p> <p>Anchors spaced $> 3c_{a1}$ are not assumed to act as a group in shear.</p> <p>Check shear parallel to x+ edge $\rightarrow c_{a1} = 6$ in</p> $3c_{a1} = (3)(6 \text{ in}) = 18 \text{ in}$ $s_y = 4 \text{ in}$ $4 \text{ in} < 18 \text{ in} \rightarrow \text{consider group action}$ <p>If an edge distance perpendicular to the direction of the applied shear load (c_{a2}) is $> 1.5c_{a1}$, the edge is not assumed to influence the shear anchor capacity. Check shear parallel to x+ edge $\rightarrow c_{a2} = 8$ in.</p> $1.5c_{a1} = (1.5)(6 \text{ in}) = 9 \text{ in}$ $8 \text{ in} < 9 \text{ in} \rightarrow \text{consider edge influence in shear}$	D.8.1 D.8.2 RD.8	Section 4.1.9 Table 3 Figure 4
<p>Minimum base material thickness = 6 in</p> <p>Actual base material thickness (h) = 12 in.</p> $6 \text{ in} < 12 \text{ in} \rightarrow \text{OK}$	D.8.5 RD.8.5	Section 4.1.9 Table 3
<p>NOTES ON INSTALLATION:</p> <p>$h_{ef} = 4$ in for a 5/8" KWIK BOLT-TZ having $h_{nom} = 4.75$ in.</p> <p>h_{nom} = hole depth.</p> <p>anchor length (ℓ_{anch}) = 6" for a 5/8" x 6" KWIK BOLT-TZ.</p> <p>fixture thickness ($t_{fixture}$) = 1/2 in.</p> <p>assume the nut/washer thickness = 3/4 in.</p> <p>actual thread length = 2.75 in.</p> <p>available thread length = $\ell_{anch} - h_{ef} = 6 \text{ in} - 4 \text{ in} = 2 \text{ in}$.</p> <p>$t_{fixture} + \text{nut/washer thickness} = 1/2 \text{ in} + 3/4 \text{ in} = 1.25 \text{ in}$</p> <p>2 in $>$ 1.25 in OK</p>	-	Table 1
<p>Calculate Design Steel Strength in Tension.</p> <p>$\Phi_{Steel} \Phi_{nonductile} N_{sa}$</p>	D.5.12	Section 4.1.2
<p>4-anchors in tension.</p> <p>Highest tension load acting on a single anchor = $N_{ua} / 4$</p> $= 1500 \text{ lb} / 4\text{-anchors}$ $= 375 \text{ lb} / \text{anchor}$ <p>Steel material: $N_{sa} = 17,170 \text{ lb/anchor}$</p> <p>KWIK BOLT-TZ anchors are considered ductile steel elements. When designing for SDC C+, the non-ductile reduction factor does not need to be applied per ACI 318-08, D.3.3.6.</p> <p>$\Phi_{Steel} = 0.75$ $N_{sa} = 17,170 \text{ lb/anchor}$</p> <p>$\Phi_{Steel} N_{sa} = (0.75)(17,170 \text{ lb/anchor}) = 12,877 \text{ lb/anchor}$</p>	D.3.3.3 D.3.3.4 D.3.3.6 D.5.1.2	Table 3 Footnote 10

Anchor Principles and Design 3.1

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-1917, KWIK BOLT-TZ	ACI 318 Ref.	ESR Ref.
<p>Calculate Design Concrete Breakout Strength in Tension.</p> $\Phi N_{cbg} = \Phi_{\text{seismic}} \Phi_{\text{concrete}} \Phi_{\text{nonductile}} \left[\frac{A_{Nc}}{A_{Nco}} \cdot \psi_{ec,N} \cdot \psi_{ed,N} \cdot \psi_{c,N} \cdot \psi_{cp,N} \cdot N_b \right]$	D.3.3 D.5.2.1 (b) Eq. (D-5)	Section 4.1.3
$c_{-x} = \infty$ $s_x = 4 \text{ in}$ $c_{+x} = 6 \text{ in}$ $c_{+y} = 8 \text{ in}$ $s_y = 4 \text{ in}$ $c_{-y} = \infty$	D.5.2.1	-
$c_{\max} = 1.5 \cdot h_{ef} = (1.5) (4 \text{ in}) = 6 \text{ in}$ if $c \geq 6 \text{ in}$ use $1.5 \cdot h_{ef}$ $s_{\max} = 3 \cdot h_{ef} = (3) (4 \text{ in}) = 12 \text{ in}$ if $s > 12 \text{ in}$, no group action $A_{Nc} = (c_{-x} + s_x + c_{+x}) (c_{+y} + s_y + c_{-y})$ $= (6 \text{ in} + 4 \text{ in} + 6 \text{ in}) (6 \text{ in} + 4 \text{ in} + 6 \text{ in}) = 256 \text{ in}^2$ $A_{Nco} = (9) (h_{ef})^2 = (9) (4 \text{ in})^2 = 144 \text{ in}^2$	D.5.2.1 Eq. (D-6)	-
No tension eccentricity $\rightarrow \psi_{ec,N} = 1.0$	D.5.2.4 Eq. (D-9)	-
The smallest edge distance (c_{\min}) = 6 in = $1.5h_{ef}$ \rightarrow no reduction for edge distance. $\psi_{ed,N} = 1.0$	D.5.2.5 Eq. (D-11)	-
NOTE: cracked concrete conditions have been assumed. $\psi_{c,N} = 1.0$ $\psi_{cp,N} = 1.0$	D.5.2.6 D.5.2.7	-
NOTE: cracked concrete conditions assumed normal weight concrete $\rightarrow \lambda = 1.0$. $N_b = k_{c,cr} \lambda \sqrt{f'_c} (h_{ef})^{1.5} = (17) (1.0) \sqrt{4000} (4 \text{ in})^{1.5} = 8601 \text{ lb}$	D.5.2.2 Eq. (D-7)	Table 3
$N_{cbg} = \left(\frac{256 \text{ in}^2}{144 \text{ in}^2} \right) (1.0) (1.0) (1.0) (1.0) (8601 \text{ lb}) = 15,290 \text{ lb}$ Design Steel Strength (ΦN_{sa}) will not control per D.3.3.4. Assume seismic provisions of ACI 318-08, D.3.3.6: * non-ductile reduction factor = $\Phi_{\text{nonductile}}$ * assume designer-selected value for $\Phi_{\text{nonductile}} = 0.85$ NOTE: The non-ductile reduction factor, $\Phi_{\text{nonductile}}$, can vary from the default value = 0.4 per D.3.3.6 and RD.3.3.6. It is the responsibility of the designer when inputting values for $\Phi_{\text{nonductile}}$ different than the values noted in ACI 318-08, D.3.3.6 to determine if they are consistent with the design provisions of ACI 318-08, the applicable version of ASCE 7 and the governing building code. $\Phi_{\text{seismic}} = 0.75$ $\Phi_{\text{concrete}} = 0.65$ $\Phi_{\text{nonductile}} = 0.85$ $\Phi N_{cbg} = (0.75) (0.65) (0.85) (15,290 \text{ lb}) = 6335 \text{ lb}$	D.3.3.3 D.3.3.6 D.5.2.1 (b) Eq. (D-5)	Table 3

3.1.9.9 Design Examples

30 Hilti, Inc. (US) 1-800-879-8000 | www.us.hilti.com | en español 1-800-879-5000 | Hilti (Canada) Corp. 1-800-363-4458 | www.hilti.ca | Anchor Fastening Technical Guide 2011

Anchor Principles and Design 3.1

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-1917, KWIK BOLT-TZ	ACI 318 Ref.	ESR Ref.
<p>Calculate Design Concrete Breakout Strength in Shear.</p> $\Phi V_{cbg} = \Phi_{seismic} \Phi_{concrete} \Phi_{nonductile} \left[\frac{A_{Vc}}{A_{Vco}} \cdot \psi_{ec,V} \cdot \psi_{ed,V} \cdot \psi_{c,V} \cdot \psi_{h,V} \cdot V_b \right]$	D.3.3 D.6.2.1 (b) Eq. (D-22)	Section 4.1.7
<p> $c_{-x} = \infty$ $s_x = 4$ in $c_{+x} = 6$ in $c_{+y} = 8$ in $s_y = 4$ in $c_{-y} = \infty$ NOTE: Shear load acts in the -y direction. $c_{-y} = \infty \rightarrow$ no concrete breakout assumed in the -y direction. Concrete breakout for shear parallel to the edge (+x direction) should be checked per D.6.2.1(c). </p>	D.6.2.1 (c)	
<p>Assume the full shear load acts on the row of anchors nearest to the x+ edge $\rightarrow c_{a1} = 6$ in.</p> <p> $1.5c_{a1} = (1.5)(6 \text{ in}) = 9 \text{ in}$ if $c \geq 9$ in use $1.5 \cdot c_{a1}$ $h = 12$ in $s_{max} = 3 \cdot c_{a1} = (3)(6 \text{ in}) = 18 \text{ in}$ if $s > 18$ in, no group action </p> <p> $A_{Vc} = (c_{+y} + s_y + c_{-y}) [\text{MINIMUM } (1.5c_{a1} ; h)]$ $= (8 \text{ in} + 4 \text{ in} + 9 \text{ in})(9 \text{ in}) = 189 \text{ in}^2$ $A_{Vco} = (4.5)(c_{a1})^2 = (4.5)(6 \text{ in})^2 = 162 \text{ in}^2$ </p>	D.3.3.6 D.6.2.1 Eq. (D-23)	-
<p>No shear eccentricity $\rightarrow \psi_{ec,V} = 1.0$</p>	D.6.2.5 Eq. (D-26)	-
<p>The edge distances perpendicular to the direction of the shear load are defined as c_{a2}.</p> <p>NOTE: D.6.2.1(c) permits $\psi_{ed,V} = 1.0$ to be used when calculating shear parallel to an edge.</p> <p>The $\psi_{ed,V}$ calculation in this example is conservative.</p> <p> $c_{a2+y} = 8$ in $c_{a2-y} = \infty$. $\psi_{ed,V} = 0.7 + 0.3 \left(\frac{c_{a2+y}}{1.5c_{a1}} \right)$ $= 0.7 + 0.3 \left(\frac{8 \text{ in}}{9 \text{ in}} \right)$ $= 0.97$ </p>	D.6.2.6 Eq. (D-28)	-
<p>Cracked concrete conditions, no edge reinforcement assumed $\rightarrow \psi_{c,V} = 1.0$</p>	D.6.2.7	-
<p> $\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}}$ Check: $h_a = 12$ in ; $1.5c_{a1} = 9$ in $12 \text{ in} > 9 \text{ in} \rightarrow \psi_{h,V} = 1.0$ </p>	D.6.2.8 Eq. (D-29)	

3.1 Anchor Principles and Design

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-1917, KWIK BOLT-TZ	ACI 318 Ref.	ESR Ref.
<p>NOTE: normal weight concrete $\rightarrow \lambda = 1.0$</p> $V_b = (7) \left(\frac{\ell_e}{d_{\text{anchor}}} \right)^{0.2} \lambda \sqrt{d_{\text{anchor}}} \sqrt{f'_c} (c_{a1})^{1.5}$ $\ell_e = \text{MINIMUM} \{h_{ef}; 8d_{\text{anchor}}\} = \text{MINIMUM} \{4 \text{ in}; 5 \text{ in}\} = 4 \text{ in}$ $V_b = (7) \left(\frac{4 \text{ in}}{0.625 \text{ in}} \right)^{0.2} (1.0) \sqrt{0.625 \text{ in}} \sqrt{4000 \text{ psi}} (6 \text{ in})^{1.5} = 7456 \text{ lb}$	D.6.2.2 Eq. (D-24)	Table 3
$V_{\text{cbg}} = \left(\frac{189 \text{ in}^2}{162 \text{ in}^2} \right) (1.0) (0.97) (1.0) (1.0) (7456 \text{ lb}) = 8,437 \text{ lb}$ <p>Calculate shear parallel to edge: $\Phi V_{\text{cbg,parallel}} = (2) (8437 \text{ lb}) = 16,874 \text{ lb}$</p> <p>Design Steel Strength ($\Phi_{\text{steel}} V_{sa}$) will not control per D.3.3.4. Assume seismic provisions of ACI 318-08, D.3.3.6:</p> <ul style="list-style-type: none"> * non-ductile reduction factor = $\Phi_{\text{nonductile}}$ * assume designer-selected value for $\Phi_{\text{nonductile}} = 0.85$ <p>NOTE: The non-ductile reduction factor, $\Phi_{\text{nonductile}}$, can vary from the default value = 0.4 per D.3.3.6 and RD.3.3.6. It is the responsibility of the designer when inputting values for $\Phi_{\text{nonductile}}$ different from the values noted in ACI 318-08, D.3.3.6 to determine if they are consistent with the design provisions of ACI 318-08, the applicable version of ASCE 7 and the governing building code.</p> $\Phi_{\text{seismic}} = 0.75 \quad \Phi_{\text{concrete}} = 0.70 \quad \Phi_{\text{nonductile}} = 0.85$ $\Phi V_{\text{cbg}} = (0.75) (0.70) (0.85) (16,874 \text{ lb}) = 7530 \text{ lb}$	D.3.3.3 D.3.3.6 D.6.2.1 (b) D.6.2.1 (c) Eq. (D-22)	Table 3
<p>Calculate Design Concrete Pryout Strength in Shear.</p> $\Phi V_{\text{cbg}} = \Phi_{\text{seismic}} \Phi_{\text{concrete}} \Phi_{\text{nonductile}} (k_{cp}) (N_{\text{cbg}})$	D.6.3.1 (b) Eq. (D-31)	Section 4.1.8 D.6.3.2 (b) Eq. (D-30b)
$V_{\text{cpg}} = (k_{cp}) (N_{\text{cbg}})$ $N_{\text{cbg}} = 15,290 \text{ lb} \quad h_{ef} = 4 \text{ in} \rightarrow k_{cp} = 2$ $V_{\text{cpg}} = (2)(15,290 \text{ lb}) = 30,580 \text{ lb}$ <p>Assume seismic provisions of ACI 318-08, D.3.3.6:</p> <ul style="list-style-type: none"> * non-ductile reduction factor = $\Phi_{\text{nonductile}}$ * designer-selected value for $\Phi_{\text{nonductile}} = 0.85$ $\Phi_{\text{seismic}} = 0.75 \quad \Phi_{\text{concrete}} = 0.70 \quad \Phi_{\text{nonductile}} = 0.85$ $\Phi V_{\text{cbg}} = (0.75) (0.70) (0.85) (30,580 \text{ lb}) = 13,646 \text{ lb}$	D.3.3.3 D.3.3.6 D.6.3.1 (b) Eq. (D-31)	Table 3

Anchor Principles and Design 3.1

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-1917, KWIK BOLT-TZ			
SUMMARY			
NOTE: ✓ indicates controlling Design Strength			
TENSION SUMMARY	ΦN_N	N_{ua}	% Utilization $N_{ua} / \Phi N_N$
Design Steel Strength	$\Phi N_{sa} = 12,877 \text{ lb/anchor}$	375 lb/anchor	3%
Design Concrete Breakout Strength	$\Phi N_{cbg} = 6335 \text{ lb}$	1500 lb	24% ✓
Design Pullout Strength	$\Phi N_{pn,f'c} = N/A$	375 lb/anchor	NA
SHEAR SUMMARY			
	ΦV_N	V_{ua}	% Utilization $V_{ua} / \Phi V_N$
Design Steel Strength	$\Phi V_{sa} = 6861 \text{ lb/anchor}$	1250 lb/anchor	18%
Design Concrete Breakout Strength	$\Phi V_{cbg} = 7530 \text{ lb}$	5000 lb	66% ✓
Design Pry-Out Strength	$\Phi V_{cpg} = 13,646 \text{ lb}$	5000 lb	37%
Calculation per ACI 318-08 Appendix D, ICC-ES ESR-1917			
INTERACTION EQUATION		ACI 318 Ref.	ESR Ref.
Check: $V_{ua} \leq (0.2)\Phi V_{cbg}$ $V_{ua} = 5000 \text{ lb} \quad (0.2) (7530 \text{ lb}) = 1506 \text{ lb}$ $V_{ua} > (0.2)\Phi V_{cbg}$		D.7.1	
Check: $N_{ua} \leq (0.2)\Phi N_{cbg}$ $N_{ua} = 1500 \text{ lb} \quad (0.2) (6335 \text{ lb}) = 1267 \text{ lb}$ $N_{ua} > (0.2)\Phi N_{cbg}$		D.7.2	
Use Interaction Equation: $\frac{N_{ua}}{\Phi \cdot N_{cbg}} + \frac{V_{ua}}{\Phi \cdot V_{cbg}} \leq 1.2$ Use Interaction Equation: $\frac{1500 \text{ lb}}{6355 \text{ lb}} + \frac{5000 \text{ lb}}{7530 \text{ lb}} \leq 1.2$ $0.24 + 0.66 = 0.90 < 1.2 \rightarrow \text{OK}$		D.7.3 EQ. (D-32)	

3.1 Anchor Principles and Design

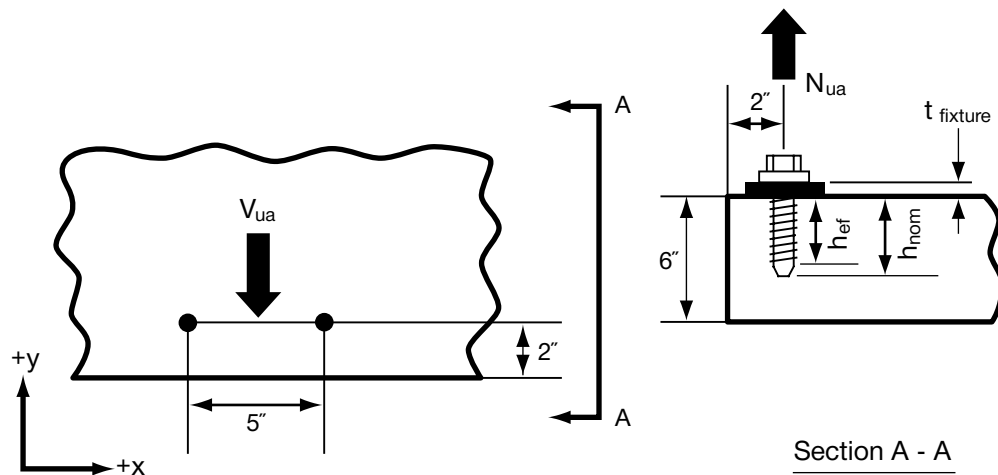
3.1.9.9 Design Examples

Strength Design Example, Mechanical Anchors, KWIK HUS-EZ

Objective:

Determine the controlling design strength in tension and shear.

Check the controlling design strength in tension and shear against the factored service load in tension and shear.


Dimensional
Parameters:

d_0	=	1/2 in
h_{nom}	=	3 in
h_{ef}	=	2.16 in
$t_{fixture}$	=	3/8 in
h	=	6 in
s	=	5 in
c	=	2 in

Given:

Normal weight concrete, $f'_c = 4,000$ psi
 Cracked concrete conditions assumed
 Seismic design category (SDC) C
 Reference ACI 318-08, Ch. 9 and KH-EZ Evaluation Service Report L/R factors
 => Assume Condition B for all Φ factors
 Carbon Steel 1/2" x 4" KWIK HUS-EZ anchors
 Anchors are considered non-ductile steel elements
 2 – anchors in tension
 No tension eccentricity
 2 – anchors in shear
 No shear eccentricity
 $N_{ua} = 500$ lb $V_{ua} = 500$ lb towards the fixed edge

Things to check:

- Geometry requirements
- Tension Design Strengths
- Shear Design Strengths
- Tension/Shear Interaction

References:

- Mechanical Anchor – KWIK HUS-EZ
- ACI 318-08, Appendix D
- ICC-ES ESR-3027

Anchor Principles and Design 3.1

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3027, KWIK HUS-EZ	ACI 318 Ref.	ESR Ref.
Check Minimum Anchor Spacing, Edge Distance, Concrete Member Thickness.		
$s_{min} = 3 \text{ in}$ $s_{max} = 3h_{ef} = (3)(2.16 \text{ in}) = 6.48 \text{ in}$ NOTE: anchors spaced $> 3h_{ef}$ are not assumed to act as a group in tension. $3 \text{ in} \leq 5 \text{ in} \leq 6.48 \text{ in}$ OK anchors spaced $> 3c_{a1}$ are not assumed to act as a group in shear. $3 \text{ in} \leq 5 \text{ in} \leq (3)(2 \text{ in})$ OK	D.8.1 D.8 D.5.2.1 D.6.2.1	Section 4.1.10 Table 2
$c_{min} = 1.75 \text{ in}$ $c_{max} = 1.5h_{ef} = (1.5)(2.16 \text{ in}) = 3.24 \text{ in}$ NOTE: If an edge distance is $> 1.5h_{ef}$, it is not assumed to influence the tension anchor capacity unless splitting is considered. $1.75 \text{ in} \leq 2 \text{ in} \leq 3.24 \text{ in}$ OK If an edge distance perpendicular to the factored shear load (V_{ua}) is $> 1.5c_{a1}$, it is not assumed to influence the shear anchor capacity. Edge distances perpendicular to the factored shear load are assumed infinite for this example. OK	D.8.3 RD.8.3 D.5.2.1 D.6.2.1	Section 4.1.10 Table 2
$h_{min} = 5.50 \text{ in}$ $h = 6 \text{ in} > 5.50 \text{ in}$ OK NOTES ON INSTALLATION: $h_{ef} = 2.16"$ for a 1/2" KWIK HUS-EZ having $h_{nom} = 3"$. The anchor length not including the head (l_{anch}) = 4" for a 1/2" x 4" KH-EZ. The actual $h_{nom} = l_{anch} - t_{fixture} = 4 \text{ in} - 0.375 \text{ in} = 3.625 \text{ in}$ $h = 6 \text{ in} > 5.50 \text{ in}$ actual $h_{nom} = 3.625 \text{ in} < 6 \text{ in}$ OK $h_{hole} = 3.625 \text{ in} + 0.375 \text{ in} = 4 \text{ in}$ $4 \text{ in} < 6 \text{ in}$ OK	-	Section 4.1.10 Table 1 Table 2
Calculate Design Steel Strength in Tension. $\Phi_{Steel} \Phi_{nonductile} N_{sa}$	D.5.12	Section 4.1.2
2-anchors in tension. Highest tension load acting on a single anchor = $N_{ua} / 2$ = 500 lb / 2-anchors = 250 lb / anchor Steel material: $N_{sa} = 18,120 \text{ lb/anchor}$ $\Phi_{steel} = 0.65$ KWIK HUS-EZ anchors are non-ductile steel elements. Assume seismic provisions of ACI 318-08, D.3.3.6: * non-ductile reduction factor = $\Phi_{nonductile}$ * assume designer-selected value for $\Phi_{nonductile} = 0.60$ NOTE: The non-ductile reduction factor, $\Phi_{nonductile}$, can vary from the default value = 0.4 per D.3.3.6 and RD.3.3.6. It is the responsibility of the designer when inputting values for $\Phi_{nonductile}$ different than the values noted in ACI 318-08, D.3.3.6 to determine if they are consistent with the design provisions of ACI 318-08, the applicable version of ASCE 7 and the governing building code. $\Phi_{steel} = 0.75$ $\Phi_{nonductile} = 0.60$ $\Phi_{Steel} \Phi_{nonductile} N_{sa} = (0.65) (0.60) (18,120 \text{ lb/anchor}) = 7066 \text{ lb/anchor}$	D.5.1.2	Table 3 Footnote 6

3.1 Anchor Principles and Design

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3027, KWIK HUS-EZ	ACI 318 Ref.	ESR Ref.
<p>Calculate Design Concrete Breakout Strength in Tension.</p> $\Phi N_{cbg} = \Phi_{seismic} \Phi_{concrete} \Phi_{nonductile} \left[\frac{A_{Nc}}{A_{Nco}} \cdot \psi_{ec,N} \cdot \psi_{ed,N} \cdot \psi_{c,N} \cdot \psi_{cp,N} \cdot N_b \right]$	D.3.3 D.5.2.1 (b) Eq. (D-5)	Section 4.1.3
$c_{-x} = \infty \quad s_x = 5 \text{ in} \quad c_{+x} = \infty$ $c_{+y} = \infty \quad c_{-y} = 2 \text{ in}$	D.5.2.1	-
$c_{max} = 1.5 \cdot h_{ef} = (1.5)(2.16 \text{ in}) = 3.24 \text{ in}$ if $c \geq 3.24 \text{ in}$ use $1.5 \cdot h_{ef}$ $s_{max} = 3 \cdot h_{ef} = (3)(2.6 \text{ in}) = 6.48 \text{ in}$ if $s > 6.48 \text{ in}$, no group action $A_{Nc} = (c_{-x} + s_x + c_{+x})(c_{+y} + c_{-y})$ $= (3.24 \text{ in} + 5 \text{ in} + 3.24 \text{ in})(3.24 \text{ in} + 2 \text{ in}) = 60 \text{ in}^2$ $A_{Nco} = (9)(h_{ef})^2 = (9)(2.16 \text{ in})^2 = 42 \text{ in}^2$	D.5.2.1 Eq. (D-6)	-
No tension eccentricity $\rightarrow \psi_{ec,N} = 1.0$	D.5.2.4 Eq. (D-9)	-
$\psi_{ed,N} = 0.70 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}} \right) = 0.70 + 0.3 \left(\frac{2 \text{ in}}{(1.5)(2.16 \text{ in})} \right) = 0.89$	D.5.2.5 Eq. (D-11)	-
<p>NOTE: cracked concrete conditions have been assumed.</p> $\psi_{c,N} = 1.0$ $\psi_{cp,N} = 1.0$	D.5.2.6 D.5.2.7	-
<p>NOTE: cracked concrete conditions assumed normal weight concrete $\rightarrow \lambda = 1.0$.</p> $N_b = k_{c,cr} \lambda \sqrt{f'_c} (h_{ef})^{1.5} = (17)(1.0)\sqrt{4000} (2.16 \text{ in})^{1.5} = 3413 \text{ lb}$	D.5.2.2 Eq. (D-7)	Table 3
$N_{cbg} = \left(\frac{60 \text{ in}^2}{42 \text{ in}^2} \right) (1.0)(0.89)(1.0)(1.0)(3413 \text{ lb}) = 4339 \text{ lb}$ $\Phi_{seismic} = 0.75 \quad \Phi_{concrete} = 0.65 \quad \Phi_{nonductile} = 0.60$ $\Phi N_{cbg} = (0.75)(0.65)(0.60)(4339 \text{ lb}) = 1269 \text{ lb}$	D.5.2.1 (b) Eq. (D-5)	Table 3

Anchor Principles and Design 3.1

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3027, KWIK HUS-EZ	ACI 318 Ref.	ESR Ref.
<p>Calculate Design Pullout Strength in Tension.</p> $\Phi N_{cbg} = \Phi_{\text{seismic}} \Phi_{\text{concrete}} \Phi_{\text{nonductile}} \left(N_{eq} \sqrt{\frac{f'_c}{2500}} \right)$	-	Section 4.1.8.2 Eq. 1 Table 3
<p>NOTE: Pullout Strength does not need to be considered. Reference Table 3, Footnote 3 in ESR-3027.</p>	-	Table 3 Footnote 3
<p>Calculate Design Steel Strength in Shear.</p> $\Phi_{\text{Steel}} \Phi_{\text{nonductile}} V_{sa}$	D.6.1.2	Section 4.1.5
<p>2-anchors in shear. Highest load acting on a single anchor = $V_{ua} / 2$ = 500 lb / 2-anchors = 250 lb / anchor</p> <p>KWIK HUS-EZ anchors are non-ductile steel elements. Assume seismic provisions of ACI 318-08, D.3.3.6:</p> <p>* non-ductile reduction factor = $\Phi_{\text{nonductile}}$ * assume designer-selected value for $\Phi_{\text{nonductile}} = 0.60$</p> <p>NOTE: The non-ductile reduction factor, $\Phi_{\text{nonductile}}$, can vary from the default value = 0.4 per D.3.3.6 and RD.3.3.6. It is the responsibility of the designer when inputting values for $\Phi_{\text{nonductile}}$ different than the values noted in ACI 318-08, D.3.3.6 to determine if they are consistent with the design provisions of ACI 318-08, the applicable version of ASCE 7 and the governing building code.</p> <p>Steel material: $V_{eq} = 5547$ lb/anchor $\Phi_{\text{steel}} = 0.60$ $\Phi_{\text{nonductile}} = 0.60$</p> <p>$\Phi_{\text{steel}} \Phi_{\text{nonductile}} V_{sa} = (0.60)(0.60)(5547 \text{ lb/anchor}) = 1997 \text{ lb/anchor}$</p>	D.6.1.2	Table 4 Footnote 5
<p>Calculate Design Concrete Breakout Strength in Shear.</p> $\Phi V_{cbg} = \Phi_{\text{seismic}} \Phi_{\text{concrete}} \Phi_{\text{nonductile}} \left[\frac{A_{Vc}}{A_{Vco}} \cdot \psi_{ec,V} \cdot \psi_{ed,V} \cdot \psi_{c,V} \cdot \psi_{h,V} \cdot V_b \right]$	D.3.3 D.6.2.1 (b) EQ. (D-22)	Section 4.1.6
<p>$c_{a1} = 2$ in $s_x = 5$ in $c_{a2-} = \infty$ $c_{a2+} = \infty$ $1.5c_{a1} = 3$ in projection from surface down = MINIMUM {$1.5c_{a1}$; h} = MINIMUM {3 in ; 6 in} = 3 in</p>	D.6.2.1	-
<p>$A_{Vc} = (c_{a2-} + s_x + c_{a2+}) (1.5c_{a1})$ = $(1.5c_{a1} + 5 \text{ in} + 1.5c_{a1}) (1.5c_{a1})$ = $(3 \text{ in} + 5 \text{ in} + 3 \text{ in}) (3 \text{ in}) = 33 \text{ in}^2$</p> <p>$A_{Vco} = (4.5) (c_{a1})^2 = (4.5) (2 \text{ in})^2 = 18 \text{ in}^2$</p>	D.6.2.1 EQ. (D-23)	-
<p>No shear eccentricity $\rightarrow \psi_{ec,V} = 1.0$</p>	D.6.2.5 EQ. (D-26)	-
<p>Edge projections in x+ and x- directions are assumed to be infinite for purposes of concrete breakout calculations in shear $\rightarrow \psi_{ed,V} = 1.0$.</p>	D.6.2.6 EQ. (D-28)	-
<p>Cracked concrete conditions, no edge reinforcement assumed $\rightarrow \psi_{c,V} = 1.0$</p>	D.6.2.7	-

3.1 Anchor Principles and Design

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3027, KWIK HUS-EZ		ACI 318 Ref.	ESR Ref.
$\psi_{h,v} = \sqrt{\frac{1.5c_{a1}}{h_a}}$ <p>Check: $h_a = 6 \text{ in}$; $1.5c_{a1} = 3 \text{ in}$ $6 \text{ in} > 3 \text{ in}$ $\psi_{h,v} = 1.0$</p>		D.6.2.8 EQ. (D-29)	
<p>NOTE: normal weight concrete $\rightarrow \lambda = 1.0$</p> $V_b = (7) \left(\frac{\ell_e}{d_{\text{anchor}}} \right)^{0.2} \lambda \sqrt{d_{\text{anchor}}} \sqrt{f'_c} (c_{a1})^{1.5}$ <p>$\ell_e = \text{MINIMUM} \{h_{ef}; 8d_{\text{anchor}}\} = \text{MINIMUM} \{2.16 \text{ in}; 4 \text{ in}\} = 2.16 \text{ in}$</p> $V_b = (7) \left(\frac{2.16 \text{ in}}{0.50 \text{ in}} \right)^{0.2} (1.0) \sqrt{0.50 \text{ in}} \sqrt{4000 \text{ psi}} (2 \text{ in})^{1.5} = 1186 \text{ lb}$		D.6.2.2 EQ. (D-24)	Table 4
$V_{cbg} = \left(\frac{33 \text{ in}^2}{18 \text{ in}^2} \right)^{0.2} (1.0) (1.0) (1.0) (1.0) (1186 \text{ lb}) = 2174 \text{ lb}$ <p>$\Phi_{\text{seismic}} = 0.75$ $\Phi_{\text{concrete}} = 0.70$ $\Phi_{\text{nonductile}} = 0.60$</p> $\Phi V_{cbg} = (0.75)(0.70)(0.60)(2174 \text{ lb}) = 685 \text{ lb}$		D.6.2.1 (b) EQ. (D-22)	Table 4
<p>Calculate Design Concrete Pryout Strength in Shear.</p> $\Phi V_{cpg} = \Phi_{\text{seismic}} \Phi_{\text{concrete}} \Phi_{\text{nonductile}} (k_{cp}) (N_{cbg})$		D.6.3.1 (b) EQ. (D-31)	Section 4.1.7 D.6.3.2 (b) EQ. (D-30b)
$V_{cpg} = (k_{cp}) (N_{cbg})$ <p>$N_{cbg} = 4339 \text{ lb}$ $h_{ef} = 2.16 \text{ in}$ $k_{cp} = 1$</p> $V_{cpg} = (1) (4339 \text{ lb}) = 4339 \text{ lb}$ <p>$\Phi_{\text{seismic}} = 0.75$ $\Phi_{\text{concrete}} = 0.70$ $\Phi_{\text{nonductile}} = 0.60$</p> $\Phi V_{cpg} = (0.75)(0.70)(0.60)(4339 \text{ lb}) = 1367 \text{ lb}$		D.6.3.1 (b) EQ. (D-31)	Table 4
<p>SUMMARY</p> <p>NOTE: ✓ indicates controlling Design Strength</p>			
TENSION SUMMARY	ΦN_N	N_{ua}	% Utilization $N_{ua} / \Phi N_N$
Design Steel Strength	$\Phi N_{sa} = 7066 \text{ lb/anchor}$	250 lb/anchor	4%
Design Concrete Breakout Strength	$\Phi N_{cbg} = 1269 \text{ lb}$	500 lb	39% ✓
Design Pullout Strength	$\Phi N_{pn,f/c} = \text{N/A}$	250 lb/anchor	N/A
SHEAR SUMMARY	ΦV_N	V_{ua}	% Utilization $V_{ua} / \Phi V_N$
Design Steel Strength	$\Phi V_{sa} = 1997 \text{ lb/anchor}$	250 lb/anchor	13%
Design Concrete Breakout Strength	$\Phi V_{cbg} = 685 \text{ lb}$	500 lb	73% ✓
Design Pry-Out Strength	$\Phi V_{cpg} = 1367 \text{ lb}$	500 lb	37%

Anchor Principles and Design 3.1

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3027, KWIK HUS-EZ		ACI 318 Ref.	ESR Ref.
INTERACTION EQUATION		D.7	Section 4.1.9
Check: $V_{ua} \leq (0.2)\Phi V_{cbg}$ $V_{ua} = 500 \text{ lb} \quad (0.2)(685 \text{ lb}) = 137 \text{ lb}$ $V_{ua} > (0.2)\Phi V_{cbg}$		D.7.1	
Check: $N_{ua} \leq (0.2)\Phi N_{cbg}$ $N_{ua} = 500 \text{ lb} \quad (0.2)(1269 \text{ lb}) = 254 \text{ lb}$ $N_{ua} > (0.2)\Phi N_{cbg}$		D.7.2	
Use Interaction Equation: $\frac{N_{ua}}{\Phi \cdot N_{cbg}} + \frac{V_{ua}}{\Phi \cdot V_{cbg}} \leq 1.2$ $\frac{500 \text{ lb}}{1269 \text{ lb}} + \frac{500 \text{ lb}}{685 \text{ lb}} \leq 1.2$ $0.39 + 0.73 = 1.12 < 1.2 \rightarrow \text{OK}$ <p>This fastening satisfies the design criteria that have been assumed.</p>		D.7.3 EQ. (D-32)	

3.1 Anchor Principles and Design

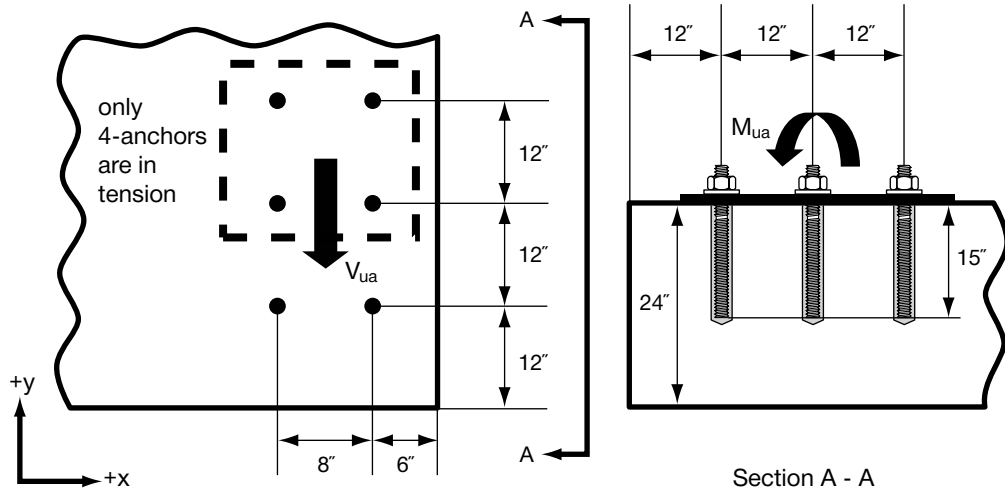
3.1.9.9 Design Examples

Strength Design Example, Adhesive Anchors, HIT-HY 150 MAX-SD

Objective:

Determine the controlling design strength in tension and shear.

Check the design strengths against the factored service loads.


Dimensional Parameters:

h_{ef}	= 15 in
h	= 24 in
s_x	= 8 in
s_{y1}	= 12 in
s_{y2}	= 12 in
c_{+x}	= 6 in
c_{-y}	= 12 in
d_{anchor}	= 1 in

Given:

Normal weight concrete, $f'_c = 6,000$ psi, Cracked concrete conditions assumed

Seismic design category (SDC) D. Design per ACI 318-08, D.3.3.6.

Use ACI 318-08, Ch. 9 / ESR-3013 L/R factors

=> Assume Condition B for all Φ factors

HIT-HY 150 MAX-SD Adhesive with 1" ASTM A193 B7 threaded rod

Anchors are ductile steel

4 - anchors in tension

Tension eccentricity = 2.899 in.

6 - anchors in shear

No eccentricity in shear

Bending Moment about x-axis = 240,000 in-lb

=> resultant tension load = 12,172 lb

$V_{ua} = 5,000$ lb

Things to check:

- Geometry requirements
- Tension Design Strengths
- Shear Design Strengths
- V_{cbg} acting at a corner
- Tension/Shear Interaction

References:

- Adhesive Anchor: HIT-HY 150 MAX-SD
- ACI 318-08, Appendix D
- ICC-ES Acceptance Criteria AC308
- ICC-ES ESR-3013

Anchor Principles and Design 3.1

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3013, HIT-HY 150 MAX-SD	ACI 318 Ref.	ESR Ref.
Check Minimum: Anchor Spacing, Edge Distance and Member Thickness.		
<p>MINIMUM $\{s_x; s_{y1}; s_{y2}\} = \text{MINIMUM} \{8 \text{ in}; 12 \text{ in}; 12 \text{ in}\} = 8 \text{ in}$</p> <p>$s_{\min} = 5 \text{ in}$ $s_{\max} = 3h_{ef} = (3)(15 \text{ in}) = 45 \text{ in}$</p> <p>NOTE: anchors spaced $> 3h_{ef}$ are not assumed to act as a group in tension.</p> <p>$5 \text{ in} \leq 8 \text{ in} \leq 45 \text{ in}$ OK</p>	D.8.1 RD.8 D.5.2.1	Table 6
<p>MINIMUM $\{c_{+x}; c_{-x}; c_{+y}; c_{-y}\} = \text{MINIMUM} \{6 \text{ in}; \infty; \infty; 12 \text{ in}\} = 6 \text{ in}$</p> <p>$c_{\min} = 5 \text{ in}$ $c_{\max} = 1.5h_{ef} = (1.5)(15 \text{ in}) = 22.5 \text{ in}$</p> <p>NOTE: if an edge distance is $> 1.5h_{ef}$, it is not assumed to influence the anchor capacity unless splitting is considered.</p> <p>$5 \text{ in} \leq 6 \text{ in} \leq 22.5 \text{ in}$ OK</p>	D.8.3 RD.8.3 D.5.2.1	Table 6
<p>$h_{\min} = h_{ef} + 2d_{\text{anchor}} = 15 \text{ in} + 2(1 \text{ in}) = 17 \text{ in}$ $h = 24 \text{ in} > 17 \text{ in}$ OK</p>	-	Table 6
<p>Calculate Design Steel Strength in Tension.</p> <p>$\Phi_{\text{Steel}} N_{sa}$</p>	D.5.1.2	Section 4.1.2
<p>4-anchors in tension. Highest load acting on a single anchor = 4513 lb.</p> <p>NOTE: factored load values determined using PROFIS Anchor software.</p> <p>NOTE: ASTM A193 B7 threaded rods are ductile steel elements and can be designed using the provisions of ACI 318-08, D.3.3.4. The Design Steel Strength $\Phi_{\text{Steel}} N_{sa}$ and $\Phi_{\text{Steel}} V_{sa}$ in tension and shear respectively must be the controlling design strengths in order to satisfy D.3.3.4.</p> <p>Neither $\Phi_{\text{Steel}} N_{sa}$ nor $\Phi_{\text{Steel}} V_{sa}$ will control for this example. Use the seismic provisions of ACI 318-08, D.3.3.6.</p> <p>Steel material: ASTM A 193 B7</p> <p>$N_{sa} = 75,710 \text{ lb/anchor}$, $\Phi_{\text{Steel}} = 0.75$</p> <p>Solution: $\Phi_{\text{Steel}} N_{sa} = 56,782 \text{ lb/anchor}$</p>	D.3.3.3 D.5.1.2	Table 5
<p>Calculate Design Concrete Breakout Strength in Tension.</p> <p>$\Phi N_{cbg} = \Phi_{\text{seismic}} \Phi_{\text{concrete}} \Phi_{\text{nonductile}} \left[\frac{A_{Nc}}{A_{Nco}} \cdot \psi_{ec,N} \cdot \psi_{ed,N} \cdot \psi_{c,N} \cdot \psi_{cp,N} \cdot N_b \right]$</p>	D.3.3 D.5.2.1 (b) Eq. (D-5)	Section 4.1.3
<p>$c_{-x} = \infty$ $s_x = 8 \text{ in}$ $c_{+x} = 6 \text{ in}$</p> <p>$c_{+y} = \infty$ $s_{y1} = 12 \text{ in}$ $s_{y2} = 12 \text{ in}$ $c_{-y} = 12 \text{ in}$</p> <p>NOTE: Only the top 4 - anchors are in tension.</p> <p>Disregard s_{y2}. c_{-y} will be MINIMUM $\{1.5 \cdot h_{ef}; 24 \text{ in}\}$</p> <p>Therefore: $c_{-y} = \text{MINIMUM} \{22.5 \text{ in}; 24 \text{ in}\}$</p> <p>$c_{-y} = 22.5 \text{ in}$</p>	D.5.2.1	-
<p>Assume seismic provisions of ACI 318-08, D.3.3.6:</p> <p>* non-ductile reduction factor = $\Phi_{\text{nonductile}}$</p> <p>* assume user-selected value for $\Phi_{\text{nonductile}} = 0.80$</p> <p>NOTE: The non-ductile reduction factor, $\Phi_{\text{nonductile}}$, can vary from the default value = 0.4 per D.3.3.6 and RD.3.3.6. It is the responsibility of the designer when inputting values for $\Phi_{\text{nonductile}}$ different than the values noted in ACI 318-08, D.3.3.6 to determine if they are consistent with the design provisions of ACI 318-08, the applicable version of ASCE 7 and the governing building code.</p>	D.3.3.6	
<p>$c_{\max} = 1.5 \cdot h_{ef} = 22.5 \text{ in}$ if $c \geq 22.5 \text{ in}$ in use $1.5 \cdot h_{ef}$</p> <p>$s_{\max} = 3 \cdot h_{ef} = 45 \text{ in}$ if $s > 45 \text{ in}$, no group action</p> <p>$A_{Nc} = (c_{-x} + s_x + c_{+x})(c_{+y} + s_{y2} + c_{-y})$</p> <p>$= (22.5 \text{ in} + 8 \text{ in} + 6 \text{ in})(22.5 \text{ in} + 12 \text{ in} + 22.5 \text{ in}) = 2080 \text{ in}^2$</p> <p>$A_{Nco} = (9)(h_{ef})^2 = (9)(15 \text{ in})^2 = 2025 \text{ in}^2$</p>	D.5.2.1 Eq. (D-6)	-

3.1 Anchor Principles and Design

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3013, HIT-HY 150 MAX-SD	ACI 318 Ref.	ESR Ref.
<p>NOTE: tension eccentricity determined using PROFIS Anchor software.</p> <p>$e_N' = 2.899 \text{ in.}$</p> $\psi_{ec,N} = \left(\frac{1}{1 + \frac{2e_N'}{3h_{ef}}} \right) = \left(\frac{1}{1 + \frac{(2)(2.899 \text{ in.})}{(3)(15 \text{ in.})}} \right) = 0.89$	D.5.2.4 Eq. (D-9)	-
$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}} \right) = 0.7 + 0.3 \left(\frac{6 \text{ in}}{(1.5)(15 \text{ in.})} \right) = 0.78$	D.5.2.5 Eq. (D-11)	-
<p>NOTE: cracked concrete conditions have been assumed.</p> <p>$\psi_{c,N} = 1.0$ $\psi_{cp,N} = 1.0$</p>	D.5.2.6 D.5.2.7	-
<p>NOTE: cracked concrete conditions assumed normal weight concrete $\rightarrow \lambda = 1.0$</p> $N_b = k_{c,cr} \lambda \sqrt{f_c'} (h_{ef})^{1.5} = (17) (1.0) \sqrt{6000} (15 \text{ in.})^{1.5} = 76,500 \text{ lb}$	D.5.2.2 EQ. (D-7)	Table 6
$N_{cbg} = \left(\frac{2080 \text{ in}^2}{2025 \text{ in}^2} \right) (0.89) (0.78) (1.0) (1.0) (76,500) = 54,548 \text{ lb}$ <p>$\Phi_{seismic} = 0.75 \quad \Phi_{concrete} = 0.65 \quad \Phi_{nonductile} = 0.80$</p> $\Phi N_{cbg} = (0.75) (0.65) (0.80) (54,548 \text{ lb}) = 21,273 \text{ lb}$	D.3.3.3 D.3.3.6 D.5.2.1 (b) Eq. (D-5)	Table 6
<p>Calculate Design Bond Strength in Tension.</p> $\Phi N_{ag} = \Phi_{seismic} \Phi_{bond} \Phi_{nonductile} \left[\frac{A_{Na}}{A_{Na0}} \cdot \psi_{ed,Na} \cdot \psi_{g,Na} \cdot \psi_{ec,Na} \cdot \psi_{p,Na} \cdot N_{a0} \right]$	-	Section 4.1.4 D.5.3.7 (b) EQ. (D-16b)
$s_{cr,Na} = 20d_{anchor} \sqrt{\frac{\tau_{k,uncr}}{1450}} = 20 (1 \text{ in}) \sqrt{\frac{1440 \text{ psi}}{1450}} = 19.93 \text{ in}$ <p>Check : $= 3h_{ef} = 45 \text{ in} \quad 19.93 \text{ in} < 45 \text{ in} \rightarrow s_{cr,Na} = 19.93 \text{ in}$</p> $c_{cr,Na} = \left(\frac{s_{cr,Na}}{2} \right) = \left(\frac{19.93 \text{ in}}{2} \right) = 9.97 \text{ in}$ <p>$c_{max} = c_{cr,Na}$ if $c \geq c_{cr,Na} \rightarrow$ use $c_{cr,Na}$</p> <p>$s_{max} = s_{cr,Na}$ if $s > s_{cr,Na} \rightarrow$ no group action</p> $A_{Na} = (c_{-x} + s_x + c_{+x}) (c_{+y} + s_{y2} + c_{-y})$ $= (9.97 \text{ in} + 8 \text{ in} + 6 \text{ in}) \times (9.97 \text{ in} + 12 \text{ in} + 9.97 \text{ in}) = 765 \text{ in}^2$ $A_{Na0} = (s_{cr,Na})^2 = (19.93 \text{ in})^2 = 397 \text{ in}^2$	-	Section 4.1.4 D.5.3.7 EQ. (D-16c) D.5.3.8 EQ. (D-16d) EQ. (D-16e) Table 7
$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{cr,Na}} \right) = 0.7 + 0.3 \left(\frac{6 \text{ in}}{9.97 \text{ in}} \right) = 0.88$	-	Section 4.1.4 D.5.3.12 EQ. (D-16m)

Anchor Principles and Design 3.1

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3013, HIT-HY 150 MAX-SD	ACI 318 Ref.	ESR Ref.
<p>NOTE: the following parameters will be used when calculating $\psi_{g,Na}$:</p> <p>$f'_c = 6000 \text{ psi} \rightarrow (1.06) (\tau_{k,cr}) = (1.06) (896 \text{ psi}) = 950 \text{ psi}$</p> <p>average spacing = $\left(\frac{12 \text{ in} + 8 \text{ in}}{2} \right) = 10 \text{ in}$</p>		<p>Section 4.1.4</p> <p>D.5.3.10</p> <p>Table 7</p> <p>Footnote 1</p>
<p>Number of anchors in tension = 4</p> <p>$\tau_{k,max,cr} = \left(\frac{k_{c,cr}}{(\pi) (d_{anchor})} \right) \sqrt{(h_{ef}) (f'_c)} = \left(\frac{17}{\pi} \right) \sqrt{(15) (6000 \text{ psi})} = 1623 \text{ psi}$</p> <p>$\psi_{g,Na0} = \sqrt{4} - \left[\left(\sqrt{4} - 1 \right) \left(\frac{\tau_{k,cr}}{\tau_{k,max,cr}} \right)^{1.5} \right] = 2 - \left[(1) \left(\frac{950 \text{ psi}}{1623 \text{ psi}} \right)^{1.5} \right] = 1.55$</p> <p>$\psi_{g,Na} = \psi_{g,Na0} + \left[\left(\frac{s_{average}}{s_{cr,Na}} \right)^{0.5} (1 - \psi_{g,Na0}) \right] = 1.55 + \left[\left(\frac{10 \text{ in}}{19.93 \text{ in}} \right)^{0.5} (1 - 1.55) \right] = 1.16$</p>	-	<p>Section 4.1.4</p> <p>D.5.3.10</p> <p>Eq. (D-16g)</p> <p>Eq. (D-16h)</p> <p>Eq. (D-16i)</p> <p>Table 6</p> <p>Table 7</p>
<p>$e_N' = 2.899 \text{ in}$</p> <p>$\psi_{ec,Na} = \frac{1}{1 + \left(\frac{2e_N'}{s_{cr,Na}} \right)} = \frac{1}{1 + \left(\frac{5.80 \text{ in}}{19.93 \text{ in}} \right)} = 0.77$</p>	-	<p>Section 4.1.4</p> <p>D.5.3.11</p> <p>EQ. (D-16j)</p>
<p>NOTE: cracked concrete conditions have been assumed.</p> <p>$\psi_{p,Na} = 1.0$</p>	-	<p>Section 4.1.4</p> <p>D.5.3.14</p>
<p>NOTE: $f'_c = 6000 \text{ psi} \rightarrow (1.06) (\tau_{k,cr}) = (1.06) (896 \text{ psi}) = 950 \text{ psi}$</p> <p>$N_{ao} = (\tau_{k,cr}) (\pi) (d_{anchor}) (h_{ef}) = (950 \text{ psi}) (\pi) (1 \text{ in}) (15 \text{ in}) = 44,767 \text{ lb}$</p>	-	<p>Section 4.1.4</p> <p>D.5.3.9</p> <p>EQ. (D-16f)</p> <p>Table 7</p> <p>Footnote 1</p>
<p>$N_{ag} = \left(\frac{765 \text{ in}^2}{397 \text{ in}^2} \right) (0.88) (1.16) (0.77) (1.0) (44,767 \text{ lb}) = 67,805 \text{ lb}$</p> <p>$\Phi_{seismic} = 0.75 \quad \Phi_{concrete} = 0.65 \quad \Phi_{nonductile} = 0.80$</p> <p>$\Phi N_{ag} = (0.75) (0.65) (0.80) (67,805 \text{ lb}) = 26,444 \text{ lb}$</p>	<p>D.3.3.3</p> <p>D.3.3.6</p>	<p>Section 4.1.4</p> <p>D.5.3.7 (b)</p> <p>EQ. (D-16b)</p> <p>Table 7</p>

Anchor Principles and Design 3.1

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3013, HIT-HY 150 MAX-SD	ACI 318 Ref.	ESR Ref.
<p>NOTE: normal weight concrete $\rightarrow \lambda = 1.0$</p> $V_b = (7) \left(\frac{\ell_e}{d_{\text{anchor}}} \right)^{0.2} \lambda \sqrt{d_{\text{anchor}}} \sqrt{f'_c} (c_{a1})^{1.5}$ $\ell_e = \text{MINIMUM} \{h_{ef}; 8d_{\text{anchor}}\} = \text{MINIMUM} \{15 \text{ in}; 8 \text{ in}\} = 8 \text{ in}$ $V_b = (7) \left(\frac{8 \text{ in}}{1 \text{ in}} \right)^{0.2} (1.0) \sqrt{1 \text{ in}} \sqrt{6000 \text{ psi}} (12 \text{ in})^{1.5} = 34,163 \text{ lb}$	D.6.2.2 EQ. (D-24)	-
$V_{cbg} = \left(\frac{576 \text{ in}^2}{648 \text{ in}^2} \right) (1.0) (0.80) (1.0) (1.0) (34,163 \text{ lb}) = 24,293 \text{ lb}$ $\Phi_{\text{seismic}} = 0.75 \quad \Phi_{\text{concrete}} = 0.70 \quad \Phi_{\text{nonductile}} = 0.80$ $\Phi V_{cbg} = (0.75) (0.70) (0.80) (24,293 \text{ lb}) = 10,203 \text{ lb}$	D.3.3.3 D.3.3.6 D.6.2.1 (b) EQ. (D-22)	Table 6
<p>Note: Concrete Breakout in the +x direction should also be checked since the anchor is located in a corner.</p> <p>For this example, Concrete Breakout in the -y direction controls.</p>	D.6.2.1 (d)	
<p>Calculate Design Concrete Pryout Strength in Shear.</p> $\Phi V_{cp} = \Phi_{\text{seismic}} \Phi_{\text{concrete}} \Phi_{\text{nonductile}} (k_{cp}) [\text{MINIMUM} \{N_{cbg}; N_{ag}\}]$	D.6.3.1 (b) EQ. (D-31)	Section 4.1.7 D.6.3.2 (b) EQ. (D-30b)
<p>Note: 6-anchors are in shear. Calculate N_{cbg} and N_{ag} for 6-anchors.</p>	-	-
<p>Calculate N_{cbg} for 6-anchors.</p> $c_{-x} = \infty \quad s_x = 8 \text{ in} \quad c_{+x} = 6 \text{ in}$ $c_{+y} = \infty \quad s_{y1} = 12 \text{ in} \quad s_{y2} = 12 \text{ in} \quad c_{-y} = 12 \text{ in}$	-	-
<p>Assume seismic provisions of ACI 318-08, D.3.3.6:</p> <p>* non-ductile reduction factor = $\Phi_{\text{nonductile}}$</p> <p>* assume user-selected value for $\Phi_{\text{nonductile}} = 0.80$</p>	D.3.3.6	-
$c_{\text{max}} = 1.5 \cdot h_{ef} = 22.5 \text{ in} \quad \text{if } c \geq 22.5 \text{ in use } 1.5 \cdot h_{ef}$ $s_{\text{max}} = 3 \cdot h_{ef} = 45 \text{ in} \quad \text{if } s > 45 \text{ in, no group action}$ $A_{Nc} = (c_{-x} + s_x + c_{+x}) (c_{+y} + s_{y1} + s_{y2} + c_{-y})$ $= (22.5 \text{ in} + 8 \text{ in} + 6 \text{ in}) (22.5 \text{ in} + 12 \text{ in} + 12 \text{ in} + 12 \text{ in}) = 2135 \text{ in}^2$ $A_{Nco} = (9) (h_{ef})^2 = (9) (15 \text{ in})^2 = 2025 \text{ in}^2$		
<p>NOTE: tension eccentricity not considered for shear.</p> $\psi_{ec,N} = 1.0$	D.5.2.4 EQ. (D-9)	
$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,\text{min}}}{1.5h_{ef}} \right) = 0.7 + 0.3 \left(\frac{6 \text{ in.}}{(1.5)(15 \text{ in.})} \right) = 0.78$	D.5.2.5 Eq. (D-11)	
<p>NOTE: cracked concrete conditions have been assumed.</p> $\psi_{c,N} = 1.0$ $\psi_{cp,N} = 1.0$	D.5.2.6 D.5.2.7	

3.1 Anchor Principles and Design

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3013, HIT-HY 150 MAX-SD	ACI 318 Ref.	ESR Ref.
<p>Note: cracked concrete conditions assumed normal weight concrete $\rightarrow \lambda = 1.0$.</p> $N_b = k_{c,cr} \lambda \sqrt{f'_c} (h_{ef})^{1.5} = (17) \sqrt{6000} (15 \text{ in})^{1.5} = 76,500 \text{ lb}$	D.5.2.2 Eq. (D-7)	Table 6
$N_{cbg} = \left(\frac{2135 \text{ in}^2}{2025 \text{ in}^2} \right) (1.0) (0.78) (1.0) (1.0) (76,500 \text{ lb}) = 62,911 \text{ lb}$		
<p>Calculate N_{ag} for 6-anchors.</p> $c_{-x} = \infty \quad s_x = 8 \text{ in} \quad c_{+x} = 6 \text{ in}$ $c_{+y} = \infty \quad s_{y1} = 12 \text{ in} \quad s_{y2} = 12 \text{ in} \quad c_{-y} = 12 \text{ in}$		
$S_{cr,Na} = 20d_{\text{anchor}} \sqrt{\frac{\tau_{k,uncr}}{1450}} = 20 (1 \text{ in}) \sqrt{\frac{1440 \text{ psi}}{1450}} = 19.93 \text{ in}$ <p>Check : $= 3h_{ef} = 45 \text{ in} \quad 19.93 \text{ in} < 45 \text{ in} \rightarrow s_{cr,Na} = 19.93 \text{ in}$</p> $c_{cr,Na} = \left(\frac{s_{cr,Na}}{2} \right) = \left(\frac{19.93 \text{ in}}{2} \right) = 9.97 \text{ in}$ <p>if $c \geq c_{cr,Na} \rightarrow$ use $c_{cr,Na}$</p> <p>if $s > s_{cr,Na} \rightarrow$ no group action</p> $A_{Na} = (c_{-x} + s_x + c_{+x}) (c_{+y} + 2s_{y2} + c_{-y})$ $= (9.97 \text{ in} + 8 \text{ in} + 6 \text{ in}) \times (9.97 \text{ in} + 12 \text{ in} + 12 \text{ in} + 9.97 \text{ in}) = 1053 \text{ in}^2$ $A_{Nc0} = (s_{cr,Na})^2 = (19.93 \text{ in})^2 = 397 \text{ in}^2$		Section 4.1.4 D.5.3.7 EQ. (D-16c) D.5.3.8 EQ. (D-16d) EQ. (D-16e)
$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{cr,Na}} \right) = 0.7 + 0.3 \left(\frac{6 \text{ in}}{9.97 \text{ in}} \right) = 0.88$	-	Section 4.1.4 D.5.3.12 EQ. (D-16m)
<p>Note: $f'_c = 6000 \text{ psi} \rightarrow (1.06) (\tau_{k,cr}) = (1.06) (896 \text{ psi}) = 950 \text{ psi}$</p> <p>average spacing = 10 in</p>	-	Section 4.1.4 D.5.3.10 Table 7 Footnote 1
<p>Number of anchors in tension = 6</p> $\tau_{k,max,cr} = \left(\frac{k_{c,cr}}{(n)(d_{\text{anchor}})} \right) \sqrt{(h_{ef})(f'_c)} = \left(\frac{17}{n} \right) \sqrt{(15)(6000 \text{ psi})} = 1623 \text{ psi}$ $\psi_{6,Na0} = \sqrt{6} - \left[(\sqrt{6} - 1) \left(\frac{\tau_{k,cr}}{\tau_{k,max,cr}} \right)^{1.5} \right] = 2.45 - \left[(1.45) \left(\frac{950 \text{ psi}}{1623 \text{ psi}} \right)^{1.5} \right] = 1.80$ $\psi_{6,Na} = \psi_{g,Na0} + \left[\left(\frac{s_{\text{average}}}{s_{cr,Na}} \right)^{0.5} (1 - \psi_{g,Na0}) \right] = 1.80 + \left[\left(\frac{10 \text{ in}}{19.93 \text{ in}} \right)^{0.5} (1 - 1.80) \right] = 1.23$	-	Section 4.1.4 D.5.3.10 Eq. (D-16g) Eq. (D-16h) Eq. (D-16i) Table 6 Table 7
<p>Note: tension eccentricity not considered for shear.</p> $\psi_{ec,Na} = 1.0$		Section 4.1.4 D.5.3.11

Anchor Principles and Design 3.1

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3013, HIT-HY 150 MAX-SD		ACI 318 Ref.	ESR Ref.
NOTE: cracked concrete conditions have been assumed. $\psi_{p,Na} = 1.0$			Section 4.1.4 D.5.3.14
NOTE: $f'_c = 6000 \text{ psi} \rightarrow (1.06) (\tau_{k,cr}) = (1.06) (896 \text{ psi}) = 950 \text{ psi}$ $N_{ao} = (\tau_{k,cr}) (n) (d_{\text{anchor}}) (h_{ef}) = (950 \text{ psi}) (n) (1 \text{ in}) (15 \text{ in}) = 44,767 \text{ lb}$			Section 4.1.4 D.5.3.9 EQ. (D-16f) Table 7 Footnote 1
$N_{ag} = \left(\frac{1053 \text{ in}^2}{397 \text{ in}^2} \right) (0.88) (1.23) (1.0) (1.0) (44,767 \text{ lb}) = 128,523 \text{ lb}$			Section 4.1.4 D.5.3.7 (b) EQ. (D-16b)
$V_{cpg} = (k_{cp}) [\text{MINIMUM}\{N_{cbg} ; N_{ag}\}]$ $N_{cbg} = 62,911 \text{ lb} \quad N_{ag} = 128,523 \text{ lb} \quad h_{ef} = 15 \text{ in} \quad k_{cp} = 2$ Concrete Breakout Strength controls: $V_{cpg} = (2) (62,911 \text{ lb}) = 125,822 \text{ lb}$ $\Phi_{\text{seismic}} = 0.75 \quad \Phi_{\text{concrete}} = 0.70 \quad \Phi_{\text{nonductile}} = 0.80$ $\Phi V_{cbg} = (0.75) (0.70) (0.80) (125,822 \text{ lb}) = 52,845 \text{ lb}$		D.3.3.3 D.3.3.6 D.6.3.1 (b) EQ. (D-31)	Table 6
SUMMARY NOTE: Factored loads calculated using PROFIS Anchor 2.1. ✔ indicates controlling Design Strength			
TENSION SUMMARY	ΦN_N	N_{ua}	% utilization $N_{ua} / \Phi N_N$
Design Steel Strength	$\Phi N_{sa} = 56,782 \text{ lb/anchor}$	4513 lb/anchor	8%
Design Concrete Breakout Strength	$\Phi N_{cbg} = 21,273 \text{ lb}$	12,172 lb	57% ✔
Design Bond Strength	$\Phi N_{ag} = 26,787 \text{ lb}$	12,172 lb	45%
SHEAR SUMMARY	ΦV_N	V_{ua}	% utilization $V_{ua} / \Phi V_N$
Design Steel Strength	$\Phi V_{sa} = 20,668 \text{ lb/anchor}$	833 lb/anchor	4%
Design Concrete Breakout Strength	$\Phi V_{cbg} = 10,203 \text{ lb}$	5000 lb	49% ✔
Design Pry-Out Strength	$\Phi V_{cpg} = 52,845 \text{ lb}$	5000 lb	9%

3.1 Anchor Principles and Design

3.1.9.9 Design Examples

Calculation per ACI 318-08 Appendix D, ICC-ES ESR-3013, HIT-HY 150 MAX-SD		ACI 318 Ref.	ESR Ref.
INTERACTION EQUATION		D.7	Section 4.1.9
Check: $V_{ua} \leq (0.2)\Phi V_{cbg}$ $V_{ua} = 5000 \text{ lb} \quad (0.2) (10,203 \text{ lb}) = 2041 \text{ lb}$ $V_{ua} > (0.2)\Phi V_{cbg}$		D.7.1	
Check: $N_{ua} \leq (0.2)\Phi N_{cbg}$ $N_{ua} = 12,172 \text{ lb} \quad (0.2) (21,273 \text{ lb}) = 4255 \text{ lb}$ $N_{ua} > (0.2)\Phi N_{cbg}$		D.7.2	
Use Interaction Equation: $\frac{N_{ua}}{\Phi \cdot N_{ag}} + \frac{V_{ua}}{\Phi \cdot V_{cbg}} \leq 1.2$ $\frac{12,172 \text{ lb}}{21,273 \text{ lb}} + \frac{5000 \text{ lb}}{10,203 \text{ lb}} \leq 1.2$ $0.57 + 0.49 = 1.06 < 1.2 \rightarrow \text{OK}$ <p>This fastening satisfies the design criteria that have been assumed.</p>		D.7.3 EQ. (D-32)	

Anchor Principles and Design 3.1

3.1.10 Torquing and Pretensioning of Anchors

Application of torque to anchor bolts 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-straightening an anchor after installation, hammer impacts, etc., can significantly alter the torque-tension relationship and result in improper anchor function under load, including failure of the anchorage. 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 in 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 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 such as 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 standard texts for additional information on this subject. Design of anchors for fatigue should consider the following points:

1. The use 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.

Hilti has conducted extensive testing of a variety of anchor types under fatigue conditions and can provide specific design recommendations for many situations. For specific cases, please contact Hilti Technical Support at 1-800-879-6000.

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. Hilti can provide such data for specific cases. Please contact Hilti Technical Support at 1-800-879-6000.

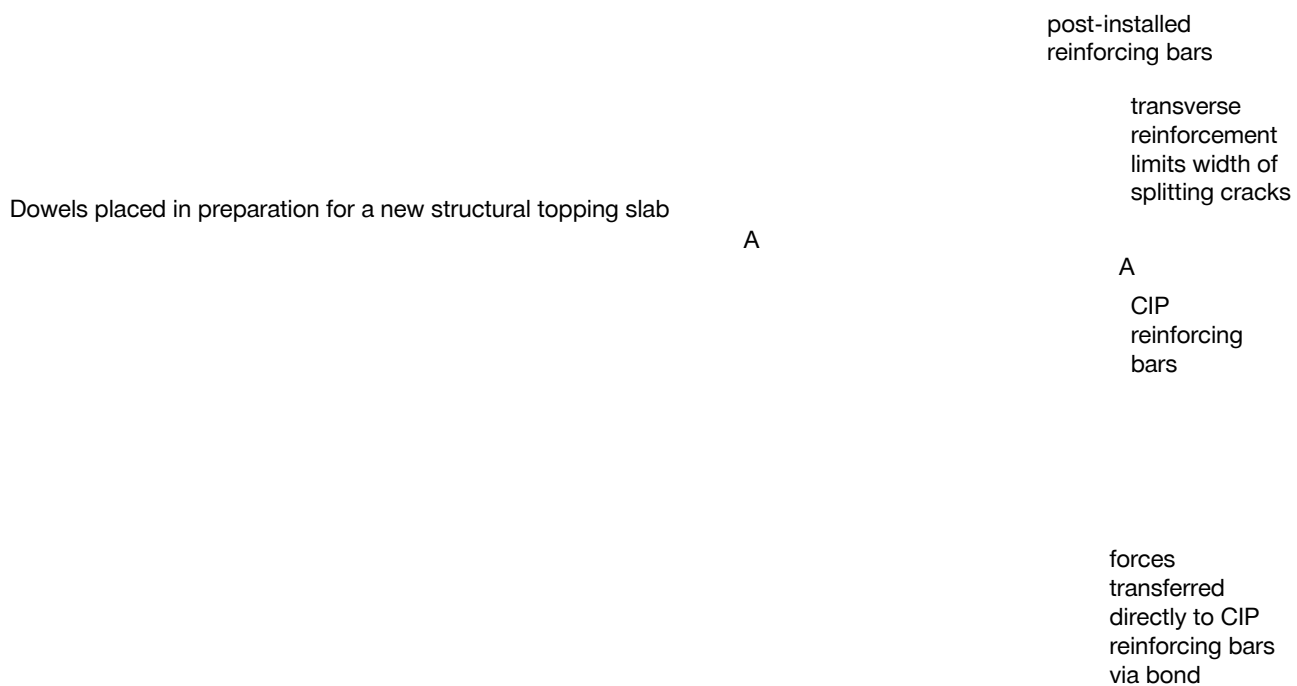
3.1 Anchor Principles and Design

3.1.13 Design of Post-Installed Reinforcing Bar Connections

C_{critical}S_{critical}

Polymer bonding materials such as Hilti HIT-HY and HIT-RE are increasingly used to execute the installation of reinforcing bars in hardened concrete, either to serve as dowels for structural extensions (slabs, footings), or to provide shear connection for seismic retrofitting elements such as infill shear walls.

Reinforcing dowels designed using anchor theory



Post-installed reinforcing for widening of a bridge deck

A distinction must be made between cases where the reinforcing bar is designed in the same manner as a post-installed adhesive anchor, i.e. using the principles of anchor design as described in this document, and those instances where the bar embedment length is established using the principles of reinforcing, e.g. in accordance with ACI 318 Chapter 12. This distinction is generally made on the basis of the specific geometry of the connection and whether the anticipated concrete failure mode corresponds to one of those considered in anchor design, e.g., concrete breakout, pryout etc. as opposed to the splitting failure mode associated with reinforcing bar design.

Section A-A




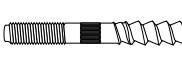
Post-installed reinforcement designed as a lap splice

For specific cases, please contact Hilti Technical Support at 1-800-879-6000.

Anchor Selection Guide 3.1.14

Applications Grid

Key: ● Very suitable ○ May be suitable per application

Design Criteria		Anchor Products	HIT-HY 150 MAX-SD Adhesive	HIT-RE 500-SD Epoxy	HIT-HY 150 MAX Adhesive		RE 500 Epoxy
					w/ threaded rod or rebar 	w/ HIT-TZ rod 	
Section Number:			3.2.3	3.2.4	3.2.6	3.2.5	3.2.7
ICC-ES ESR:			ESR-3013	ESR-2322	ESR-2262 (AC308) ESR-1967 (AC58)		
Fastening Base Material ¹	Uncracked concrete		●	●	●	●	●
	Cracked concrete		●	●		○	
	Lightweight concrete		○	○	●	○	○
	Hollow core concrete						
	Grout filled concrete block		○	○	●	○	○
	Hollow concrete block						
	Solid brick		○	○	○		○
	Hollow brick						
Installation	Oversized holes (per ICC)						○
	Cored holes (per ICC)			●		○	○
	Water saturated concrete (per ICC)		●	●	●	○	○
	Water-filled holes (per ICC)			●		○	○
	Submerged (per ICC)			●			○
	Overhead		●	●	●	○	●
	Sustained load		●	●	●	○	●
	In-place (through) fastening		●	●	●	●	●
Application Criteria ²	Finish			with HIS Insert	with HIS Insert		with HIS Insert
	Removeable to flush surface			with HIS Insert	with HIS Insert		with HIS Insert
	Seismic		●	●	○	○	○
	High cycle fatigue		○	●	○	○	●
	Shock / Impact load		○	○	○	○	○
	High temperature resistance		○	○	○	○	○
	Electro/Mechanically zinc plated		●	●	●	●	●
Corrosion ³	Sherardized carbon steel						
	Hot-dipped galvanized		7/8-in.	7/8-in.	7/8-in.		7/8-in.
	Stainless steel		304, 316	304, 316	304, 316	316	304, 316
Miscellaneous	Gel time/Cure time ⁴		5 min / 30 min	30 min / 12 hours	6 min / 30 min	6 min / 30 min	30 min / 12 hours
	Fastener diameters available (in.) ⁵		3/8, 1/2, 5/8, 3/4, 7/8, 1, 1-1/4	3/8, 1/2, 5/8, 3/4, 7/8, 1, 1-1/4	3/8, 1/2, 5/8, 3/4, 7/8, 1, 1-1/4	3/8, 1/2, 5/8, 3/4	3/8, 1/2, 5/8, 3/4, 7/8, 1, 1-1/4
	Anchor working principles ⁶		adhesive bond	adhesive bond	adhesive bond	expansion against bonding to base material	adhesive bond

** Refer to product literature for detailed information.

1 Base material may vary widely. Site specific anchor testing may be required.

2 Most testing is performed in normal weight concrete. Light weight concrete may be addressed. See product technical information.

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


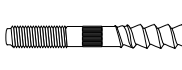
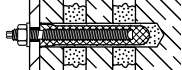


4 Gel time and cure time are given at a standard 68°F (20°C).

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

6 Refer to Section 3.1.5 for more detailed discussion on anchor working principles.

3.1.14 Anchor Selection Guide

Applications Grid Key: ● Very suitable ○ May be suitable per application

Design Criteria		HIT-ICE Adhesive		HIT-HY 20	HFX	HIT-HY 10
		w/ threaded rod or rebar	w/ HIT-TZ rod			
						
Section Number:		3.2.8	3.2.5	3.2.9		
ICC-ES ESR:				ESR-2659 (AC60)		
Fastening Base Material ¹	Uncracked concrete	●	●		●	●
	Cracked concrete		○			
	Lightweight concrete	●	○		○	○
	Hollow core concrete			○	○	○
	Grout filled concrete block	●	○		○	○
	Hollow concrete block			●	○	○
	Solid brick	○		●	○	○
	Hollow brick			●	○	○
Installation	Oversized holes (per ICC)					
	Cored holes (per ICC)		○	○		
	Water saturated concrete (per ICC)	○	○			
	Water-filled holes (per ICC)					
	Submerged (per ICC)					
	Overhead	●	○	○		
	Sustained load	●	○	○		
Application Criteria ²	In-place (through) fastening	●	●	○	●	●
	Finish	with HIS Insert		with HIT-I	with HIS Insert	with HIS Insert
	Removeable to flush surface	with HIS Insert		with HIT-I	with HIS Insert	with HIS Insert
	Seismic	○	○	○	○	○
	High cycle fatigue	○	○	○	○	○
	Shock / Impact load	○	○			
	High temperature resistance	○	○	○		
Corrosion ³	Electro/Mechanically zinc plated	●	●	●	●	●
	Sherardized carbon steel					
	Hot-dipped galvanized	7/8-in.		7/8-in.	7/8-in.	7/8-in.
	Stainless steel	304, 316	316	304, 316	304, 316	304, 316
Miscellaneous	Gel time/Cure time ⁴	4 min / 1 hour	4 min / 1 hour	6 min / 1 hour	5 min / 40 min	4 min / 1 hr
	Fastener diameters available (in.) ⁵	3/8, 1/2, 5/8, 3/4, 7/8, 1, 1-1/4	3/8, 1/2, 5/8, 3/4	5/16, 3/8, 1/2, 5/8, 3/4	3/8, 1/2, 5/8, 3/4, 7/8, 1, 1-1/4	3/8, 1/2, 5/8, 3/4, 7/8, 1, 1-1/4
	Anchor working principles ⁶	adhesive bond	expansion against bonding to base material	adhesive keying	adhesive bond	adhesive bond

** Refer to product literature for detailed information.

1 Base material may vary widely. Site specific anchor testing may be required.

2 Most testing is performed in normal weight concrete. Light weight concrete may be addressed. See product technical information.

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

4 Gel time and cure time are given at a standard 68°F (20°C).

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

6 Refer to Section 3.1.5 for more detailed discussion on anchor working principles.

Anchor Selection Guide 3.1.14

Applications Grid Key: ● Very suitable ○ May be suitable per application n/a Not applicable

Design Criteria		HVA Adhesive	HTE 50 Transportation Epoxy	HDA Undercut Anchor	HSL-3 Heavy Duty Expansion Anchor	HSL Heavy Duty Expansion Anchor
		HVU Capsule w/ HAS threaded rod				
Section Number:		3.2.10		3.3.1	3.3.2	3.3.3
ICC-ES ESR:				ESR-1546	ESR-1545	
Fastening Base Material ¹	Uncracked concrete	●	●	●	●	●
	Cracked concrete			●	●	●
	Lightweight concrete	○	○		●	○
	Hollow core concrete					
	Grout filled concrete block	○	○			
	Hollow concrete block					
	Solid brick	○	○			
	Hollow brick					
Installation	Oversized holes (per ICC)			n/a	n/a	n/a
	Cored holes (per ICC)					
	Water saturated concrete (per ICC)		●			
	Water-filled holes (per ICC)		○			
	Submerged (per ICC)		○			
	Overhead	●				
	Sustained load	●				
Application Criteria ²	In-place (through) fastening	●	●	●	●	●
	Finish	with HIS Insert	with HIS Insert	Stud	Stud/Bolt/Flush	Stud/Flush
	Removeable to flush surface	with HIS Insert	with HIS Insert	●	●	●
	Seismic	○	○	●	●	○
	High cycle fatigue	●	○	○	○	○
	Shock / Impact load	○		○	○	○
	High temperature resistance	○		●	●	●
Corrosion ³	Electro/Mechanically zinc plated	●	●	●	●	●
	Sherardized carbon steel			●		
	Hot-dipped galvanized	7/8-in.	7/8-in.			
	Stainless steel	304, 316	304, 316	316		316
Miscellaneous	Gel time/Cure time ⁴	8 min / 20 min	20 min / 24 hr			
	Fastener diameters available (in.) ⁵	3/8, 1/2, 5/8, 3/4, 7/8, 1, 1-1/4	3/8, 1/2, 5/8, 3/4, 7/8, 1, 1-1/4	M10, M12, M16, M20	M8, M10, M12, M16, M20, M24	M10, M12, M16, M20
	Anchor working principles ⁶	adhesive bond	adhesive bond	undercut	torque control expansion	torque control expansion

** Refer to product literature for detailed information.

1 Base material may vary widely. Site specific anchor testing may be required.

2 Most testing is performed in normal weight concrete. Light weight concrete may be addressed. See product technical information.

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

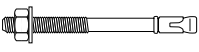
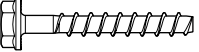
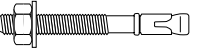
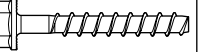

4 Gel time and cure time are given at a standard 68°F (20°C).

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

6 Refer to Section 3.1.5 for more detailed discussion on anchor working principles.

3.1.14 Anchor Selection Guide

Applications Grid Key: ● Very suitable ○ May be suitable per application

Anchor Products Design Criteria		KWIK Bolt TZ Expansion Anchor	KWIK HUS-EZ Screw Anchor	KWIK Bolt 3 Expansion Anchor	KWIK HUS Screw Anchor	HCA Coil Anchor
						
Section Number:		3.3.4	3.3.5	3.3.6	3.3.7	3.3.8
ICC-ES ESR:		ESR-1917	ESR-3027 (AC193)	ESR-2302 (AC193) ESR-1385 (AC01)		
Fastening Base Material ¹	Uncracked concrete	●	●	●	●	●
	Cracked concrete	●	●			
	Lightweight concrete	●	●	●	●	
	Hollow core concrete		○		○	
	Grout filled concrete block	○	●	●	●	
	Hollow concrete block					
	Solid brick					
	Hollow brick					
Application Criteria ²	In-place (through) fastening	●	●	●	●	●
	Finish	Stud	Bolt	Stud	Bolt	Bolt
	Removeable to flush surface		●		●	●
	Seismic	●	●	○	○	
	High cycle fatigue					
	Shock / Impact load					
	High temperature resistance	●	●	●	●	●
Corrosion ³	Electro/Mechanically zinc plated	●	●	●	●	●
	Sherardized carbon steel					
	Hot-dipped galvanized			●		
	Stainless steel	304, 316		304, 316		
Miscellaneous	Gel time/Cure time ⁴					
	Fastener diameters available (in.) ⁵	3/8, 1/2, 5/8, 3/4	1/4, 3/8, 1/2, 5/8, 3/4	1/4, 3/8, 1/2, 5/8, 3/4, 1	3/8, 1/2, 5/8, 3/4	1/4, 3/8, 1/2, 5/8, 3/4
	Anchor working principles ⁶	torque control expansion	undercutting screw threads	torque control expansion	undercutting screw threads	metal expansion coil

** Refer to product literature for detailed information.

1 Base material may vary widely. Site specific anchor testing may be required.

2 Most testing is performed in normal weight concrete. Light weight concrete may be addressed. See product technical information.

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

4 Gel time and cure time are given at a standard 68°F (20°C).

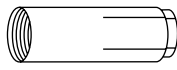

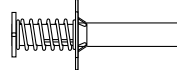
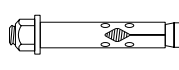
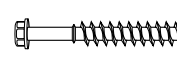
5 Listed diameters are those with published load data. Larger diameter elements may be used with some adhesive anchor systems, contact Hilti for more information.

6 Refer to Section 3.1.5 for more detailed discussion on anchor working principles.

Anchor Selection Guide 3.1.14

Applications Grid

Key: ● Very suitable ○ May be suitable per application

Anchor Products		HDI/HDI-L Drop-In Anchors	HDI-P Drop-In Anchor	HCI-WF/MD Cast-In Anchors	HLC Sleeve Anchor	KWIK Con II+ Screw Anchor
						
Section Number:		3.3.9	3.3.10	3.3.11	3.3.12	3.3.13
ICC-ES ESR:						
Fastening Base Material ¹	Uncracked concrete	●	●	●	●	●
	Cracked concrete					
	Lightweight concrete	●	○	●	○	○
	Hollow core concrete				○	○
	Grout filled concrete block	○	○		○	●
	Hollow concrete block				●	●
	Solid brick				●	●
	Hollow brick				○	●
Application Criteria ²	In-place (through) fastening				●	●
	Finish	Flush	Flush	Flush		
	Removeable to flush surface	●	●	●	○	●
	Seismic					
	High cycle fatigue					
	Shock / Impact load					
	High temperature resistance	●	●	●	●	●
Corrosion ³	Electro/Mechanically zinc plated	●	●	●	●	●
	Sherardized carbon steel					
	Hot-dipped galvanized					
	Stainless steel	303			304	410
Miscellaneous	Gel time/Cure time ⁴					
	Fastener diameters available (in.) ⁵	1/4, 3/8, 1/2, 5/8, 3/4	3/8		1/4, 5/16, 3/8, 1/2, 5/8, 3/4	3/16, 1/4
	Anchor working principles ⁶	displacement controlled expansion	displacement controlled expansion	cast-in anchor	Metal circumferential expander sleeve	undercutting screw threads

** Refer to product literature for detailed information.

1 Base material may vary widely. Site specific anchor testing may be required.

2 Most testing is performed in normal weight concrete. Light weight concrete may be addressed. See product technical information.

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

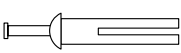

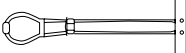
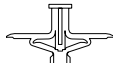

4 Gel time and cure time are given at a standard 68°F (20°C).

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

6 Refer to Section 3.1.5 for more detailed discussion on anchor working principles.

3.1.14 Anchor Selection Guide

Applications Grid Key: ● Very suitable ○ May be suitable per application

Design Criteria		Anchor Products	Metal HIT Anchor	HPS-1 Impact Anchor	HTB TOGGLER Bolt	HLD KWIK-Tog	IDP Insulation Anchor
							
Section Number:			3.3.14	3.3.15	3.3.16	3.3.17	3.3.19
ICC-ES ESR:							
Fastening Base Material ¹	Uncracked concrete		●	●		○	●
	Cracked concrete					○	●
	Lightweight concrete		○	○		○	●
	Hollow core concrete		○	○		○	○
	Grout filled concrete block		○	○		○	○
	Hollow concrete block		●	●	●	●	○
	Solid brick		●	●		○	●
	Hollow brick		○	○		○	○
Application Criteria ²	In-place (through) fastening		●	●	○		●
	Finish						
	Removeable to flush surface		○	●	●	○	
	Seismic						
	High cycle fatigue						
	Shock / Impact load						
	High temperature resistance		○	○	○		
Corrosion ³	Electro/Mechanically zinc plated		● Drive pin	● Drive pin	●		
	Sherardized carbon steel						
	Hot-dipped galvanized						
	Stainless steel		304 (Drive Pin)	304 (Drive screw)			
Miscellaneous	Gel time/Cure time ⁴						
	Fastener diameters available (in.) ⁵		3/16, 1/4	3/16, 1/4, 5/16	3/16, 1/4, 3/8, 1/2		
	Anchor working principles ⁶		impact expansion anchor	impact expansion anchor	anchor holds by keying	Hollow base = Keying Solid base = Friction	Friction

** Refer to product literature for detailed information.

1 Base material may vary widely. Site specific anchor testing may be required.

2 Most testing is performed in normal weight concrete. Light weight concrete may be addressed. See product technical information.

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

4 Gel time and cure time are given at a standard 68°F (20°C).

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

6 Refer to Section 3.1.5 for more detailed discussion on anchor working principles.

Adhesive Anchoring Systems 3.2

3.2.1 Adhesive Anchoring Systems Overview

3.2.1.1 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:

- Cure time
- Installation procedure
- Bond Strength
- Temperature sensitivity
- Creep resistance
- Inspection requirements

3.2.1.2 Hilti Accredited Installer Program

The Hilti Difference

In 2008, Hilti introduced the Hilti Accredited Installer Program. Participants in this program enhance their Adhesive Anchoring System knowledge and sharpen their installation skills.

Accredited Installer Program

Hilti Accredited Installers take pride in applying their new skills after completing this 4-hour course.

- Advanced skills include challenging applications such as deep embedment and water-filled holes
- All participants gain hands on experience and take a written exam to test their knowledge
- Participants understand how various jobsite conditions may influence the performance of adhesive anchor systems
- Hilti Accredited Installers become knowledgeable and efficient installers of Hilti Adhesive Anchoring Systems

On-Site Training Program

Participants receive application specific training to improve speed and efficiency.

- Course conducted on-site at no cost
- 1-hour course on Hilti Adhesive Anchoring Systems includes basic hands-on and theory concluded by a written test

Upon completion of either program, students receive a pocket card and/or certificate to document their achievement. Contact your Hilti representative for details.

3.2.1.3 Frequently Asked Questions

What is creep?

Creep is the slow and continuous deformation of a material over time, generally due to a sustained load. All materials experience some sort of creep - concrete, steel, stone and adhesive anchor systems.

- All current Hilti Adhesive Anchor Systems passed the creep test requirements of 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.

How does installation affect adhesive anchors?

Proper installation is the single most influential factor when it comes to an adhesive anchor system's bond strength and ultimately, creep 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".

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. ICC-ES AC308 is the latest acceptance criteria published in 2005 for evaluating Adhesive Anchoring Systems. How do they differ? Some differences are:

- ICC-ES AC308 only requires periodic special inspection for the highest performing products. ICC-ES AC58 requires continuous special inspection for all products.
- ICC-ES AC308 includes provisions for evaluating adhesive anchor systems in cracked concrete. ICC-ES AC58 based reports did not qualify products for use in cracked concrete.
- ICC-ES AC308 more thoroughly examines the sensitivity of adhesive anchor systems to improperly cleaned holes.
- ICC-ES AC308 requires testing for sustained loads. ICC-ES AC58 had sustained load testing but it was optional. Additionally, sustained load testing according to AC308 is evaluated to 10 years where AC58 only evaluated sustained loads to 600 days.
- ICC-ES AC308 includes provisions for evaluating adhesive anchor systems for high temperatures.

3.2.2 The Hilti HIT System

3.2.2.1 Hilti Adhesive Anchoring Systems

To address the various conditions found on today's construction projects, Hilti offers the most complete selection of 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.

*Hollow base materials require the use of a screen tube

Premium

RE 500-SD^{1,2}



T _{Gel} T _{Cure}	Appl. Temp.	Base Mat.
30 min 12 hr (@ 68°F)	41° to 104°F	

HY 150 MAX-SD^{1,2}



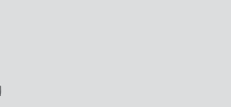
T _{Gel} T _{Cure}	Appl. Temp.	Base Mat.
6 min 30 min (@ 68°F)	14° to 104°F	

RE 500



T _{Gel} T _{Cure}	Appl. Temp.	Base Mat.
30 min 12 hr	23° to 104°F	

HY 150 MAX^{1,2}



T _{Gel} T _{Cure}	Appl. Temp.	Base Mat.
6 min 30 min (@ 68°F)	14° to 104°F	

HY 20^{1,2}

T _{Gel} T _{Cure}	Appl. Temp.	Base Mat.
6 min 1 hr (@ 68°F)	23° to 104°F	

HY 10

HFX



T _{Gel} T _{Cure}	Appl. Temp.	Base Mat.
4 min 1 hr (@ 68°F)	32° to 104°F	

T _{Gel} T _{Cure}	Appl. Temp.	Base Mat.
4 min 1 hr	32° to 104°F	

Use with standard caulk dispenser

Standard



Cracked Concrete



Concrete



Brick



Hollow CMU/Block



Grout-filled CMU/Block

¹ **2009 IBC**
Compliant Anchor

² **2006 IBC**
Compliant Anchor

HIT-HY 150 MAX-SD is the industry's first fast cure adhesive with a cracked concrete approval from ICC-ES for use in seismic applications. A perfect example of Hilti leading the way.

* Project/performance considerations include (but are not limited to), bond strength/capacity, approvals, use in wet/damp/cored holes, tested performance for dynamic loads, cracked concrete conditions, extent of technical documentation, temperature limitations, etc. The project engineer must always verify suitability — contact Hilti for details.

The Hilti HIT System 3.2.2

Most cartridges come in sizes:

- 11.1 oz (330 ml)
- 16.9 oz (500 ml)
- 47.3 oz (1400 ml)

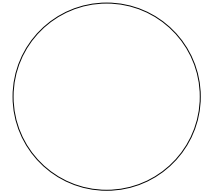
Contact your Hilti Representative for more information.



HIT-HY and HIT-RE Refill Packs

The HIT adhesives are supplied in the revolutionary refill packs*

- Integrated piercing device in refill packs for self-opening convenience — no cutting required
- The refill pack reduces waste up to 70% when compared to conventional hard cartridges
- HIT-ICE allows easy handling even with heavy winter gloves by using co-axial hard cartridges and large twist off caps



* excluding HIT-ICE

Refill Pack Holder

The refill pack holder is a reusable, hard cartridge

- The refill pack is easily inserted in the holder and the holder in the dispenser, for quick easy use
- The holder can be used to store and transport partially used refill packs

HIT-HY or HIT-RE Dispensers

- Fast, trouble free injections with a minimum of effort
- Designed and built to last
- ED 3500 Battery Dispenser for effortless dispensing

3.2.3 HIT-HY 150 MAX-SD Adhesive Anchoring System

3.2.3.1 Product Description

3.2.3.2 Material Specifications

3.2.3.3 Strength Design

3.2.3.4 Technical Data

3.2.3.5 Installation Instructions

3.2.3.6 Ordering Information

Listings/Approvals

ICC-ES (International Code Council)
ESR-3013

NSF/ANSI Std 61

certification for use in potable water

COLA (City of Los Angeles)

RR 25881



Independent Code Evaluation

IBC®/IRC® 2009 (ICC-ES AC308)

IBC®/IRC® 2006 (ICC-ES AC308)

IBC®/IRC® 2003 (ICC-ES AC308)

IBC®/IRC® 2000 (ICC-ES AC308)

FBC® 2007

LEED®: Credit 4.1-Low Emitting Materials

3.2.3.1 Product Description

Hilti HIT-HY 150 MAX-SD Adhesive Anchoring System is an injectable two-component hybrid adhesive. The two components are kept separate by means of a dual-cylinder foil pack attached to a manifold. The two components combine and react when dispensed through a static mixing nozzle attached to the manifold.

Hilti HIT-HY 150 MAX-SD Adhesive Anchoring System may be used with continuously threaded rod or deformed reinforcing bar installed in cracked or uncracked concrete. The primary components of the Hilti Adhesive Anchoring System are:

- Hilti HIT-HY 150 MAX-SD adhesive packaged in foil packs
- Adhesive mixing and dispensing equipment
- Equipment for hole cleaning and adhesive injection

Product Features

- Superior bond performance in cracked and uncracked normal weight concrete
- Seismic qualified per IBC®/IRC® 2009, IBC®/IRC® 2006, IBC®/IRC® 2003 and IBC®/IRC® 2000 (ICC-ES AC308). Please refer to ESR-3013 (ICC-ES AC308) for Seismic Design Category A through F
- Mixing tube provides proper mixing, eliminates measuring errors and minimizes waste
- Contains no styrene; virtually odorless
- Excellent weathering resistance; Resistance against elevated temperatures

The Leadership in Energy and Environmental Design (LEED®) Green Building Rating system™ is the nationally accepted benchmark for the design, construction and operation of high performance green buildings.

Fastener Components

HAS Threaded Rods

Rebar (supplied by contractor)



Mixing Nozzle

HIT-HY 150 MAX-SD
Refill Pack

HIT-HY 150 MAX-SD
Medium Cartridge

HIT-HY 150 MAX-SD
Jumbo Cartridge

Refill Pack Holder

Refill Pack Holder

ED 3500
Battery
Dispenser

P3500
Dispenser

MD2500
Dispenser

P8000D
Dispenser

HIT-HY 150 MAX-SD Adhesive Anchoring System 3.2.3

Guide Specifications

Master Format Section:

Previous 2004 Format

03250 03 16 00 (Concrete Anchors)

Related Sections:

03200 03 20 00 (Concrete Reinforcing)

05050 05 50 00 (Metal Fabrications)

05120 05 10 00 (Structural Metal Framing)

Injectable adhesive shall be used for installation of all reinforcing steel dowels or threaded anchor rods into new or existing concrete. Adhesive shall be furnished in side-by-side refill packs which keep component A and component B separate. Side-by-side packs shall be designed to compress during use to minimize waste volume. Side-by-side packs shall also be

designed to accept static mixing nozzle which thoroughly blends component A and component B and allows injection directly into drilled hole. Only injection tools and static mixing nozzles as recommended by manufacturer shall be used. Manufacturer's instructions shall be followed. Injection adhesive shall be formulated to include resin and hardener to provide optimal curing speed as well as high strength and stiffness. Typical curing time at 68°F (20°C) shall be approximately 30 minutes.

Injection adhesive shall be HIT-HY 150 MAX-SD, as furnished by Hilti.

Anchor Rods shall be furnished with chamfered ends so that either end will accept a nut and washer. Alternatively, anchor rods shall be furnished with a 45 degree chisel point on one end to allow for easy insertion into the adhesive-filled hole. Anchor rods shall be manufactured to meet the following requirements:

1. ISO 898 Class 5.8
2. ASTM A 193, Grade B7 (high strength carbon steel anchor);
3. AISI 304 or AISI 316 stainless steel, meeting the requirements of ASTM F 593 (condition CW).

Special order length HAS Rods may vary from standard product.

Nuts and Washers of other grades and styles having specified proof load strength greater than the specified grade and style are also suitable. Nuts must have specified proof load strength equal to or greater than the minimum tensile strength of the specified threaded rod.

3.2.3.2 Material Specifications

Material Properties for Cured Adhesive

Compressive strength ¹	70	N/mm ²	ISO 604
Compressive strength module (E-modulus) ¹	1350	N/mm ²	ISO 604
Tensile strength @ break	9.5	N/mm ²	ASTM D 638-97
Elongation @ break	2.75	%	ASTM D 638-97
Tensile modulus	2663	N/mm ²	ASTM D 638
Flexural strength	42.83	N/mm ²	ASTM D 790
Flexural modulus	2870	N/mm ²	ASTM D 790
Volume shrinkage	3	%	ISO 3521
Linear shrinkage	3	%	
Water absorption (28 d)	5.3	%	ISO 62
pH value cured mortar	6		EN 1245
Thermal expansion coefficient	31	ppm/°C	
Specific contact resistance	2.17 x 10 ⁹	Ωxcm	DIN IEC 93
Specific surface resistance	5.05 x 10 ⁹	Ωxcm	DIN IEC 93
Electric strength	2.85	kV/mm	DIN VDE 303
UV stability cured mortar	Stable		EN ISO 4862-2

¹ Minimum values obtained as a result of three cure temperatures (23°, 40°, 60°F)

3.2.3 HIT-HY 150 MAX-SD Adhesive Anchoring System

3.2.3.3 Strength Design^{1,2}

3.2.3.3.1 General: Design strengths are determined in accordance with ACI 318-08 Appendix D (ACI 318) and supplemented by ICC-ES ESR-3013.

Design parameters are provided in Table 5 through Table 19. Strength reduction factors, Φ , as given in ACI 318 D.4.4 must be used for load combinations calculated in accordance with Section 1605.2.1 of the IBC and Section 9.2 of ACI 318. Strength reduction factors, Φ , as given in ACI 318 D.4.5 must be used for load combinations calculated in accordance with ACI 318 Appendix C.

The following amendments to ACI 318 Appendix D must be used as required for the strength design of adhesive anchors. In conformance with ACI 318, all equations are expressed in inch-pound units.

Modify ACI 318 D.4.1.2 as follows:

D.4.1.2 — In Eq. (D-1) and (D-2), ΦN_n and ΦV_n are the lowest design strengths determined from all appropriate failure modes. ΦN_n is the lowest design strength in tension of an anchor or group of anchors as determined from consideration of ΦN_{sa} , either ΦN_a or ΦN_{ag} and either ΦN_{cb} or ΦN_{cbg} . ΦV_n is the lowest design strength in shear of an anchor or a group of anchors as determined from consideration of: ΦV_{sa} , either ΦV_{cb} or ΦV_{cbg} , and either ΦV_{cp} or ΦV_{cpg} . For adhesive anchors subjected to tension resulting from sustained loading, refer to D.4.1.4 for additional requirements.

Add ACI 318 Section D.4.1.4 as follows:

D.4.1.4 — For adhesive anchors subjected to tension resulting from sustained loading, a supplementary check shall be performed using Eq. (D-1), whereby N_{ua} is determined from the sustained load alone, e.g., the dead load

and that portion of the live load acting that may be considered as sustained and ΦN_n is determined as follows:

D.4.1.4.1 — For single anchors,
 $\Phi N_n = 0.75\Phi N_{a0}$.

D.4.1.4.2 — For anchor groups, Eq. (D-1) shall be satisfied by taking $\Phi N_n = 0.75fN_{a0}$ for that anchor in an anchor group that resists the highest tension load.

D.4.1.4.3 — Where shear loads act concurrently with the sustained tension load, the interaction of tension and shear shall be analyzed in accordance with D.4.1.3.

Modify ACI 318 D.4.2.2 in accordance with 2009 IBC Section 1908.1.10 as follows:

D.4.2.2 — The concrete breakout strength requirements for anchors in tension shall be considered satisfied by the design procedure of D.5.2 provided Equation D-8 is not used for anchor embedments exceeding 25 inches. The concrete breakout strength requirements for anchors in shear with diameters not exceeding 2 inches shall be considered satisfied by the design procedure of D.6.2. For anchors in shear with diameters exceeding 2 inches, shear anchor reinforcement shall be provided in accordance with the procedures of D.6.2.9.

3.2.3.3.2. Static Steel Strength in

Tension: The nominal static steel strength of a single anchor in tension, N_{sa} , in accordance with ACI 318 D.5.1.2 and strength reduction factor, Φ , in accordance with ACI D.4.4 are given in the tables outlined in Table 1a for the corresponding anchor steel.

3.2.3.3.3. Static Concrete Breakout Strength in Tension:

The nominal static concrete breakout strength of a single anchor or group of anchors in tension, N_{cb} or N_{cbg} , must be calculated in accordance with ACI 318 D.5.2 with the following addition:

D.5.2.10 (2009 IBC) or D.5.2.9 (2006 IBC) — The limiting concrete strength of adhesive anchors in tension shall be calculated in accordance with D.5.2.1 to D.5.2.9 under the 2009 IBC or D.5.2.1 to D.5.2.8 under the 2006 IBC where the value of k_c to be used in Eq. (D-7) shall be:

$k_{c,cr}$ where analysis indicates cracking at service load levels in the anchor vicinity (cracked concrete). The values of $k_{c,cr}$ are given in Tables 6, 9, 12, 15 and 18 of this document.

$k_{c,uncr}$ where analysis indicates no cracking at service load levels in the anchor vicinity (uncracked concrete). The values of $k_{c,uncr}$ are given in Tables 6, 9, 12, 15 and 18 of this document.

The basic concrete breakout strength of a single anchor in tension, N_b , must be calculated in accordance with ACI D.5.2.2 using values of h_{ef} , $k_{c,cr}$ and $k_{c,uncr}$ as described in the tables of this document. The modification factor “ λ ” shall be taken as 1.0. Anchors shall not be installed in lightweight concrete. The value of f'_c used for calculation must be limited to 8,000 psi (55 MPa) in accordance with ACI 318 D.3.5.

1 ACI 318-05 or 318-02 may also be used. The section references and terminology are different from those given in this section.

2 This section 3.2.3.3 is a reproduction of the content of ICC-SR 3013, representing the opinions and recommendations of ICC-ES.

HIT-HY 150 MAX-SD Adhesive Anchoring System 3.2.3

3.2.3.3.4. Static Pullout Strength

in Tension: In lieu of determining the nominal static pullout strength in accordance with ACI 318 D.5.3, nominal bond strength in tension must be calculated in accordance with the following sections added to ACI 318:

D.5.3.7 — The nominal bond strength of a single adhesive anchor N_a , or group of adhesive anchors, N_{ag} , in tension shall not exceed

(a) for a single anchor

$$N_a = \frac{A_{Na}}{A_{Na0}} \cdot \psi_{ed,Na} \cdot \psi_{p,Na} \cdot N_{a0} \quad (D-16a)$$

(b) for a group of anchors

$$N_{ag} = \frac{A_{Na}}{A_{Na0}} \cdot \psi_{ed,Na} \cdot \psi_{g,Na} \cdot \psi_{ec,Na} \cdot \psi_{p,Na} \cdot N_{a0} \quad (D-16b)$$

where:

A_{Na} is the projected area of the failure surface for the single anchor or group of anchors that shall be approximated as the base of the rectilinear geometrical figure that results from projecting the failure surface outward a distance, $c_{cr,Na}$, from the centerline of the anchor, or in the case of a group of anchors, from a line through a row of adjacent anchors. A_{Na} shall not exceed nA_{Na0} where n is the number of anchors in tension in the group. In ACI 318 Figures RD.5.2.1a and RD.5.2.1b, the terms $1.5h_{ef}$ and $3.0h_{ef}$ shall be replaced with $c_{cr,Na}$ and $s_{cr,Na}$ respectively.

A_{Na0} is the projected area of the failure surface of a single anchor without the influence of proximate edges in accordance with Eq. (D-16c):

$$A_{Na0} = (s_{cr,Na})^2 \quad (D-16c)$$

with

$s_{cr,Na}$ = as given by Eq. (D-16d).

D.5.3.8 — The critical spacing $s_{cr,Na}$ and critical edge distance $c_{cr,Na}$ shall be calculated as follows:

$$s_{cr,Na} = 20 \cdot d \sqrt{\frac{t_{k,uncr}}{1,450}} \leq 3 \cdot h_{ef} \quad (D-16d)$$

$$c_{cr,Na} = \frac{s_{cr,Na}}{2} \quad (D-16e)$$

D.5.3.9 — The basic strength of a single adhesive anchor in tension in cracked concrete shall not exceed:

$$N_{a0} = \tau_{k,cr} \cdot \pi \cdot d \cdot h_{ef} \quad (D-16f)$$

where:

$\tau_{k,cr}$ is the bond strength in cracked concrete

D.5.3.10 — The modification factor for the influence of the failure surface of a group of adhesive anchors is:

$$\psi_{g,Na} = \psi_{g,Na0} + \left[\left(\frac{s}{s_{cr,Na}} \right)^{0.5} \cdot (1 - \psi_{g,Na0}) \right] \quad (D-16g)$$

Where

$$\psi_{g,Na0} = \sqrt{n} - \left[(\sqrt{n} - 1) \cdot \left(\frac{\tau_{k,cr}}{\tau_{k,max,cr}} \right)^{1.5} \right] \geq 1.0 \quad (D-16h)$$

Where

n = the number of tension-loaded adhesive anchors in a group.

$$\tau_{k,max,cr} = \frac{k_{c,cr}}{\pi \cdot d} \cdot \sqrt{h_{ef} \times f'_c} \quad (D-16i)$$

The value of f'_c must be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318 D.3.5.

D.5.3.11 — The modification factor for eccentrically loaded adhesive anchor groups is:

$$\psi_{ec,Na} = \frac{1}{1 + \frac{2e'_N}{s_{cr,Na}}} \leq 1.0 \quad (D-16j)$$

Eq. (D-16j) is valid for $e'_N \leq \frac{s}{2}$

If the loading on an anchor group is such that only certain anchors are in tension, only those anchors that are in tension shall be considered when determining the eccentricity e'_N for use in Eq. (D-16j).

In the case where eccentric loading exists about two orthogonal axes, the modification factor $\psi_{ec,Na}$ shall be computed for each axis individually and the product of these factors used as $\psi_{ec,Na}$ in Eq. (D-16b).

D.5.3.12 — The modification factor for the edge effects for a single adhesive anchor or anchor groups loaded in tension is:

$$\psi_{ed,Na} = 1.0 \text{ when } c_{a,min} \geq c_{cr,Na} \quad (D-16l)$$

$$\psi_{ed,Na} = \left(0.7 + 0.3 \cdot \frac{c_{a,min}}{c_{cr,Na}} \right) \leq 1.0 \text{ when } c_{a,min} < c_{cr,Na} \quad (D-16m)$$

D.5.3.13 — When an adhesive anchor or a group of adhesive anchors is located in a region of a concrete member where analysis indicates no cracking at service load levels, the nominal strength, N_a or N_{ag} , of a single adhesive anchor or a group of adhesive anchors shall be calculated according to Eq. (D-16a) and Eq. (D-16b) with $\tau_{k,uncr}$ substituted for $\tau_{k,cr}$ in the calculation of the basic strength N_{a0} in accordance with Eq. (D-16f). The factor $\psi_{g,Na0}$ shall be calculated in accordance with Eq. (D-16h) whereby the value of $\psi_{k,max,uncr}$ shall be calculated in accordance with Eq. (D-16n) and substituted for $\tau_{k,max,cr}$ in Eq. (D-16h).

$$\tau_{k,max,uncr} = \frac{\tau_{k,uncr}}{\pi \cdot d} \cdot \sqrt{h_{ef} \cdot f'_c} \quad (D-16n)$$

D.5.3.14—When an adhesive anchor or a group of adhesive anchors is located in a region of a concrete member where analysis indicates no cracking at service load levels, the modification factor $\psi_{p,Na}$ shall be taken as:

$$\psi_{p,Na} = 1.0 \text{ when } c_{a,min} \geq c_{ac} \quad (D-16o)$$

$$\psi_{p,Na} = \frac{\max |c_{a,min}; c_{cr,Na}|}{c_{ac}} \text{ when } c_{a,min} < c_{ac} \quad (D-16p)$$

where:

c_{ac} shall be determined in accordance with Section 3.2.3.3.10 of this document.

3.2.3 HIT-HY 150 MAX-SD Adhesive Anchoring System

For all other cases: $c_{p,Na} = 1.0$ (e.g. when cracked concrete is considered).

Additional information for the determination of nominal bond strength in tension is given in Section 3.2.3.3.8 of this document.

3.2.3.3.5. Static Steel Strength in Shear:

The nominal static steel strength of a single anchor in shear as governed by the steel, V_{sa} , in accordance with ACI 318 D.6.1.2 and strength reduction factor, Φ , in accordance with ACI 318 D.4.4 are given in the tables outlined in Table 1a of this document for the corresponding anchor steel.

3.2.3.3.6. Static Concrete Breakout Strength in Shear:

The nominal static concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg} , must be calculated in accordance with ACI 318 D.6.2 based on information given in the tables outlined in Table 1a of this document for the corresponding anchor steel. The basic concrete breakout strength of a single anchor in shear, V_b , must be calculated in accordance with ACI 318 D.6.2.2 using the values of d given in the tables outlined in Table 1a for the corresponding anchor steel in lieu of d_a (IBC 2009) and d_0 (IBC 2006). In addition, h_{ef} must be substituted for ℓ_e . In no case shall h_{ef} exceed $8d$. The value of f'_c must be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318 D.3.5.

3.2.3.3.7. Static Concrete Pryout Strength in Shear:

In lieu of determining the nominal static pryout strength in accordance with ACI 318 D.6.3.1, the nominal pryout strength in shear must be calculated in accordance with the following sections added to ACI 318:

D.6.3.2 — The nominal pryout strength of an adhesive anchor or group of adhesive anchors shall not exceed:

(a) for a single adhesive anchor:

$$V_{cp} = \min | k_{cp} \cdot N_a ; k_{cp} \cdot N_{cb} | \quad (D-30a)$$

(b) for a group adhesive anchors:

$$V_{cpg} = \min | k_{cp} \cdot N_{ag} ; k_{cp} \cdot N_{cbg} | \quad (D-30b)$$

where:

$$k_{cp} = 1.0 \text{ for } h_{ef} < 2.5 \text{ inches (64 mm)}$$

$$k_{cp} = 2.0 \text{ for } h_{ef} \geq 2.5 \text{ inches (64 mm)}$$

N_a shall be calculated in accordance with Eq. (D-16a).

N_{ag} shall be calculated in accordance with Eq. (D-16b).

N_{cb} and N_{cbg} shall be determined in accordance with D.5.2.

3.2.3.3.8. Bond Strength

Determination: Bond strength values are a function of the concrete compressive strength, whether the concrete is cracked or uncracked and the installation conditions (dry, water-saturated concrete). The resulting characteristic bond strength must be multiplied by the associated strength reduction factor Φ_{nn} as follows:

Concrete Type	Permissible Installation Conditions	Bond Strength	Associated Strength Reduction Factor
Uncracked	Dry	$\tau_{k,uncr}$	Φ_d
	Water-saturated	$\tau_{k,uncr}$	Φ_{ws}
Cracked	Dry	$\tau_{k,cr}$	Φ_d
	Water-saturated	$\tau_{k,cr}$	Φ_{ws}

Figure 2 of this document presents a bond strength design selection flowchart. Strength reduction factors for determination of the bond strength are given in the tables outlined in Table 1a of this document. Adjustments to the bond strength may also be taken for increased concrete compressive strength. These factors are given in the corresponding tables as well.

3.2.3.3.9. Minimum Member Thickness, h_{min} , Anchor spacing, s_{min} , and Edge Distance, c_{min} :

In lieu of ACI 318 D.8.3, values of c_{min} and s_{min} described in this document must be observed for anchor design and installation. In lieu of ACI 318 D.8.5, the minimum member thicknesses, h_{min} , described in this document must be observed for anchor design and installation. In determining minimum edge distance, c_{min} , the following section must be added to ACI 318:

D.8.8 — For adhesive anchors that will remain untorqued, the minimum edge distance shall be based on minimum cover requirements for reinforcement in 7.7. For adhesive anchors that will be torqued, the minimum edge distance and spacing shall be given in Tables 6, 9, 12, 15 and 18 of this document.

For edge distances c_{ai} and anchor spacing s_{ai} the maximum torque T'_{max} shall comply with the following requirements:

Reduced Installation Torque T_{max} for Edge Distances $c_{ai} < (5 \times d)$		
Edge Distance c_{ai}	Minimum Anchor Spacing, s_{ai}	$= >$ Torque, T_{max}
1.75 in. (45 mm)	$5 \times d \leq s_{ai} < 16$ in.	$0.3 \times T_{max}$
$\leq c_{ai} < 5 \times d$	$s_{ai} \geq 16$ in. (406 mm)	$0.5 \times T_{max}$

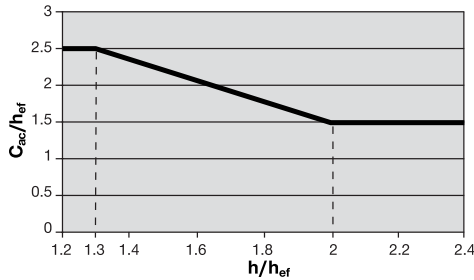
3.2.3.3.10. Critical Edge Distance, c_{ac} :

For the calculation of N_{cb} , N_{cbg} , N_a and N_{ag} in accordance with ACI 318 Section D.5.2.7 and Section 3.2.3.3.4 of this document, the critical edge distance, c_{ac} , must be taken as follows:

- $c_{ac} = 1.5 h_{ef}$ for $h/h_{ef} \geq 2$
- $c_{ac} = 2.5 h_{ef}$ for $h/h_{ef} \leq 1.3$

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For definition of h and h_{ef} , see Figure 1 of this document.



Linear interpolation is permitted to determine the ratio c_{ac}/h_{ef} for values of h/h_{ef} between 2 and 1.3 as illustrated in the graph above.

3.2.3.3.11. Design Strength in Seismic Design Categories C, D, E and F: In

structures assigned to Seismic Design Category C, D, E or F under the IBC or IRC, the design must be performed according to ACI 318 Section D.3.3, and the anchor strength must be adjusted in accordance with 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16.

For brittle steel elements, the anchor strength must be adjusted in accordance with ACI 318-05 D.3.3.5 or ACI 318-08 D.3.3.5 or D.3.3.6. The nominal steel shear strength, V_{sa} , must be adjusted by $\alpha_{V,seis}$ as given in the tables summarized in Table 1a for the corresponding anchor steel. An adjustment of the nominal bond strength $\tau_{k,cr}$ by $\alpha_{N,seis}$ is not necessary, since $\alpha_{N,seis} = 1.0$ in all cases.

3.2.3.3.12. Interaction of Tensile and Shear Forces: For designs that include

combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 D.7.

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3.2.3.4 Technical Data

Figure 1—Installation Parameters

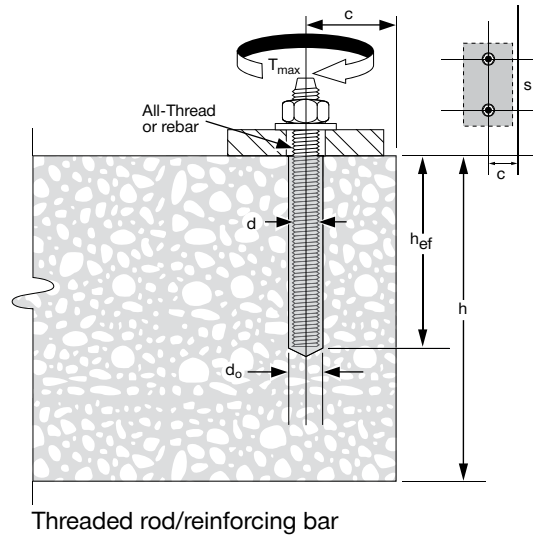


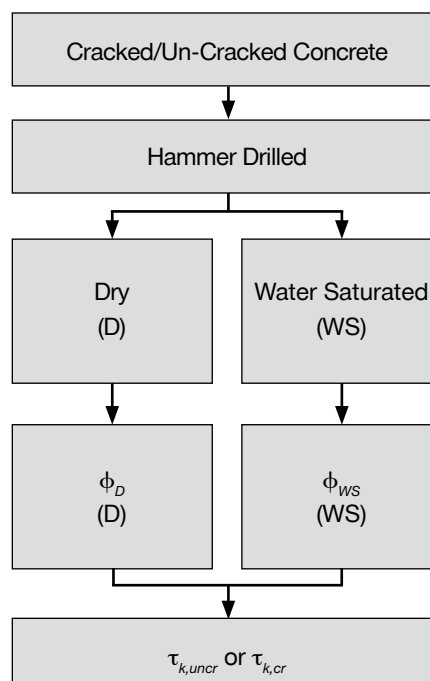
Table 1a— Design Table Index

Design strength ¹		Threaded rod		Deformed reinforcement bar		
		Fractional	Metric	U.S. (imperial)	EU (metric)	Canadian (metric)
Steel	N_{sa}, V_{sa}	Table 5	Table 8	Table 11	Table 14	Table 17
Concrete	$N_{cb}, N_{cbg}, V_{cb}, V_{cbg}, V_{cp}, V_{cpg}$	Table 6	Table 9	Table 12	Table 15	Table 18
Bond ²	N_a, N_{ag}	Table 7	Table 10	Table 13	Table 16	Table 19

1 Design strengths are as set forth in ACI 318 D.4.1.2.

2 See Section 3.2.3.3.4 of this document for bond strength information.

Figure 2 — Flowchart for Establishment of Design Bond Strength



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Table 1b — Example Allowable Stress Design Values for Illustrative Purposes

Nominal Anchor Diameter	Effective Embedment Depth	f'_c	$k_{c,uncr}$	α	Φ	Allowable Tension Load $\Phi N_n / \alpha$
d	h_{ef}					
(in)	(in)	(psi)	(-)	(-)	(-)	(lb)
3/8	2 3/8	2,500	24	1.48	0.65	1929
1/2	2 3/8	2,500	24	1.48	0.65	1929
5/8	3 1/8	2,500	24	1.48	0.65	2911
3/4	3 1/2	2,500	24	1.48	0.65	3451*
7/8	3 1/2	2,500	27	1.48	0.65	3882
1	4	2,500	27	1.48	0.65	4743

For SI: 1 lb = 4.45 kN, 1 psi = 0.00689 MPa, 1 in. = 25.4 mm, °C = [(°F) - 32]/1.8

Design Assumptions:

1. Single anchor with static tension load only; ASTM A 193 Grade B7 threaded rod, ductile.
2. Vertical downward installation direction.
3. Inspection Regimen = Periodic.
4. Installation temperature = 14 – 104 °F.
5. Long term temperature = 75 °F.
6. Short term temperature = 104 °F.
7. Dry hole condition — carbide drilled hole.
8. Embedment depth = $h_{ef min}$.
9. Concrete determined to remain uncracked for the life of the anchorage.
10. Load combination from ACI 318 Section 9.2 (no seismic loading).
11. 30 percent Dead Load (D) and 70 percent Live Load (L); Controlling load combination 1.2 D + 1.6 L.
12. Calculation of α based on weighted average: $\alpha = 1.2 D + 1.6 L = 1.2 (0.30) + 1.6 (0.70) = 1.48$.
13. Normal weight concrete: $f'_c = 2,500$ psi
14. Edge distance: $c_{a1} = c_{a2} > c_{ac}$
15. Member thickness: $h \geq h_{min}$.

* Verify capacity

Capacity	ACI 318 reference	Formula	Calculation	Φ	ΦN_n
Steel	D.5.1	$N_{sa} = n A_{se, N} f_{uta}$	$N_{sa} = 0.3345 \cdot 125,000$	0.75	31,360 lb
Concrete	D.5.2	$N_{cb} = k_{c,uncr} (f'_c)^{0.5} h_{ef}^{1.5}$	$N_{cb} = 24 \cdot (2,500)^{0.5} \cdot 3^{1.5}$	0.65	5,107 lb
Bond	D.5.3**	$N_b = \pi d h_{ef} \tau_{k,uncr}$	$N_b = \pi \cdot 3/4 \cdot 3.5 \cdot 1,710$	0.65	9,166 lb
Concrete breakout is decisive; hence the ASD value will be calculated as $\frac{5,107 \text{ lb}}{1.48} = 3,451 \text{ lb}$					

** Design equation provided in Section 3.2.3.3.4 as new section ACI 318 D.5.3.9, Eq. (D-16f).

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Table 2 — Tensile Properties of Common Carbon Steel Threaded Rod Materials¹

Threaded Rod Specification		Minimum Specified Ultimate Strength f_{uta}	Minimum Specified Yield Strength 0.2% Offset f_{ya}	f_{uta}/f_{ya}	Minimum Elongation, Percent ⁵	Minimum Reduction of Area, Percent	Specification for Nuts ⁶
ASTM A 193 ² Grade B7 ≤ 2-1/2 in (≤ 64 mm)	psi (MPa)	125,000 (860)	105,000 (725)	1.19	16	50	ASTM A194
ASTM F 568M ³ Class 5.8 M5 (1/4 in) to M24 (1 in) (equivalent to ISO 898-1)	MPa (psi)	500 (72,500)	400 (58,000)	1.25	10	35	DIN 934 (8-A2K) ASTM A563 Grade DH ⁷
ISO 898-1 ⁴ Class 5.8	MPa (psi)	500 (72,500)	400 (58,000)	1.25	22	-	DIN 934 (Grade 6)
ISO 898-1 ⁴ Class 8.8	MPa (psi)	800 (116,000)	640 (92,800)	1.25	12	52	DIN 934 (Grade 8)

1 Hilti HIT-HY 150 MAX-SD adhesive may be used in conjunction with all grades of continuously threaded carbon steel rod (all-thread) that comply with the code reference standards and that have thread characteristics comparable with ANSI B1.1 UNC Coarse Thread Series or ANSI B1.13M M Profile Metric Thread Series. Values for threaded rod types and associated nuts supplied by Hilti are provided here.

2 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

3 Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

4 Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs

5 Based on 2-in. (50 mm) gauge length except ASTM A 193, which are based on a gauge length of 4d and ISO 898 which is based on 5d.

6 Nuts of other grades and styles having specified proof load stresses greater than the specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than the minimum tensile strength of the specified threaded rod.

7 Nuts for fractional rods.

Table 3 — Tensile Properties of Common Stainless Steel Threaded Rod Materials¹

Threaded Rod Specification		Minimum Specified Ultimate Strength f_{uta}	Minimum Specified Yield Strength 0.2% Offset f_{ya}	f_{uta}/f_{ya}	Minimum Elongation, Percent ⁵	Minimum Reduction of Area, Percent	Specification for Nuts ⁴
ASTM F 593 ² CW1 (316) 1/4 to 5/8 in	psi (MPa)	100,000 (690)	65,000 (450)	1.54	20	-	F 594
ASTM F 593 ² CW2 (316) 3/4 to 1-1/2 in	psi (MPa)	85,000 (585)	45,000 (310)	1.89	25	-	F 594
ISO 3506-1 ³ A4-70 M8 – M24	MPa (psi)	700 (101,500)	450 (65,250)	1.56	40	-	ISO 4032

1 Hilti HIT-HY 150 MAX-SD may be used in conjunction with all grades of continuously threaded stainless steel rod (all-thread) that comply with the code reference standards and that have thread characteristics comparable with ANSI B1.1 UNC Coarse Thread Series or ANSI B1.13M M Profile Metric Thread Series. Values for threaded rod types and associated nuts supplied by Hilti are provided here.

2 Standard Steel Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

3 Mechanical properties of corrosion-resistant stainless steel fasteners — Part 1: Bolts, screws and studs

4 Nuts of other grades and styles having specified proof load stresses greater than the specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than the minimum tensile strength of the specified threaded rod.

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Table 4 — Tensile Properties of Common Reinforcing Bars

Reinforcing Bar Specification		Minimum Specified Ultimate Strength f_{uta}	Minimum specified yield strength f_{ya}
ASTM A 615 ¹ Gr. 60	psi (MPa)	90,000 (620)	60,000 (415)
ASTM A 615 ¹ Gr. 40	psi (MPa)	60,000 (415)	40,000 (275)
DIN 488 ² BSt 500	MPa (psi)	550 (79,750)	500 (72,500)
CAN/CSA-G30.18 ³ Gr. 400	MPa (psi)	540 (78,300)	400 (58,000)

1 Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement

2 Reinforcing steel; reinforcing steel bars; dimensions and masses

3 Billet-Steel Bars for Concrete Reinforcement

3.2.3 HIT-HY 150 MAX-SD Adhesive Anchoring System

Table 5 — Steel Design Information for Fractional Threaded Rod¹

Design Information		Symbol	Units	Nominal rod diameter (in)					
				3/8	1/2	5/8	3/4	7/8	1
Rod O.D.		d	in (mm)	0.375 (9.5)	0.5 (12.7)	0.625 (15.9)	0.75 (19.1)	0.875 (22.2)	1 (25.4)
Rod effective cross-sectional area		A _{se}	in ² (mm ²)	0.0775 (50)	0.1419 (92)	0.2260 (146)	0.3345 (216)	0.4617 (298)	0.6057 (391)
ISO 898-1 Class 5.8	Nominal strength as governed by steel strength	N _{sa}	lbf (kN)	5,620 (25.0)	10,290 (45.8)	16,385 (72.9)	24,250 (107.9)	33,470 (148.9)	43,910 (195.3)
		V _{sa}	lbf (kN)	2,810 (12.5)	6,175 (27.5)	9,830 (43.7)	14,550 (64.7)	20,085 (89.3)	26,345 (117.2)
	Reduction for seismic shear	α _{V,seis}	-	0.70					
	Strength reduction factor Φ for tension ²	Φ	-	0.65					
	Strength reduction factor Φ for shear ²	Φ	-	0.60					
ASTM A 193 B7	Nominal strength as governed by steel strength	N _{sa}	lbf (kN)	9,690 (43.1)	17,740 (78.9)	28,250 (125.7)	41,810 (186.0)	57,710 (256.7)	75,710 (336.8)
		V _{sa}	lbf (kN)	4,845 (21.5)	10,640 (47.3)	16,950 (75.4)	25,090 (111.6)	34,630 (154.0)	45,425 (202.1)
	Reduction for seismic shear	α _{V,seis}	-	0.70					
	Strength reduction factor Φ for tension ³	Φ	-	0.75					
	Strength reduction factor Φ for shear ³	Φ	-	0.65					
ASTM F593, CW Stainless	Nominal strength as governed by steel strength	N _{sa}	lbf (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	28,430 (126.5)	39,245 (174.6)	51,485 (229.0)
		V _{sa}	lbf (kN)	3,875 (17.2)	8,515 (37.9)	13,560 (60.3)	17,060 (75.9)	23,545 (104.7)	30,890 (137.4)
	Reduction for seismic shear	α _{V,seis}	-	0.70					
	Strength reduction factor Φ for tension ²	Φ	-	0.65					
	Strength reduction factor Φ for shear ²	Φ	-	0.60					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

- Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official. Nuts and washers must be appropriate for the rod strength.
- For use with the load combinations of IBC Section 1605.2.1, or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.
- For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5. Values correspond to a ductile steel element.

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Table 6 — Concrete Breakout Design Information for Fractional Threaded Rod¹

Design Information	Symbol	Units	Nominal rod diameter (in)					
			3/8	1/2	5/8	3/4	7/8	1
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	in-lb (SI)	24 (10)	24 (10)	24 (10)	24 (10)	27 (11.3)	27 (11.3)
Effectiveness factor for cracked concrete	$k_{c,cr}$	in-lb (SI)	17 (7)	17 (7)	17 (7)	17 (7)	17 (7)	17 (7)
Minimum anchor spacing ⁴	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)
Minimum edge distance ⁴	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)
Minimum member thickness	h_{min}	in (mm)	$h_{ef} + 1-1/4$ ($h_{ef} + 30$)		$h_{ef} + 2d_0^{(3)}$			
Critical edge distance — splitting (for uncracked concrete)	c_{ac}	-	See Section 3.2.3.3.10 of this document.					
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	-	0.65					
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	-	0.70					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1 For additional setting information, see installation instructions in Figure 5.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5.

3 d_0 = hole diameter.

4 For installations with a 1-3/4 in. edge distance, the installation torque must be reduced. Please refer to section 3.2.3.3.9.

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Table 7 — Bond Strength Design Information for Fractional Threaded Rod¹

Design Information			Symbol	Units	Nominal rod diameter (in)					
					3/8	1/2	5/8	3/4	7/8	1
Temperature range ²	A	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (MPa)	1,985 (13.7)	1,985 (13.7)	1,850 (12.7)	1,710 (11.8)	1,575 (10.9)	1,440 (9.9)
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	psi (MPa)	696 (4.8)	763 (5.3)	821 (5.7)	881 (6.1)	889 (6.1)	896 (6.2)
	B	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (MPa)	1,610 (11.1)	1,610 (11.1)	1,495 (10.3)	1,385 (9.6)	1,275 (8.8)	1,170 (8.1)
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	psi (MPa)	561 (3.9)	615 (4.2)	662 (4.6)	711 (4.9)	717 (4.9)	723 (5.0)
	C	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (MPa)	930 (6.4)	930 (6.4)	865 (6.0)	805 (5.5)	740 (5.1)	675 (4.7)
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	psi (MPa)	321 (2.2)	352 (2.4)	379 (2.6)	407 (2.8)	410 (2.8)	414 (2.9)
Minimum anchor embedment depth			$h_{ef,min}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (79)	3-1/2 (89)	3-1/2 (89)	4 (102)
Maximum anchor embedment depth			$h_{ef,max}$	in. (mm)	7-1/2 (191)	10 (254)	12-1/2 (318)	15 (381)	17-1/2 (445)	20 (508)
Permissible installation conditions	Dry concrete and Water-saturated concrete		Anchor Category	-	1					
			Φ_d & Φ_{ws}		0.65					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1 Bond strength values correspond to concrete compressive strength range $2,500 \text{ psi} \leq f'_c \leq 4,500 \text{ psi}$. For $4,500 \text{ psi} < f'_c \leq 6,500 \text{ psi}$, tabulated characteristic bond strengths may be increased by 6 percent. For $6,500 \text{ psi} < f'_c \leq 8,000 \text{ psi}$, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).
 Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).
 Temperature range C: Maximum short term temperature = 248°F (120°C), maximum 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.

3 For structures assigned to Seismic Design Categories C, D, E or F, bond strength values are multiplied by $\alpha_{N,seis} = 1.0 \Rightarrow$ no reduction.

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Table 8 — Steel Design Information for Metric Threaded Rod¹

Design Information		Symbol	Units	Nominal rod diameter (mm)				
				10	12	16	20	24
Rod O.D.		d	mm (in)	10 (0.39)	12 (0.47)	16 (0.63)	20 (0.79)	24 (0.94)
Rod effective cross-sectional area		A _{se}	mm ² (in ²)	58 (0.090)	84.3 (0.131)	157 (0.243)	245 (0.380)	353 (0.547)
ISO 898-1 Class 5.8	Nominal strength as governed by steel strength	N _{sa}	kN (lbf)	29.0 (6,520)	42.2 (9,475)	78.5 (17,650)	122.5 (27,540)	176.5 (39,680)
		V _{sa}	kN (lbf)	14.5 (3,260)	25.3 (5,685)	47.1 (10,590)	73.5 (16,525)	105.9 (23,810)
	Reduction for seismic shear	α _{V,seis}	-	0.70				
	Strength reduction factor Φ for tension ²	Φ	-	0.65				
	Strength reduction factor Φ for shear ²	Φ	-	0.60				
ISO 898-1 Cl. 8.8	Nominal strength as governed by steel strength	N _{sa}	kN (lbf)	46.4 (10,430)	67.4 (15,160)	125.6 (28,235)	196.0 (44,065)	282.4 (63,485)
		V _{sa}	kN (lbf)	23.2 (5,215)	40.5 (9,100)	75.4 (16,940)	117.6 (26,440)	169.4 (38,090)
	Reduction for seismic shear	α _{V,seis}	-	0.70				
	Strength reduction factor Φ for tension ²	Φ	-	0.65				
	Strength reduction factor Φ for shear ²	Φ	-	0.60				
ISO 3506-1 Cl. A4 SS ³	Nominal strength as governed by steel strength	N _{sa}	kN (lbf)	40.6 (9,130)	59.0 (13,263)	109.9 (24,703)	171.5 (38,555)	247.1 (55,550)
		V _{sa}	kN (lbf)	20.3 (4,565)	35.4 (7,960)	65.9 (14,825)	102.9 (23,135)	148.3 (33,330)
	Reduction for seismic shear	α _{s,seis}	-	0.70				
	Strength reduction factor Φ for tension ²	Φ	-	0.65				
	Strength reduction factor Φ for shear ²	Φ	-	0.60				

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

- Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official. Nuts and washers must be appropriate for the rod strength.
- For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of f must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.
- A4-70 Stainless (M10 - M24 diameters)

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Table 9 — Concrete Breakout Design Information for Metric Threaded Rod¹

Design Information	Symbol	Units	Nominal rod diameter (mm)				
			10	12	16	20	24
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	SI (in-lb)	10 (24)	10 (24)	10 (24)	10 (24)	11.3 (27)
Effectiveness factor for cracked concrete	$k_{c,cr}$	SI (in-lb)	7 (17)	7 (17)	7 (17)	7 (17)	7 (17)
Minimum anchor spacing ⁴	s_{min}	mm (in)	50 (2.0)	60 (2.4)	80 (3.2)	100 (3.9)	120 (4.7)
Minimum edge distance ⁴	c_{min}	mm (in)	50 (2.0)	60 (2.4)	80 (3.2)	100 (3.9)	120 (4.7)
Minimum member thickness	h_{min}	mm (in)	$h_{ef} + 30$ ($h_{ef} + 1-1/4$)	$h_{ef} + 2d_0^{(3)}$			
Critical edge distance — splitting (for uncracked concrete)	c_{ac}	-	See Section 3.2.3.3.10 of this document.				
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	-	0.65				
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	-	0.70				

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1 For additional setting information, see installation instructions in Figure 5.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5.

3 d_o = drill bit diameter.

4 For installations with a 1-3/4 in. edge distance, the installation torque must be reduced. Please refer to section 3.2.3.3.9.

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Table 10 — Bond Strength Design Information for Metric Threaded Rod¹

Design Information			Symbol	Units	Nominal rod diameter (mm)				
					10	12	16	20	24
Temperature range ²	A	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	MPa (psi)	13.7 (1,985)	13.7 (1,985)	12.7 (1,850)	11.8 (1,710)	10.9 (1,575)
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	MPa (psi)	4.9 (705)	5.1 (744)	5.7 (822)	6.1 (884)	6.2 (893)
	B	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	MPa (psi)	11.1 (1,610)	11.1 (1,610)	10.3 (1,500)	9.6 (1,390)	8.8 (1,275)
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	MPa (psi)	3.9 (569)	4.1 (600)	4.6 (663)	4.9 (712)	5.0 (720)
	C	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	MPa (psi)	6.4 (930)	6.4 (930)	6.0 (865)	5.5 (805)	5.1 (740)
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	MPa (psi)	2.2 (326)	2.4 (343)	2.6 (379)	2.8 (408)	2.8 (412)
Minimum anchor embedment depth			$h_{ef,min}$	mm (in.)	60 (2.4)	70 (2.8)	80 (3.1)	90 (3.5)	96 (3.8)
Maximum anchor embedment depth			$h_{ef,max}$	mm (in.)	200 (7.9)	240 (9.4)	320 (12.6)	400 (15.7)	480 (18.9)
Permissible installation conditions	Dry concrete and Water-saturated concrete		Anchor Category	-	1				
			Φ_d & Φ_{ws}	-	0.65				

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1 Bond strength values correspond to concrete compressive strength range $2,500 \text{ psi} \leq f'_c \leq 4,500 \text{ psi}$. For $4,500 \text{ psi} < f'_c \leq 6,500 \text{ psi}$, tabulated characteristic bond strengths may be increased by 6 percent. For $6,500 \text{ psi} < f'_c \leq 8,000 \text{ psi}$, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).
Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).
Temperature range C: Maximum short term temperature = 248°F (120°C), maximum 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.

3 For structures assigned to Seismic Design Categories C, D, E or F, bond strength values are multiplied by $\alpha_{N,seis} = 1.0 \Rightarrow$ no reduction.

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Table 11 — Steel Design Information for U.S. Imperial Reinforcing Bars¹

Design Information		Symbol	Units	Bar Size					
				No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Nominal bar diameter		d	in. (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	7/8 (22.2)	1 (25.4)
Bar effective cross-sectional area		A _{se}	in. ² (mm ²)	0.11 (71)	0.2 (129)	0.31 (200)	0.44 (284)	0.6 (387)	0.79 (510)
ASTM A 615 Gr. 40	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	36,000 (160.1)	47,400 (210.9)
		V _{sa}	lbf (kN)	3,960 (17.6)	7,200 (32.0)	11,160 (49.6)	15,840 (70.5)	21,600 (96.1)	28,440 (126.5)
	Reduction for seismic shear	α _{v,seis}	-	0.70					
	Strength reduction factor Φ for tension ²	Φ	-	0.65					
	Strength reduction factor Φ for shear ²	Φ	-	0.60					
ASTM A 615 Gr. 60	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	9,900 (44.0)	18,000 (80.1)	27,900 (124.1)	39,600 (176.2)	54,000 (240.2)	71,100 (316.3)
		V _{sa}	lb (kN)	5,940 (26.4)	10,800 (48.0)	16,740 (74.5)	23,760 (105.7)	32,400 (144.1)	42,660 (189.8)
	Reduction for seismic shear	α _{v,seis}	-	0.70					
	Strength reduction factor f for tension ²	Φ	-	0.65					
	Strength reduction factor f for shear ²	Φ	-	0.60					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

- Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official. Nuts and washers must be appropriate for the rod strength.
- For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of f must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.

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Table 12 — Concrete Breakout Design Information for U.S. Imperial Reinforcing Bars¹

Design Information	Symbol	Units	Bar Size					
			No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	in-lb (SI)	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)
Effectiveness factor for cracked concrete	$k_{c,cr}$	in-lb (SI)	17 (7)	17 (7)	17 (7)	17 (7)	17 (7)	17 (7)
Minimum bar spacing ⁴	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)
Minimum edge distance ⁴	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)
Minimum member thickness	h_{min}	in. (mm)	$h_{ef} + 1\text{-}1/4$ ($h_{ef} + 30$)		$h_{ef} + 2d_0^{(3)}$			
Critical edge distance — splitting (for uncracked concrete)	c_{ac}	-	See Section 3.2.3.3.10 of this document.					
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	-	0.65					
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	-	0.70					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1 For additional setting information, see installation instructions in Figure 5.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of f must be determined in accordance with ACI 318 D.4.5.

3 d_0 = drill bit diameter.

4 For installations with a 1-3/4 in. edge distance, the installation torque must be reduced. Please refer to section 3.2.3.3.9.

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Table 13 — Bond Strength Design Information for U.S. Imperial Reinforcing Bars¹

Design Information			Symbol	Units	Bar Size					
					No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Temperature range ²	A	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi MPa	1,290 (8.9)					
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	psi MPa	696 (4.8)	763 (5.3)	821 (5.7)	881 (6.1)	889 (6.1)	896 (6.2)
	B	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi MPa	1,045 (7.2)					
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	psi MPa	561 (3.9)	615 (4.2)	662 (4.6)	711 (4.9)	717 (4.9)	723 (5.0)
	C	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi MPa	605 (4.2)					
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	psi MPa	321 (2.2)	352 (2.4)	379 (2.6)	407 (2.8)	410 (2.8)	414 (2.9)
Minimum anchor embedment depth			$h_{ef,min}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (79)	3-1/2 (89)	3-1/2 (89)	4 (102)
Maximum anchor embedment depth			$h_{ef,max}$	in. (mm)	7-1/2 (191)	10 (254)	12-1/2 (318)	15 (381)	17-1/2 (445)	20 (508)
Permissible installation conditions	Dry concrete and Water-saturated concrete		Anchor Category	-	1					
			$\Phi_d \Phi f_{ws}$		0.65					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1 Bond strength values correspond to concrete compressive strength range $2,500 \text{ psi} \leq f'_c \leq 4,500 \text{ psi}$. For $4,500 \text{ psi} < f'_c \leq 6,500 \text{ psi}$, tabulated characteristic bond strengths may be increased by 6 percent. For $6,500 \text{ psi} < f'_c \leq 8,000 \text{ psi}$, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).
 Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).
 Temperature range C: Maximum short term temperature = 248°F (120°C), maximum 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.

3 For structures assigned to Seismic Design Categories C, D, E or F, bond strength values are multiplied by $\alpha_{N,seis} = 1.0 \Rightarrow$ no reduction.

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Table 14 — Steel Design Information for EU Metric Reinforcing Bars¹

Design Information		Symbol	Units	Bar Size					
				10	12	14	16	20	25
Nominal bar diameter		d	mm (in.)	10.0 (0.394)	12.0 (0.472)	14.0 (0.551)	16.0 (0.630)	20.0 (0.787)	25.0 (0.984)
Bar effective cross-sectional area		A _{se}	mm ² (in. ²)	78.5 (0.122)	113.1 (0.175)	153.9 (0.239)	201.1 (0.312)	314.2 (0.487)	490.9 (0.761)
DIN 488 BSt 550/500	Nominal strength as governed by steel strength	N _{sa}	kN (lb)	43.2 (9,710)	62.2 (13,985)	84.7 (19,035)	110.6 (24,860)	172.8 (38,845)	270.0 (60,695)
		V _{sa}	kN (lb)	25.9 (5,830)	37.3 (8,390)	50.8 (11,420)	66.4 (14,915)	103.7 (23,310)	162.0 (36,415)
	Reduction for seismic shear	α _{V,seis}	-	0.70					
	Strength reduction factor Φ for tension ²	Φ	-	0.65					
	Strength reduction factor Φ for shear ²	Φ	-	0.60					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

- Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official. Nuts and washers must be appropriate for the rod strength.
- For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of f must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.

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Table 15 — Concrete Breakout Design Information for EU Metric Reinforcing Bars¹

Design Information	Symbol	Units	Bar size						
			10	12	14	16	20	25	
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	SI (in-lb)	10 (24)						12.6 (30)
Effectiveness factor for cracked concrete	$k_{c,cr}$	SI (in-lb)	7 (17)						
Minimum bar spacing ⁴	s_{min}	mm (in.)	50 (2)	60 (2.4)	70 (2.8)	80 (3.1)	100 (3.9)	125 (4.9)	
Minimum edge distance ⁴	c_{min}	mm (in.)	50 (2)	60 (2.4)	70 (2.8)	80 (3.1)	100 (3.9)	125 (4.9)	
Minimum member thickness	h_{min}	mm (in.)	$h_{ef} + 30$ ($h_{ef} + 1-1/4$)		$h_{ef} + 2d_0^{(3)}$				
Critical edge distance — splitting (for uncracked concrete)	c_{ac}	-	See Section 3.2.3.3.10 of this document.						
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	-	0.65						
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	-	0.70						

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1 For additional setting information, see installation instructions in Figure 5.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of f must be determined in accordance with ACI 318 D.4.5.

3 d_0 = drill bit diameter.

4 For installations with a 1-3/4 in. edge distance, the installation torque must be reduced. Please refer to section 3.2.3.3.9.

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Table 16 — Bond Strength Design Information for EU Metric Reinforcing Bars¹

Design Information			Symbol	Units	Bar Size					
					10	12	14	16	20	25
Temperature range ⁱ	A	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	MPa (psi)	8.9 (1,290)					
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	MPa (psi)	4.9 (705)	5.1 (744)	5.4 (783)	5.7 (822)	6.1 (884)	6.1 (895)
	B	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	MPa (psi)	7.2 (1,045)					
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	MPa (psi)	3.9 (569)	4.1 (600)	4.4 (631)	4.6 (663)	4.9 (712)	5.0 (722)
	C	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	MPa (psi)	4.2 (605)					
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	MPa (psi)	2.2 (326)	2.4 (343)	2.5 (361)	2.6 (379)	2.8 (408)	2.9 (413)
Minimum anchor embedment depth			$h_{ef,min}$	mm (in.)	60 (2.4)	70 (2.8)	75 (3.0)	80 (3.1)	90 (3.5)	100 (3.9)
Maximum anchor embedment depth			$h_{ef,max}$	mm (in.)	200 (7.9)	240 (9.4)	280 (11.0)	320 (12.6)	400 (15.7)	500 (19.7)
Permissible installation conditions	Dry concrete and Water-saturated concrete		Anchor Category	-	1					
			Φ_d & Φ_{ws}	-	0.65					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1 Bond strength values correspond to concrete compressive strength range 2,500 psi $\leq f'_c \leq$ 4,500 psi. For 4,500 psi $< f'_c \leq$ 6,500 psi, tabulated characteristic bond strengths may be increased by 6 percent. For 6,500 psi $< f'_c \leq$ 8,000 psi, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).
Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).
Temperature range C: Maximum short term temperature = 248°F (120°C), maximum 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.

3 For structures assigned to Seismic Design Categories C, D, E or F, bond strength values are multiplied by $\alpha_{N,seis} = 1.0 \Rightarrow$ no reduction.

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Table 17 — Steel Design Information for Canadian Metric Reinforcing Bars¹



Design Information		Symbol	Units	Bar Size			
				10 M	15 M	20 M	25 M
Nominal bar diameter		d	mm (in.)	11.3 (0.445)	16.0 (0.630)	19.5 (0.768)	25.2 (0.992)
Bar effective cross-sectional area		A _{se}	mm ² (in. ²)	100.3 (0.155)	201.1 (0.312)	298.6 (0.463)	498.8 (0.773)
CSA-G30.18 Gr.400	Nominal strength as governed by steel strength	N _{sa}	kN (lb)	54.2 (12,175)	108.6 (24,410)	161.3 (36,255)	269.3 (60,550)
		V _{sa}	kN (lb)	32.5 (7,305)	65.1 (14,645)	96.8 (21,755)	161.6 (36,330)
	Reduction for seismic shear	α _{V,seis}	-	0.70			
	Strength reduction factor f for tension ²	α	-	0.65			
	Strength reduction factor f for shear ²	α	-	0.60			

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

- Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official. Nuts and washers must be appropriate for the rod strength.
- For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of f must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.

Table 18 — Concrete Breakout Design Information for Canadian Metric Reinforcing Bars¹



Design Information	Symbol	Units	Bar size			
			10 M	15 M	20 M	25 M
Effectiveness factor for uncracked concrete	k _{c,uncr}	SI (in-lb)	10 (24)	10 (24)	10 (24)	11.3 (27)
Effectiveness factor for cracked concrete	k _{c,cr}	SI (in-lb)	7 (17)	7 (17)	7 (17)	7 (17)
Minimum bar spacing ⁴	s _{min}	mm (in.)	57 (2.2)	80 (3.1)	98 (3.8)	126 (5.0)
Minimum edge distance ⁴	c _{min}	mm (in.)	57 (2.2)	80 (3.1)	98 (3.8)	126 (5.0)
Minimum member thickness	h _{min}	mm (in.)	h _{ef} + 30 (h _{ef} + 1-1/4)			
Critical edge distance — splitting (for uncracked concrete)	c _{ac}	-	See Section 3.2.3.3.10 of this document.			
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	-	0.65			
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	-	0.70			

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

- For additional setting information, see installation instructions in Figure 5.
- Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of f must be determined in accordance with ACI 318 D.4.5.
- d₀ = drill bit diameter.
- For installations with a 1-3/4 in. edge distance, the installation torque must be reduced. Please refer to section 3.2.3.3.9.

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Table 19 — Bond Strength Design Information for Canadian Metric Reinforcing Bars¹



Design Information			Symbol	Units	Bar Size			
					10 M	15 M	20 M	25 M
Temperature range ²	A	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	MPa (psi)	8.9 (1,290)			
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	MPa (psi)	4.9 (705)	5.7 (822)	6.0 (884)	6.2 (895)
	B	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	MPa (psi)	7.2 (1,045)			
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	MPa (psi)	3.9 (569)	4.6 (663)	4.9 (712)	5.0 (722)
	C	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	MPa (psi)	4.2 (605)			
		Characteristic bond strength in cracked concrete ³	$\tau_{k,cr}$	MPa (psi)	2.2 (326)	2.6 (379)	2.8 (408)	2.9 (412)
Minimum anchor embedment depth			$h_{ef,min}$	mm (in.)	60 (2.4)	80 (3.1)	90 (3.5)	101 (4.0)
Maximum anchor embedment depth			$h_{ef,max}$	mm (in.)	226 (8.9)	320 (12.6)	390 (15.4)	504 (19.8)
Permissible installation conditions	Dry concrete and Water-saturated concrete		Anchor Category	-	1			
			Φ_d & Φ_{ws}	-	0.65			

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa.

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

1 Bond strength values correspond to concrete compressive strength range 2,500 psi $\leq f'_c \leq$ 4,500 psi. For 4,500 psi $< f'_c \leq$ 6,500 psi, tabulated characteristic bond strengths may be increased by 6 percent. For 6,500 psi $< f'_c \leq$ 8,000 psi, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).
Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).
Temperature range C: Maximum short term temperature = 248°F (120°C), maximum 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.

3 For structures assigned to Seismic Design Categories C, D, E or F, bond strength values are multiplied by $a_{N,seis} = 1.0 \Rightarrow$ no reduction.

3.2.3 HIT-HY 150 MAX-SD Adhesive Anchoring System

Resistance of HIT-HY 150 MAX-SD to Chemicals

Chemical		Behavior
Sulphuric acid	conc.	–
	30%	•
	10%	+
Hydrochloric acid	conc.	•
	10%	+
Nitric acid	conc.	–
	10%	•
Acetic acid	conc.	•
	10%	+
Formic acid	conc.	–
	10%	•
Lactic acid	conc.	+
	10%	+
Citric acid	10%	+
Sodium Hydroxide (Caustic soda)	40%	•
	20%	+
	5%	+
Ammonia	conc.	•
	5%	+
Soda solution	10%	+
Common salt solution	10%	+
Chlorinated lime solution	10%	+
Sodium hypochlorite	2%	+
Hydrogen peroxide	10%	+
Carbolic acid solution	10%	–
Ethanol		–
Sea water		+
Glycol		+
Acetone		–
Carbon tetrachloride		–
Toluene		+
Petrol/Gasoline		•
Machine oil		•
Diesel oil		•

Key: – non-resistant + resistant • limited resistance

HIT-HY 150 MAX-SD Adhesive Anchoring System 3.2.3

3.2.3.5 Installation Instructions

Adhesive anchoring system for fastenings in concrete

Prior to use of product, follow instructions for use and recommended safety precautions. Check expiration date: See expiration date imprint on foilpack manifold. (Month/Year). Do not use an expired product.

Foil pack temperature: Must be between 32 °F and 104 °F (0 °C and 40 °C) when in use.

Base material temperature at time of installation: Must be between 14 °F and 104 °F (-10 °C and 40 °C).

Instructions for transport and storage: Keep in a cool, dry and dark place between 41 °F to 77 °F (5 °C to 25 °C).

Material Safety Data Sheet: Review the MSDS before use.

Installation instructions: Follow the illustrations for the sequence of operations and refer to tables for setting details. For any application not covered by this document, contact Hilti.

1 **Drill hole** to the required depth h_o with a hammer-drill set in rotation hammer mode using an appropriately sized carbide drill bit. For holes drilled with other drill types contact a Hilti representative.

2 - 4 **Clean hole: Cleaning method has to be decided based on borehole condition. Just before setting an anchor/rebar, the borehole must be free of dust, water and debris by one of the following methods:**

Method 1 — for dry or water saturated concrete (refer to pictograms): Compressed air cleaning is permissible for all diameters and embedment depths.

- **Blow** from the back of the borehole with oil-free compressed air (min. 90psi at 3.5 CFM (6 bar at 6 m³/h)) fully retracting the air extension 2 times until return air stream is free of noticeable dust.
- **Brush 2 times** with the specified Hilti HIT-RB brush size (brush $\phi \geq$ bore hole ϕ) by inserting the round steel brush to the back of the borehole in a twisting motion and removing it. The brush should resist insertion into the borehole — if not, the brush is too small and must be replaced with a brush of appropriate brush diameter.
- **Blow** again with compressed air 2 times until return air stream is free of noticeable dust.

If required use extensions for air nozzle and brushes to reach back of deep hole.

Method 2 — for standing water (e.g. water flows into cleaned borehole):

- **Flush hole 2 times** by inserting a water hose (water-line pressure) to the back of the borehole until water runs clear.
- **Brush 2 times** with the specified Hilti HIT-RB brush size (brush $\phi \geq$ borehole ϕ) by inserting the round steel brush to the back of the borehole with a twisting motion and removing it. The brush should resist insertion into the borehole — if not, the brush is too small and must be replaced with a brush of appropriate brush diameter.
- **Flush again 2 times** until water runs clear. Remove all standing water completely (i.e. vacuum, compressed air or other appropriate procedure). To attain a dried borehole, a Hilti HIT-DL air nozzle attachment is

recommended for borehole depth ≤ 10 inch (250 mm) and required for borehole depth > 10 inch (250 mm).

- **Continue** with borehole cleaning as described in **Method 1**.

5 **Insert foil pack in foil pack holder.** Never use damaged foil packs and/or damaged or unclean foil pack holders. Attach new mixer prior to dispensing a new foil pack (snug fit).

6 **Tightly attach Hilti HIT-RE-M mixer to foil pack manifold.** Do not modify the mixer in any way. Make sure the mixing element is in the mixer. Use only the mixer supplied with the anchor adhesive.

7 **Insert foil pack holder with foil pack into HIT-dispenser.** Push release trigger, retract plunger and insert foil pack holder into the appropriate Hilti dispenser.

8 **Discard initial anchor adhesive.** The foil pack opens automatically as dispensing is initiated. Do not pierce the foilpack manually (can cause system failure). Depending on the size of the foil pack an initial amount of anchor adhesive has to be discarded. See pictogram 8 for discard quantities. Dispose discarded anchor adhesive into the empty outer packaging. If a new mixer is installed onto a previously-opened foil pack, the first trigger pulls must also be discarded as described above. For each new foil pack a new mixer must be used.

9 - 11 **Inject anchor adhesive from the back of the borehole without forming air voids:**

- **Injection method — for borehole with depth 10 inch/250 mm:**

Inject the anchor adhesive starting at the back of the hole (use the extension for deep holes), slowly withdraw the mixer with each trigger pull. Fill holes approximately 2/3 full, or as required to ensure that the annular gap between the anchor/rebar and the concrete is completely filled with anchor adhesive along the embedment length. After injection is completed, depressurize the dispenser by pressing the release trigger. This will prevent further anchor adhesive discharge from the mixer.

- **Piston plug injection — is recommended for borehole depth > 10 inch/250 mm. The installation overhead is only possible with the aid of piston plugs.** Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug. Insert piston plug HIT-SZ/IP to back of the hole, and inject anchor adhesive as described in the injection method above. During injection the piston plug will be naturally extruded out of the bore hole by the anchor adhesive pressure. (HIT-SZ (IP) is not available or required for 7/16" diameter drilled hole.)

12 **Insert anchor/rebar into bore hole.** Mark and set anchor/rebar to the required embedment depth. Before use, verify that the anchor/rebar is dry and free of oil and other contaminants. To ease installation, anchor/rebar may be slowly twisted as they are inserted. **Use only Hilti anchor rods or equivalent.** After installing an anchor/rebar, the annular gap must be completely filled with anchor adhesive.

Attention! For overhead applications take special care when inserting the anchor/rebar. Excess adhesive will be forced out of the borehole — take appropriate steps to prevent it from falling onto the installer. Position the anchor/rebar and secure it from moving/falling during the curing time (e.g. wedges).

3.2.3 HIT-HY 150 MAX-SD Adhesive Anchoring System

- 13** Observe the gel time " t_{gel} ", which varies according to temperature of base material. Minor adjustments to the anchor/rebar position may be performed during the gel time. See table 12. Once the gel time has elapsed, do not disturb the anchor/rebar until the curing time " t_{cure} " has elapsed.
- 14** **Apply designed load/torque after " t_{cure} " has passed, and the fixture to be attached has been positioned.** See table 13.

Partly used foil packs must be used up within **four weeks**. Leave the mixer attached on the foil pack manifold and store under the recommended storage conditions. If reused, attach a new mixer and discard the initial quantity of anchor adhesive as described by point 8

Safety instructions:

For industrial use only. Keep out of the reach of children.
See the Material Safety Data Sheet for this product before handling.

Caution: Irritating to eyes and skin. May cause sensitization in susceptible individuals.

Contains: dibenzoyl peroxide.

Precautions: Avoid contact with skin/eyes.

Always wear impermeable gloves and eye protection when using product. Store in a cool, dry area. Keep from freezing. Do not store in direct sunlight.

First Aid: Eyes — Immediately flush with water for 15 minutes, contact a physician. **Skin** — Wash with soap and water. Launder contaminated clothing before reuse. If irritations occurs, contact physician. **Ingestion** — Do not induce vomiting unless directed by a physician. Contact a physician immediately. **Inhalation** — Move to fresh air, give oxygen if breathing is difficult. Contact a physician if symptoms persist.

Ingredient	CAS Number	Ingredient	CAS Number
Part A: (Large side)		Part B: (Small side)	
NJ Trade Secret Registry	19136100-5001	Quartz Sand	14808-60-7
Quartz Sand	14808-60-7	Water	07732-18-5
NJ Trade Secret Registry	19136100-5003	Dibenzoyl peroxide	00094-36-0
NJ Trade Secret Registry	19136100-5004	Aluminum oxide	01344-28-1
NJ Trade Secret Registry	19136100-5005	Amorphous silica	07631-86-9
Amorphous silica	67762-90-7	1,2,3-Propantriol	00056-81-5
NJ Trade Secret Registry	19136100-5002		
NJ Trade Secret Registry	19136100-5017		
NJ Trade Secret Registry	19136100-5019		

* NJ TSNR = New Jersey Trade Secret Registry Number

In Case of Emergency, call Chem-Trec: 1-800-424-9300 (USA, P.R., Virgin Islands, Canada)

En cas d'urgence, téléphoner Chem-Trec: 1-800-424-9300 (USA, P.R., Virgin Islands, Canada)

En Caso de Emergencia, llame Chem-Trec: 001-703-527-3887 (other countries/autres pays/otros países)

Made in Germany


Net contents: 11.1 fl. oz (330 ml)/16.9 fl. oz (500 ml)

Net weight: 20.3 oz (575 g)/31.0 oz (880 g)

Warranty: Refer to standard Hilti terms and conditions of sale for warranty information.

Failure to observe these installation instructions, use of non-Hilti anchors, poor or questionable concrete conditions, or unique applications may affect the reliability or performance of the fastenings. For full set of installation instructions see literature supplied with product packaging.

HIT-HY 150 MAX-SD Adhesive Anchoring System 3.2.3

	HAS	Rebar	HIT-RB	HIT-SZ (IP)	HIT-DL
					
Ø [mm]	Ø [mm]	Ø [mm]	HIT-RB	HIT-SZ	HIT-DL
12	10	8	12	12	12
14	12	10	14	14	14
16	16	12	16	16	16
18	-	14	18	18	18
20	-	16	20	20	20
22	20	18	22	22	-
24	24	-	24	24	-
25	-	20	25	25	25
28	-	22	28	28	-
32	-	25	32	32	32

Ø [in.]	Ø [in.]	Size	HIT-RB	HIT-IP	HIT-DL
7/16	3/8	-	7/16"	-	-
1/2	-	#3	1/2"	1/2"	1/2"
9/16	1/2	10M	9/16"	9/16"	9/16"
5/8	-	#4	5/8"	5/8"	-
3/4	5/8	#5 & 15M	3/4"	3/4"	3/4"
7/8	3/4	#6	7/8"	7/8"	7/8"
1	7/8	#7 & 20M	1"	1"	1"
1-1/8	1	#8	1-1/8"	1-1/8"	-
1-1/4	-	25M	1-1/4"	1-1/4"	-

Drill bits must conform to tolerances in ANSI B212-1994.

Les mèches de forage doivent être conformes à ANSI B212-1994.

Brocas deben cumplir con el estándar ANSI B212-1994.

3.2.3 HIT-HY 150 MAX-SD Adhesive Anchoring System

Setting Details of Hilti HIT-HY 150 MAX-SD with Threaded Rod

d	d ₀	h _{ef} min-max	T _{max} *	d _f	h _{min}
[inch]	[inch]	[inch]	[ft-lb]	[inch]	[inch]
3/8	7/16	2-3/8 to 7-1/2	15	7/16	h _{ef} + 1-1/4
1/2	9/16	2-3/4 to 10	30	9/16	
5/8	3/4	3-1/8 to 12-1/2	60	11/16	h _{ef} + 2d ₀
3/4	7/8	3-1/2 to 15	100	13/16	
7/8	1	3-1/2 to 17-1/2	125	15/16	
1	1-1/8	4 to 20	150	1-1/8	

[mm]	[mm]	[mm]	[Nm]	[mm]	[mm]
M10	12	60 to 200	20	12	h _{ef} + 30
M12	14	70 to 240	40	14	
M18	18	80 to 320	80	18	h _{ef} + 2d ₀
M20	24	90 to 400	150	22	
M24	28	96 to 480	200	28	

Setting Details of Hilti HIT-HY 150 MAX-SD with Reinforcement Bars

d	d ₀	h _{ef} min-max	h _{min}
US rebar	[inch]	[inch]	[inch]
#3	7/16	2-3/8 to 7-1/2	h _{ef} + 1-1/4
#4	5/8	2-3/4 to 10	
#5	3/4	3-1/8 to 12-1/2	h _{ef} + 2d ₀
#6	7/8	3-1/2 to 15	
#7	1	3-1/2 to 17-1/2	
#8	1-1/8	4 to 20	

Rebar [mm]	[mm]	[mm]	[mm]
10	14	60 to 200	h _{ef} + 30
12	16	70 to 240	
14	18	75 to 280	h _{ef} + 2d ₀
16	20	80 to 320	
20	25	90 to 400	
25	32	100 to 500	

CA rebar	[inch]	[inch]	[inch]
10 M	9/16	2-3/4 to 8-7/8	h _{ef} + 1-1/4
15 M	3/4	3-1/8 to 12-1/2	
20 M	1	3-1/2 to 15-3/8	h _{ef} + 2d ₀
25 M	1-1/4	4 to 19-7/8	

*T _{max} : Edge Distance c _{ai} < (5 x d)		
Edge Distance c _{ai}	Anchor Spacing s _{min}	Maximum Torque
1.75 in. (45 mm) ≤ c _{ai} < 5 x d	5 x d ≤ s _{min} < 16 in. (406 mm)	0.3 x T _{max}
	s _{min} ≥ 16 in. (406 mm)	0.5 x T _{max}

HIT-HY 150 MAX-SD Adhesive Anchoring System 3.2.3

3.2.3.6 Ordering Information

HIT-HY 150 MAX-SD Fast Cure Hybrid Adhesive

Features and Applications

- First fast-cure adhesive anchor to comply with the latest building code, offering designers a strength design solution for anchors and rebar
- Fast cure time of approximately 30 min @ 68° F (20° C)
- Cold weather installation, 14° F base material temperature
- All seismic design categories and cracked concrete approval for maximum versatility

Technical Data	HIT-HY 150 MAX-SD
Product	Hybrid Urethane Methacrylate
Base material temperature	14°F to 104°F (-10°C to 40°C)
Diameter range	3/8" to 1"
Listings/Approvals <ul style="list-style-type: none"> • ICC-ES (International Code Council) - ESR-3013 • NSF/ANSI standard 61 - Certification for potable water • COLA (City of Los Angeles) Research Report 25581 	
Package volume <ul style="list-style-type: none"> • Volume of HIT 11.1 fl oz/330 ml foil pack is 20.1 in³ • Volume of HIT 16.9 fl oz/500 ml foil pack is 30.5 in³ • Volume of HIT 47.3 fl oz/1400 ml Jumbo foil pack is 85.4 in³ 	

Gel/Full Cure Time Table (Approximate)

Base Material Temperature		t _{gel}	t _{cure}
° F	° C		
14	-10	180 min	12 hrs
23	-5	40 min	4 hrs
32	0	20 min	2 hrs
50	10	8 min	1 hrs
68	20	5 min	30 min
86	30	3 min	30 min
104	40	2 min	30 min



Order Information

Description	Package Contents	Qty
HIT-HY 150 MAX-SD (11.1 fl oz/330 mL) MC (1)	Includes (1) master carton containing 25 foil packs with (1) mixer and 3/8" filler tube per pack	25
HIT-HY 150 MAX-SD (11.1 fl oz/330 mL) MC (1) + MD 2500 Manual Dispenser	Includes (1) master carton containing 25 foil packs with 1 mixer and 3/8" filler tube per pack and (1) MD 2500 Manual Dispenser	25
HIT-HY 150 MAX-SD (16.9 fl oz/500 mL) MC (1) + MD 2500 Manual Dispenser	Includes (1) master carton containing 20 foil packs with 1 mixer and 3/8" filler tube per pack and (1) MD 2500 Manual Dispenser	20
HIT-HY 150 MAX-SD (16.9 fl oz/500 mL) MC (2) + MD 2500 Manual Dispenser	Includes (2) master cartons containing 20 foil packs each with 1 mixer and 3/8" filler tube per pack and (1) MD 2500 Manual Dispenser	40
HIT-HY 150 MAX-SD (16.9 fl oz/500 mL) MC (2) + ED 3500-A CPC Cordless Dispenser Kit	Includes (2) master cartons containing 20 foil packs each with 1 mixer and 3/8" filler tube per pack, (1) ED 3500-A CPC Cordless Dispenser, (2) B 144 2.6-Ah Li-Ion batteries and (1) C 4/36 Li-Ion charger	40
HIT-HY 150 MAX-SD (16.9 fl oz/500 mL) MC (5) + MD 2500 Manual Dispensers (2)	Includes (5) master cartons containing 20 foil packs each with 1 mixer and 3/8" filler tube per pack and (2) MD 2500 Manual Dispensers	100
HIT-HY 150 MAX-SD (16.9 fl oz/500 mL) MC (5) + ED 3500-A CPC Cordless Dispenser Kit	Includes (5) master cartons containing 20 foil packs each with 1 mixer and 3/8" filler tube per pack, (1) ED 3500-A CPC Cordless Dispenser, (2) B 144 2.6-Ah Li-Ion batteries and (1) C 4/36 Li-Ion charger	100
HIT-HY 150 MAX-SD (47.3 fl oz/1400 mL) MC (16) + P 8000 Pneumatic Dispenser (1) — 1 pallet	Includes (16) master cartons containing 4 jumbo foil packs each with 1 mixer and 3/8" filler tube per pack and (1) P 8000 Pneumatic Dispenser	64
HIT-HY 150 MAX-SD (47.3 fl oz/1400 mL) MC (32) + P 8000 Pneumatic Dispenser (1) — 2 pallets	Includes (32) master cartons containing 4 jumbo foil packs each with 1 mixer and 3/8" filler tube per pack and (1) P 8000 Pneumatic Dispenser	128
HIT-HY 150 MAX-SD (47.3 fl oz/1400 mL) MC (64) + P 8000 Pneumatic Dispenser (1) — 4 pallets	Includes (64) master cartons containing 4 jumbo foil packs each with 1 mixer and 3/8" filler tube per pack and (1) P 8000 Pneumatic Dispenser	256

Refer to Section 3.2.6.5 for ordering information of HAS threaded rods.

3.2.3 HIT-HY 150 MAX-SD Adhesive Anchoring System

Dispensers

Order Description	Qty
ED 3500-A CPC 2.6-Ah Kit Includes dispenser, (2) 2.6-Ah Li-Ion battery, C 7/24 standard charger and accessories in an impact-resistant plastic tool box	1
ED 3500-A Dispenser Includes dispenser only in cardboard box	1
Battery Pack B 144 2.6-Ah CPC CPC Li-Ion 2.6-Ah battery for SFH 144-A, SF 144-A, SID 144-A, SIW 144-A, SFL 14 and ED 3500-A Dispenser	1
Battery Charger C 4/36 Li-Ion 115 V Use with all 14.4 - 36 volt Hilti CPC lithium ion batteries	1
MD 2500 Manual Dispenser with Foil Pack Holder For use with HIT 11.1 fl oz/330ml and 16.9oz/500ml foil pack	1
Foil Pack Holder Replacement holder for MD 2500 and ED 3500 dispensers	1
HIT-P 8000D Pneumatic Dispenser For use with HIT 47.3 fl oz/1400 ml jumbo foil pack	1
Jumbo Foil Pack Holder Replacement holder for P 8000D dispenser	1

Accessory Selection Table

Select the correct installation accessory according to the hole diameter

Hole Diameter ¹	Round Brush (for brushing holes)	Piston Plug (for helping prevent air voids when injecting adhesive)	Air nozzle (for blowing out holes)
Inch	Description	Description	Description
7/16	HIT-RB 7/16"	-	-
1/2	HIT-RB 1/2"	HIT-IP 1/2"	HIT-DL 1/2"
9/16	HIT-RB 9/16"	HIT-IP 9/16"	HIT-DL 9/16"
5/8	HIT-RB 5/8"	HIT-IP 5/8"	
11/16	HIT-RB 11/16"	HIT-IP 11/16"	HIT-DL 11/16"
3/4	HIT-RB 3/4"	HIT-IP 3/4"	HIT-DL 3/4"
7/8	HIT-RB 7/8"	HIT-IP 7/8"	HIT-DL 7/8"
1	HIT-RB 1"	HIT-IP 1"	HIT-DL 1"
1-1/8	HIT-RB 1 1/8"	HIT-IP 1 1/8"	-
1-1/4	HIT-RB 1 1/4"	HIT-IP 1 1/4"	-
1- 3/8	HIT-RB 1 3/8"	HIT-IP 1 3/8"	HIT-DL 1 3/8"
1-1/2	HIT-RB 1 1/2"	HIT-IP 1 1/2"	-
1-3/4	HIT-RB 1 3/4"	HIT-IP 1 3/4"	-

¹ Refer to adhesive anchor system installation instructions to determine the proper hole diameter for the fastening element to be used

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

3.2.4.1 Product Description

Hilti HIT-RE 500-SD Adhesive Anchoring System is an injectable two-component epoxy adhesive. The two components are kept separate by means of a dual-cylinder foil pack attached to a manifold. The two components combine and react when dispensed through a static mixing nozzle attached to the manifold.

Hilti HIT-RE 500-SD Adhesive Anchoring System may be used with continuously threaded rod, Hilti HIS-N and HIS-RN internally-threaded inserts or deformed reinforcing bar installed in cracked or uncracked concrete. The primary components of the Hilti Adhesive Anchoring System are:

- Hilti HIT-RE 500-SD adhesive packaged in foil packs
- Adhesive mixing and dispensing equipment
- Equipment for hole cleaning and adhesive injection

Product Features

- Superior bond performance
- Seismic qualified per IBC®/IRC® 2009, IBC®/IRC® 2006, IBC®/IRC® 2003 and IBC®/IRC® 2000. Please refer to ESR-2322 (ICC-ES AC308) for Seismic Design Category A through F
- Use in diamond cored or pneumatic drilled holes and under water up to 165 feet (50 m)
- Meets requirements of ASTM C 881-90, Type IV, Grade 2 and 3, Class A, B, C except gel times
- Meets requirements of AASHTO specification M235, Type IV, Grade 3, Class A, B, C except gel times
- Mixing tube provides proper mixing, eliminates measuring errors and minimizes waste
- Contains no styrene; virtually odorless
- Extended temperature range from 41°F to 104°F (5°C to 40°C)
- Excellent weathering resistance; Resistance against elevated temperatures

3.2.4.1 Product Description

3.2.4.2 Material Specifications

3.2.4.3 Strength Design

3.2.4.4 Technical Data

3.2.4.5 Installation Instructions

3.2.4.6 Ordering Information

Listings/Approvals

ICC-ES (International Code Council)
ESR-2322

NSF/ANSI Std 61

certification for use in potable water

European Technical Approval
ETA-07/0260

COLA (City of Los Angeles)
RR 25700



Independent Code Evaluation

IBC®/IRC® 2009 (ICC-ES AC308)

IBC®/IRC® 2006 (ICC-ES AC308)

IBC®/IRC® 2003 (ICC-ES AC308)

IBC®/IRC® 2000 (ICC-ES AC308)

FBC 2007

LEED®: Credit 4.1-Low Emitting Materials

Fastener Components

HAS Threaded Rods

HIS Internally Threaded Inserts

Rebar (supplied by contractor)



HIT RE Mixer

HIT-RE 500-SD
Refill Pack

Refill Pack Holder

HIT-RE 500-SD
Medium Cartridge

ED 3500
Battery
Dispenser

P3500
Dispenser

MD2500
Dispenser

Refill Pack Holder

HIT-RE 500-SD
Jumbo Cartridge

P8000D
Dispenser

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Guide Specifications

Master Format Section:

Previous 2004 Format

03250 03 16 00 (Concrete Anchors)

Related Sections:

03200 03 20 00 (Concrete Reinforcing)

05050 05 50 00 (Metal Fabrications)

05120 05 10 00 (Structural Metal Framing)

Injectable adhesive shall be used for installation of all reinforcing steel dowels or threaded anchor rods and inserts into existing concrete. Adhesive shall be furnished in side-by-side refill packs which keep component A and component B separate. Side-by-side packs shall be designed to compress

during use to minimize waste volume. Side-by-side packs shall also be designed to accept static mixing nozzle which thoroughly blends component A and component B and allows injection directly into drilled hole. Only injection tools and static mixing nozzles as recommended by manufacturer shall be used. Manufacturer's instructions shall be followed. Injection adhesive shall be formulated to include resin and hardener to provide optimal curing speed as well as high strength and stiffness. Typical curing time at 68°F (20°C) shall be approximately 12 hours.

Injection adhesive shall be HIT-RE 500-SD, as furnished by Hilti.

Anchor Rods shall be furnished with chamfered ends so that either end will accept a nut and washer. Alternatively, anchor rods shall be furnished with a 45 degree chisel point on one end to allow

for easy insertion into the adhesive-filled hole. Anchor rods shall be manufactured to meet the following requirements:

1. ISO 898 Class 5.8
2. ASTM A 193, Grade B7 (high strength carbon steel anchor);
3. AISI 304 or AISI 316 stainless steel, meeting the requirements of ASTM F 593 (condition CW).

Special order length HAS Rods may vary from standard product.

Nuts and Washers of other grades and styles having specified proof load strength greater than the specified grade and style are also suitable. Nuts must have specified proof load strength equal to or greater than the minimum tensile strength of the specified threaded rod.

3.2.4.2 Material Specifications

Material Properties of Cured Adhesive

Bond Strength ASTM C882-91 ¹ 2 day cure 7 day cure	12.4 MPa 12.4 MPa	1800 psi 1800 psi
Compressive Strength ASTM D-695-96 ¹	82.7 MPa	12,000 psi
Compressive Modulus ASTM D-695-96 ¹	1493 MPa	0.22 x 10 ⁶ psi
Tensile Strength 7 day ASTM D-638-97	43.5 MPa	6310 psi
Elongation at break ASTM D-638-97	2.0%	2.0%
Heat Deflection Temperature ASTM D-648-95	63°C	146°F
Absorption ASTM D-570-95	0.06%	0.06%
Linear Coefficient of Shrinkage on Cure ASTM D-2566-86	0.004	0.004
Electrical resistance DIN IEC 93 (12.93)	6.6 x 10 ¹³ Ω/m	1.7 x 10 ¹² Ω/in.

¹ Minimum values obtained as a result of three cure temperatures (23°, 40°, 60°F)

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3.2.4.3 Strength Design^{1,2}

Design strengths are determined in accordance with ACI 318-08 Appendix D (ACI 318) and supplemented by ICC-ES ESR-2322. Design parameters are provided in Table 7 through Table 34. Strength reduction factors Φ as given in ACI 318 D.4.4 shall be used for load combinations calculated in accordance with Section 1612.2 of the UBC or Section 1605.2 of the 2000, 2003 or 2006 IBC. Strength reduction factors f as given in ACI 318 D.4.5 shall be used for load combinations calculated in accordance with Section 1909.2 of the UBC.

This section provides amendments to ACI 318-08 Appendix D (ACI 318) as required for the strength design of adhesive anchors. In conformance with ACI 318-08, all equations are expressed in inch-pound units.

D.4.1.2 — In Eq. (D-1) and (D-2), N_n and V_n are the lowest design strengths determined from all appropriate failure modes. N_n is the lowest design strength in tension of an anchor or group of anchors as determined from consideration of N_{sa} , either N_a or N_{ag} and either N_{cb} or N_{cbg} . V_n is the lowest design strength in shear of an anchor or a group of anchors as determined from consideration of: V_{sa} , either V_{cb} or V_{cbg} , and either V_{cp} or V_{cpb} .

D.4.1.4 — For adhesive anchors installed overhead and subjected to tension resulting from sustained loading, Eq. (D-1) shall also be satisfied taking $N_n = 0.75 N_a$ for single anchors and $N_n = 0.75 N_{ag}$ for groups of anchors, whereby N_{ua} is determined from the sustained load alone, e.g., the dead load and that portion of the live load acting that may be considered as sustained. Where shear loads act concurrently with the

sustained tension load, interaction of tension and shear shall be checked in accordance with Section D.4.1.3.

D.5.2.9 — The limiting concrete strength of adhesive anchors in tension shall be calculated in accordance with D.5.2.1 to D.5.2.8 where the value of k_c to be used in Eq. (D-7) shall be:

$k_{c,cr}$ where analysis indicates cracking at service load levels in the anchor vicinity (cracked concrete)

$k_{c,uncr}$ where analysis indicates no cracking at service load levels in the anchor vicinity (un-cracked concrete)

D.5.3.7 — The nominal bond strength of an adhesive anchor N_a or group of adhesive anchors N_{ag} in tension shall not exceed

$$(a) \quad \text{for a single anchor} \quad N_a = \frac{A_{na}}{A_{a0}} \cdot \psi_{p,Na} \cdot N_{a0} \quad (D-14a)$$

$$(b) \quad \text{for a group of anchors} \quad N_{ag} = \frac{A_{na}}{A_{a0}} \cdot \psi_{ed,Na} \cdot \psi_{g,Na} \cdot \psi_{ec,Na} \cdot \psi_{p,Na} \cdot N_{a0} \quad (D-14b)$$

where

A_{na} is the projected area of the failure surface for the anchor or group of anchors that shall be approximated as the base of the rectilinear geometrical figure that results from projecting the failure surface outward a distance from the centerlines of the anchor, or in the case of a group of anchors, from a line through a row of adjacent anchors. A_{na} shall not exceed nA_{na0} where n is the number of anchors in tension in the group. (Refer to ACI 318 Figures RD.5.2.1a and RD.5.2.1b and replace the terms $1.5h_{ef}$ and $3.0h_{ef}$ with $c_{cr,Na}$ and $s_{cr,Na}$, respectively.)

A_{na0} is the projected area of the failure surface of a single anchor without the influence of proximate edges in accordance with Eq. (D-14c):

$$A_{na0} = \left(s_{cr,Na} \right)^2 \quad (D-14c)$$

with

$s_{cr,Na}$ = as given by Eq. (D-14h)

D.5.3.8 — The critical spacing and critical edge distance shall be calculated as follows:

$$s_{cr,Na} = 20 \cdot d \cdot \frac{\tau_{k,uncr}}{1,450} \leq 3 \cdot h_{ef} \quad (D-14h)$$

$$c_{cr,Na} = \frac{s_{cr,Na}}{2} \quad (D-14i)$$

D.5.3.9 — The basic strength of a single adhesive anchor in tension in cracked concrete shall not exceed

$$N_{a0} = \tau_{kcr} \cdot \pi \cdot d \cdot h_{ef} \quad (D-14j)$$

D.5.3.10 — The modification factor for the influence of the failure surface of a group of adhesive anchors is

$$\psi_{g,Na} = \psi_{g,Na0} + \left[\left(\frac{s}{s_{cr,Na}} \right)^{0.5} \cdot (1 - \psi_{g,Na0}) \right] \geq 1.0 \quad (D-14k)$$

where

$$\psi_{g,Na0} = \sqrt{n} - \left[(\sqrt{n} - 1) \left(\frac{\tau_{k,cr}}{\tau_{k,max,cr}} \right)^{1.5} \right] \geq 1.0 \quad (D-14l)$$

With n as the number of tension-loaded adhesive anchors in a group.

$$\tau_{k,max,cr} = \frac{k_{c,cr}}{\pi \cdot d} \sqrt{h_{ef} \cdot f'_c} \quad (D-14m)$$

D.5.3.11 — The modification factor for eccentrically loaded adhesive anchor groups is

$$\psi_{ec,Na} = \frac{1}{1 + \frac{2e'_N}{s_{cr,Na}}} \leq 1.0 \quad (D-14n)$$

Eq. (D-14n) is valid for $e'_N \leq \frac{s}{2}$

1 ACI 318-05 or 318-02 may also be used. The section references and terminology are different from those given in this section.

2 This section 3.2.4.3 is a reproduction of the content of ICC-ESR 2322, representing the opinions and recommendations of ICC-ES.

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If the loading on an anchor group is such that only some anchors are in tension, only those anchors that are in tension shall be considered when determining the eccentricity e'_N for use in Eq. (D-14n).

In the case where eccentric loading exists about two orthogonal axes, the modification factor $\psi_{ec,Na}$ shall be computed for each axis individually and the product of these factors used as $\psi_{ec,Na}$ in Eq. (D-14b).

D.5.3.12 — The modification factor for the edge effects for single adhesive anchors or anchor groups loaded on tension is:

$$\psi_{ed,Na} = 1.0 \text{ when } c_{a,min} \geq c_{cr,Na} \quad (D-14o)$$

for $C_{a,min} < C_{cr,Na}$

$$\psi_{ed,Na} = \left(0.7 + 0.3 \frac{C_{a,min}}{C_{cr,Na}} \right) \leq 1.0 \quad (D-14p)$$

D.5.3.13 — When an adhesive anchor or a group of adhesive anchors is located in a region of a concrete member where analysis indicates no cracking at service load levels, the nominal strength N_a or N_{ag} of a single adhesive anchor or a group of adhesive anchors shall be calculated according to Eq. (D-14a) and Eq. (D-14b) with $\tau_{k,uncr}$ substituted for $\tau_{k,cr}$ in the calculation of the basic strength in accordance with Eq. (D-14j). $\tau_{k,uncr}$ shall be established based on tests in accordance with AC308. The factor $\tau_{g,Na0}$ shall be calculated in accordance with Eq. (D-14l) whereby the value of $\tau_{k,max,uncr}$ shall be calculated in accordance with Eq. (D-14q) and substituted for $\tau_{k,max,cr}$ in Eq. (D-14l).

$$\tau_{k,max,uncr} = \frac{k_{c,uncr}}{\pi \cdot d} \sqrt{h_{ef} \cdot f'_c} \quad (D-14q)$$

D.5.3.14 — When an adhesive anchor or a group of adhesive anchors is located in a region of a concrete member where analysis indicates no cracking at service load levels, the modification factor shall be taken as

$$\psi_{p,Na} = 1.0 \quad \text{when } c_{a,min} \geq c_{ac} \quad (D-14r)$$

$$\psi_{p,Na} = \frac{\max |c_{a,min}; c_{cr,Na}|}{C_{ac}} \quad \text{when } c_{a,min} < c_{ac} \quad (D-14s)$$

For all other cases, $\psi_{p,Na} = 1.0$.

D.6.3.2 — The nominal pryout strength of an adhesive anchor or group of adhesive anchors shall not exceed

(a) for a single adhesive anchor

$$V_{cp} = \min |k_{cp} \cdot N_a; k_{cp} \cdot N_{cb}| \quad (D-28a)$$

(b) for a group of adhesive anchors

$$V_{cpg} = \min |k_{cp} \cdot N_{ag}; k_{cp} \cdot N_{cbg}| \quad (D-28b)$$

where

$$k_{cp} = 1.0 \text{ for } h_{ef} < 2.5 \text{ in. (64 mm)}$$

$$k_{cp} = 2.0 \text{ for } h_{ef} \geq 2.5 \text{ in. (64 mm)}$$

N_a is calculated in accordance with Eq. (D-14a)

N_{ag} is calculated in accordance with Eq. (D-14b)

N_{cb} , N_{cbg} are determined in accordance with D.5.2.8

D.8.7 — For adhesive anchors that will remain untorqued, the minimum edge distance shall be based on minimum cover requirements for reinforcement in 7.7. For adhesive anchors that will be torqued, the minimum edge distance and spacing shall be taken as $6d_o$ and $5d_o$, respectively, unless otherwise determined in accordance with AC308.

Bond strength determination:

Bond strength values are a function of concrete condition (cracked, un-cracked), drilling method (hammer drill, core drill) and installation conditions (dry, water-saturated, etc.). Bond strength values shall be modified with the factor k_{nn} for cases where holes are drilled in water-saturated concrete (k_{ws}), where the holes are water-filled at the time of anchor

installation (k_{wt}), or where the application is carried out underwater (k_{uw}).

Where applicable, the modified bond strength values shall be used in lieu of $\tau_{k,cr}$ and $\tau_{k,uncr}$ in Equations (D-14d), (D-14f), (D-14j), (D-14m), and (D-14o). The resulting nominal bond strength shall be multiplied by the associated strength reduction factor Φ_{nn} .

Minimum member thickness h_{min} , anchor spacing s_{min} and edge distance c_{min} :

In lieu of ACI 318 Section D.8.3, values of c_{min} and s_{min} as given in this section are applicable. Likewise, in lieu of

ACI 318 Section D.8.5, minimum member thicknesses h_{min} as given in this section are applicable.

Critical edge distance c_{ac} :

In lieu of ACI 318 Section D.8.6, c_{ac} may be taken as follows:

$$\text{for } h = h_{min} : c_{ac} = \frac{3(h_{ef})^2}{32d} + 1.63h_{ef}$$

$$\text{for } h \geq h_{ef} + 5(c_{a,min})^{3/4}$$

where

$$h_{ef} \leq 8d : c_{ac} = 1.5h_{ef}$$

$$h_{ef} > 8d : c_{ac} = \frac{(h_{ef})^2}{48d} + 1.33h_{ef}$$

$$\text{for all other } h \geq h_{min} : c_{ac} = 2.5h_{ef}$$

Design strength in SDC C, D, E and F:

Where anchors are designed to resist earthquake forces in structures assigned to Seismic Design Categories C, D, E or F, the anchor strength shall be adjusted in accordance with 2006 IBC Section 1908.1.16. The nominal steel shear strength, V_{sa} , shall be adjusted by $\alpha_{V,seis}$. The nominal bond strength k_{cr} shall be adjusted by $\alpha_{N,seis}$.

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3.2.4.4 Technical Data

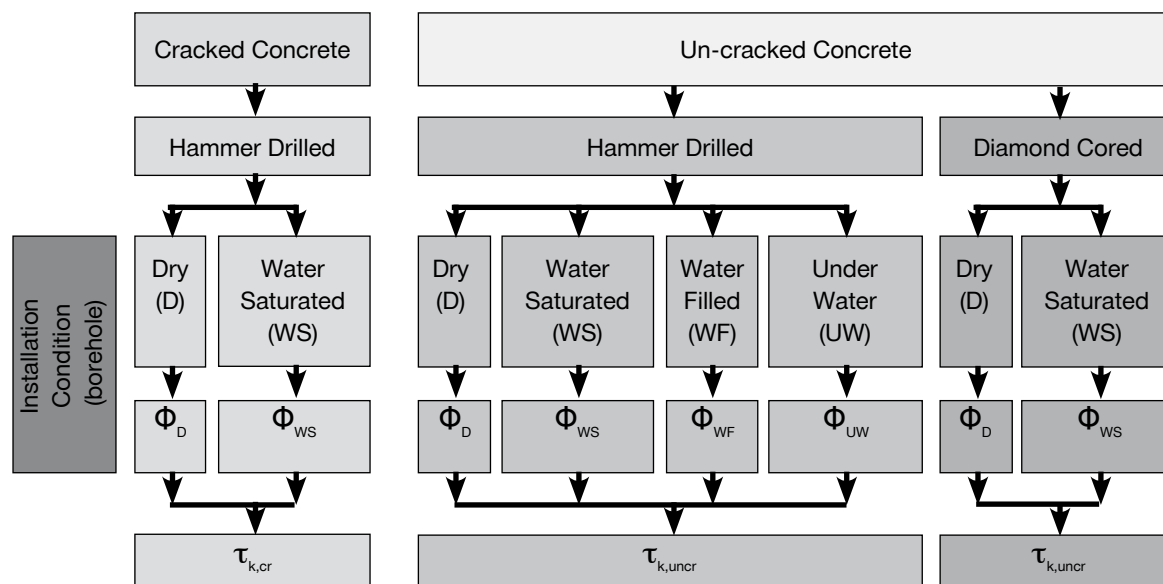
Table 1 — Design Table Index

Design strength ¹		Threaded rod		Hilti HIS internally threaded insert		Deformed reinforcement		
		fractional	metric	fractional	metric	US	EU	Canadian
Steel	N_{sa}, V_{sa}	Table 7	Table 11	Table 15	Table 19	Table 23	Table 27	Table 31
Concrete	$N_{pn}, N_{sb}, N_{sbg}, N_{cb}, N_{cbg}, V_{cb}, V_{cbg}, V_{cp}, V_{cpg}$	Table 8	Table 12	Table 16	Table 20	Table 24	Table 28	Table 32
Bond ²	N_a, N_{ag}	hammer-drilled holes		Table 9	Table 13	Table 17	Table 21	Table 25
		diamond cored holes		Table 10	Table 14	Table 18	Table 22	Table 26
						Table 29	Table 30	Table 34

1 Ref. ACI 318 Section D.4.1.2

2 See Section 3.2.4.3.

Bond Strength Design Flowchart



3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 2 — Tensile Properties of Common Carbon Steel Threaded Rod Materials¹

Threaded Rod Specification		Minimum specified ultimate strength f_{uta}	Minimum specified yield strength 0.2% offset f_{ya}	f_{uta}/f_{ya}	Elongation, min. % ⁵	Reduction of Area, min. %	Specification for nuts ⁶
ASTM A 193 ² Grade B7 ≤ 2-1/2 in. (≤ 64 mm)	psi (MPa)	125,000 (862)	105,000 (724)	1.19	16	50	ASTM A 563 Grade DH
ASTM F 568M ³ Class 5.8 M5 (1/4 in.) to M24 (1 in.) (equivalent to ISO 898-1)	psi (MPa)	72,500 (500)	58,000 (400)	1.25	10	35	DIN 934 (8-A2K ASTM A 563 Grade DH ⁷)
ISO 898-1 ⁴ Class 8.8	MPa (psi)	800 (116,000)	640 (92,800)	1.25	12	52	DIN 934 (8-A2K)

1 Hilti HIT-RE 500-SD may be used in conjunction with all grades of continuously threaded carbon steel rod (all-thread) that conform to the code and that have thread characteristics comparable with ANSI B1.1 UNC Coarse Thread Series or ANSI B1.13M M Profile Metric Thread Series. Values for threaded rod types and associated nuts supplied by Hilti are provided here.

2 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

3 Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

4 Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs

5 Based on 2-in. (50 mm) gauge length except for A193 and A449, which are based on a gauge length of 4D and ISO 898 which is based on 5D.

6 Nuts of other grades and styles having specified proof load stresses greater than the specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than the minimum tensile strength of the specified threaded rod.

7 Nuts for fractional rods.

Table 3 — Tensile Properties of Common Stainless Steel Threaded Rod Materials¹

Threaded Rod Specification		Minimum 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 ⁵
ASTM F 593 ² CW1 (316) 1/4 to 5/8 in.	psi (MPa)	100,000 (689)	65,000 (448)	1.54	20	–	F 594
ASTM F 593 ² CW2 (316) 3/4 to 1-1/2 in.	psi (MPa)	85,000 (586)	45,000 (310)	1.89	25	–	F 594
ISO 3506-1 ³ A4-70 M8 – M24	MPa (psi)	700 (101,500)	450 (65,250)	1.56	40	–	ISO 4032
ISO 3506-1 ³ A4-50 M27 – M30	MPa (psi)	500 (72,500)	210 (30,450)	2.00	40	–	ISO 4032

1 Hilti HIT-RE 500-SD may be used in conjunction with all grades of continuously threaded stainless steel rod (all-thread) that conform to the code and that have thread characteristics comparable with ANSI B1.1 UNC Coarse Thread Series or ANSI B1.13M M Profile Metric Thread Series. Values for threaded rod types and associated nuts supplied by Hilti are provided here.

2 Standard Steel Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

3 Mechanical properties of corrosion-resistant stainless steel fasteners – Part 1: Bolts, screws and studs

4 Nuts of other grades and styles having specified proof load stresses greater than the specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than the minimum tensile strength of the specified threaded rod. Differing grades of steel may affect corrosion resistance.

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 4 — Tensile Properties of Fractional and Metric HIS-N and HIS-RN Inserts

Hilti HIS and HIS-R Inserts		Minimum specified ultimate strength f_{uta}	Minimum specified yield strength f_{ya}
DIN 1651 9SMNPB28K Carbon Steel 3/8 and M8 to M10	MPa (psi)	490 (71,050)	410 (59,450)
DIN 1651 9SMNPB28K Carbon Steel 1/2 to 3/4 and M12 to M20	MPa (psi)	460 (66,700)	375 (54,375)
DIN 17440 X5CrNiMo17122 Stainless Steel	MPa (psi)	700 (101,500)	350 (50,750)

Table 5 — Tensile Properties of Common Bolts, Cap Screws and Studs for Use with HIS-N and HIS-RN Inserts^{1,2}

Bolt, Cap Screw or Stud Specification		Minimum 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 ⁵
SAE J429 ³ Grade 5	psi (MPa)	120,000 (828)	92,000 (634)	1.30	14	35	SAE J995
ASTM A 325 ⁴ 1/2 to 1-in.	psi (MPa)	120,000 (828)	92,000 (634)	1.30	14	35	A 563 C, C3, D, DH, DH3 Heavy Hex
ASTM A193 ⁵ GRADE B8M (AISI 316) for use with HIS-RN	MPa (psi)	110,000 (759)	95,000 (655)	1.16	15	45	F 594 ⁷
ASTM A193 ⁵ GRADE B8T (AISI 321) for use with HIS-RN	MPa (psi)	125,000 (862)	100,000 (690)	1.25	12	35	F 594 ⁷

1 Minimum Grade 5 bolts, cap screws or studs should be used in conjunction with carbon steel HIS inserts.

2 Use only stainless steel bolts, cap screws or studs with HIS-R inserts.

3 Mechanical and Material Requirements for Externally Threaded Fasteners

4 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

5 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

6 Nuts must have specified minimum proof load stress equal to or greater than the specified minimum full-size tensile strength of the specified stud.

7 Nuts for stainless steel studs must be of the same alloy group as the specified stud.

Table 6 — Tensile Properties of Common Reinforcing Bars

Reinforcing Bar Specification		Minimum specified ultimate strength f_{uta}	Minimum specified yield strength f_{ya}
ASTM A 615 ¹ Gr. 60	psi (MPa)	90,000 (620)	60,000 (414)
ASTM A 615 ¹ Gr. 40	psi (MPa)	60,000 (414)	40,000 (276)
DIN 488 ² BSt 500	MPa (psi)	550 (79,750)	500 (72,500)
CAN/CSA-G30.18 ³ Gr. 400	MPa (psi)	540 (78,300)	400 (58,000)

1 Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement

2 Reinforcing steel; reinforcing steel bars; dimensions and masses

3 Billet-Steel Bars for Concrete Reinforcement

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 7 — Steel Design Information for Fractional Threaded Rod^{1,3}

Design Information		Symbol	Units	Nominal Rod Diameter (in.)					
				3/8	1/2	5/8	3/4	7/8	1
Rod O.D.		d	in. (mm)	0.375 (9.5)	0.5 (12.7)	0.625 (15.9)	0.75 (19.1)	0.875 (22.2)	1 (25.4)
Rod effective cross-sectional area		A _{se}	in. ² (mm ²)	0.0775 (50)	0.1419 (92)	0.2260 (146)	0.3345 (216)	0.4617 (298)	0.6057 (391)
ISO 898-1 Class 5.8 ²	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	5,619 (25.0)	10,288 (45.8)	16,385 (72.9)	24,251 (107.9)	33,472 (148.9)	43,912 (195.3)
		V _{sa}	lb (kN)	2,809 (12.5)	6,173 (27.5)	9,831 (43.7)	14,550 (64.7)	20,083 (89.3)	26,347 (117.2)
	Reduction for seismic shear	a _{v,seis}	–	0.70					
	Strength reduction factor Φ for tension ²	Φ	–	0.65					
	Strength reduction factor Φ for shear ²	Φ	–	0.60					
ASTM A 193 B7 ²	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	9,687 (43.1)	17,737 (78.9)	28,249 (125.7)	41,812 (186.0)	57,711 (256.7)	75,711 (336.8)
		V _{sa}	lb (kN)	4,844 (21.5)	10,642 (47.3)	16,950 (75.4)	25,087 (111.6)	34,627 (154.0)	45,426 (202.1)
	Reduction for seismic shear	a _{v,seis}	–	0.70					
	Strength reduction factor Φ for tension ²	Φ	–	0.75					
	Strength reduction factor Φ for shear ²	Φ	–	0.65					
ASTM F593, CW Stainless ²	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	28,432 (126.5)	39,244 (174.6)	51,483 (229.0)
		V _{sa}	lb (kN)	3,875 (17.2)	8,514 (37.9)	13,560 (60.3)	17,059 (75.9)	23,546 (104.7)	30,890 (137.4)
	Reduction for seismic shear	a _{v,seis}	–	0.70					
	Strength reduction factor Φ for tension ²	Φ	–	0.75					
	Strength reduction factor Φ for shear ²	Φ	–	0.65					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318-08 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible provided the design is adjusted accordingly. Use nuts and washers appropriate for the rod strength. Differing grades of steel may affect corrosion resistance.

2 For use with the load combinations of ACI 318-08 Section 9.2. See ACI 318-08 Section D.4.4.

3 e.g. Hilti HAS rods

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 8 — Concrete Breakout Design Information for Fractional Threaded Rod in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information	Symbol	Units	Nominal Rod Diameter (in.)						
			3/8	1/2	5/8	3/4	7/8	1	1-1/4
Effectiveness factor for cracked concrete	k _{c,cr}	in-lb (SI)	17 (7.1)						
Effectiveness factor for un-cracked concrete	k _{c,un-cr}	in-lb (SI)	24 (10)						
Min. 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)
Min. edge distance	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 member thickness	h _{min}	in. (mm)	h _{ef} + 1-1/4 (h _{ef} + 30)		h _{ef} + 2h _o				
Critical edge distance — splitting (for un-cracked concrete)	c _{ac}	–	See Strength Design provisions above						
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	–	0.65						
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	–	0.70						

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B without supplementary reinforcement.

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Table 9 — Bond Strength Design Information for Fractional Threaded Rod in Holes Drilled with a Hammer Drill and Carbide Bit^{1,4}

Design Information		Symbol	Units	Nominal Rod Diameter (in.)					
				3/8	1/2	5/8	3/4	7/8	1
Temperature range A ³	Characteristic bond strength and minimum anchor embedment in cracked concrete	$\tau_{k,cr}$	psi (N/mm ²)	1,092 (7.5)	1,073 (7.4)	1,044 (7.2)	999 (6.9)	917 (6.3)	852 (5.9)
		$h_{ef,min}$	in. (mm)	2.43 (62)	2.81 (71)	3.14 (80)	3.44 (87)	3.71 (94)	4.0 (102)
	Characteristic bond strength and minimum anchor embedment in un-cracked concrete	$\tau_{k,uncr}$	psi (N/mm ²)	2,283 (15.7)	2,236 (15.4)	2,142 (14.8)	2,067 (14.3)	2,002 (13.8)	1,946 (13.4)
		$h_{ef,min}$	in. (mm)	2.43 (62)	2.81 (71)	3.14 (80)	3.44 (87)	3.71 (94)	4.0 (102)
Temperature range B ³	Characteristic bond strength and minimum anchor embedment in cracked concrete ²	$\tau_{k,cr}$	psi (N/mm ²)	444 (3.1)	431 (3.0)	379 (2.6)	345 (2.4)	316 (2.2)	294 (2.0)
		$h_{ef,min}$	in. (mm)	1.73 (44)	2.20 (56)	3.61 (66)	3.01 (76)	3.50 (89)	4.0 (102)
	Characteristic bond strength and minimum anchor embedment in un-cracked concrete ²	$\tau_{k,uncr}$	psi (N/mm ²)	788 (5.4)	772 (5.3)	739 (5.1)	714 (4.9)	691 (4.8)	672 (4.6)
		$h_{ef,min}$	in. (mm)	1.73 (44)	2.20 (56)	3.61 (66)	3.01 (76)	3.50 (89)	4.0 (102)
Permissible installation conditions	Dry concrete	Φ_d	–	0.65	0.65	0.65	0.65	0.55	0.55
	Water-saturated concrete	Φ_{ws}	–	0.55	0.55	0.45	0.45	0.45	0.45
		k_{ws}	–	1.0	1.0	1.0	1.0	1.0	0.99
	Water-filled hole	Φ_{wf}	–	0.45	0.45	0.45	0.45	0.45	0.45
		k_{wf}	–	1.00	1.00	0.96	0.91	0.87	0.79
	Underwater application	Φ_{uw}	–	0.45	0.45	0.45	0.45	0.45	0.45
		k_{uw}	–	0.95	0.94	0.94	0.93	0.92	0.91

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi $\leq f'_c \leq$ 4,500 psi. For 4,500 psi $\leq f'_c \leq$ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi $\leq f'_c \leq$ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Bond strength values are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- For structures assigned to SDC C, D, E or F, bond strength values shall be multiplied by $\alpha_{N,seis} = 0.65$.

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 10 — Bond Strength Design Information for Fractional Threaded Rod in Holes Drilled with a Core Drill^{1,4}

Design Information		Symbol	Units	Nominal Rod Diameter (in.)						
				3/8	1/2	5/8	3/4	7/8	1	1-1/4
Temperature range A ³	Characteristic bond strength and minimum anchor embedment in un-cracked concrete	$\tau_{k,uncr}$	psi (N/mm ²)	1,740 (12.0)	1,703 (11.7)	1,553 (10.7)	1,441 (9.9)	1,356 (9.4)	1,282 (8.8)	1,169 (8.1)
		$h_{ef,min}$	in. (mm)	2.43 (62)	2.81 (71)	3.14 (80)	3.44 (87)	3.71 (94)	4.0 (102)	5.0 (127)
Temperature range B ³	Characteristic bond strength and minimum anchor embedment in un-cracked concrete ²	$\tau_{k,uncr}$	psi (N/mm ²)	601 (4.1)	588 (4.1)	536 (3.7)	497 (3.4)	468 (3.2)	442 (3.1)	404 (2.8)
		$h_{ef,min}$	in. (mm)	1.57 (40)	2.0 (51)	2.5 (64)	3.0 (76)	3.5 (89)	4.0 (102)	5.0 (127)
Permissible installation conditions	Dry concrete	Φ_d	–	0.65	0.65	0.55	0.55	0.55	0.45	0.45
	Water-saturated concrete	Φ_{ws}	–	0.55	0.55	0.45	0.45	0.45	0.45	0.45
		k_{ws}	–	1.00	1.00	1.00	1.00	1.00	0.95	0.88

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi $\leq f'_c \leq$ 4,500 psi. For 4,500 psi $\leq f'_c \leq$ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi $\leq f'_c \leq$ 8,000 psi, tabulated characteristic bond may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- Bond strength values applicable to SDC A and B only.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 11 — Steel Design Information for Metric Threaded Rod¹

Design Information			Symbol	Units	Nominal Rod Diameter (mm)							
					8	10	12	16	20	24	27	30
Rod O.D.			d	mm (in.)	8 (0.31)	10 (0.39)	12 (0.47)	16 (0.63)	20 (0.79)	24 (0.94)	27 (1.06)	30 (1.18)
Rod effective cross-sectional area			A _{se}	mm ² (in. ²)	36.6 (0.057)	58 (0.090)	84.3 (0.131)	157 (0.243)	245 (0.380)	353 (0.547)	459 (0.711)	561 (0.870)
ISO 898-1 Class 5.8	Nominal strength as governed by steel strength	N _{sa}	kN (lb)	18.3 (4,114)	29.0 (6,519)	42.2 (9,476)	78.5 (17,647)	122.5 (27,539)	176.5 (39,679)	229.5 (51,594)	280.5 (63,059)	
		V _{sa}	kN (lb)	9.2 (2,057)	14.5 (3,260)	25.3 (5,685)	47.1 (10,588)	73.5 (16,523)	105.9 (23,807)	137.7 (30,956)	168.3 (37,835)	
	Reduction for seismic shear		α _{V,seis}	–	0.70							
	Strength reduction factor f for tension ²		Φ	–	0.65							
	Strength reduction factor f for shear ²		Φ	–	0.60							
ISO 898-1 Class 8.8	Nominal strength as governed by steel strength	N _{sa}	kN (lb)	29.3 (6,582)	46.4 (10,431)	67.4 (15,161)	125.6 (28,236)	196.0 (44,063)	282.4 (63,486)	367.2 (82,550)	448.8 (100,894)	
		V _{sa}	kN (lb)	14.6 (3,291)	23.2 (5,216)	40.5 (9,097)	75.4 (16,942)	117.6 (26,438)	169.4 (38,092)	220.3 (49,530)	269.3 (60,537)	
	Reduction for seismic shear		α _{V,seis}	–	0.70							
	Strength reduction factor Φ for tension ²		Φ	–	0.65							
	Strength reduction factor Φ for shear ²		Φ	–	0.60							
ISO 3506-1 Class A4 Stainless ³	Nominal strength as governed by steel strength	N _{sa}	kN (lb)	25.6 (5,760)	40.6 (9,127)	59.0 (13,266)	109.9 (24,706)	171.5 (38,555)	247.1 (55,550)	229.5 (51,594)	280.5 (63,059)	
		V _{sa}	kN (lb)	12.8 (2,880)	20.3 (4,564)	35.4 (7,960)	65.9 (14,824)	102.9 (23,133)	148.3 (33,330)	137.7 (30,956)	168.3 (37,835)	
	Reduction for seismic shear		α _{V,seis}	–	0.70							
	Strength reduction factor Φ for tension ²		Φ	–	0.75							
	Strength reduction factor Φ for shear ²		Φ	–	0.65							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318-08 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible provided the design is adjusted accordingly. Use nuts and washers appropriate for the rod strength. Differing grades of steel may affect corrosion resistance.

2 For use with the load combinations of ACI 318-08 Section 9.2. See ACI 318-08 Section D.4.4.

3 A4-70 Stainless (M8- M24); A4-502 Stainless (M27- M30)

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 12 — Concrete Breakout Design Information for Metric Threaded Rod in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information	Symbol	Units	Nominal Rod Diameter mm							
			8	10	12	16	20	24	27	30
Effectiveness factor for cracked concrete	$k_{c,cr}$	SI (in-lb)	7.1 (17)							
Effectiveness factor for un-cracked concrete	$k_{c,un-cr}$	SI (in-lb)	10 (24)							
Min. anchor spacing	s_{min}	mm (in.)	40 (1.6)	50 (2.0)	60 (2.4)	80 (3.2)	100 (3.9)	120 (4.7)	135 (5.3)	150 (5.9)
Min. edge distance	c_{min}	mm (in.)	40 (1.6)	50 (2.0)	60 (2.4)	80 (3.2)	100 (3.9)	120 (4.7)	135 (5.3)	150 (5.9)
Minimum member thickness	h_{min}	mm (in.)	$h_{ef} + 30$ ($h_{ef} + 1-1/4$)		$h_{ef} + 2d_o$					
Critical edge distance — splitting (for un-cracked concrete)	c_{ac}	–	See Strength Design provisions above							
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	–	0.65							
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	–	0.70							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B without supplementary reinforcement.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 13 — Bond Strength Design Information for Metric Threaded Rod in Holes Drilled with a Hammer Drill and Carbide Bit^{1,4}

Design Information		Symbol	Units	Nominal Rod Diameter (mm)							
				8	10	12	16	20	24	27	30
Temperature range A ³	Characteristic bond strength and minimum anchor embedment in cracked concrete	$\tau_{k,cr}$	N/mm ² (psi)	7.5 (1,092)	7.5 (1,092)	7.5 (1,092)	7.2 (1,044)	6.7 (972)	6.0 (877)	5.7 (831)	5.3 (768)
		$h_{ef,min}$	mm (in.)	57 (2.23)	63 (2.49)	69 (2.73)	80 (3.15)	89 (3.52)	98 (3.86)	108 (4.25)	120 (4.72)
	Characteristic bond strength and minimum anchor embedment in un-cracked concrete	$\tau_{k,uncr}$	N/mm ² (psi)	15.6 (2,264)	15.6 (2,264)	15.6 (2,264)	14.8 (2,142)	14.1 (2,039)	13.6 (1,974)	13.3 (1,927)	13.0 (1,880)
		$h_{ef,min}$	mm (in.)	57 (2.23)	63 (2.49)	69 (2.73)	80 (3.15)	89 (3.52)	98 (3.86)	108 (4.25)	120 (4.72)
Temperature range B ³	Characteristic bond strength and minimum anchor embedment in cracked concrete ²	$\tau_{k,cr}$	N/mm ² (psi)	3.1 (444)	3.1 (444)	3.1 (444)	2.6 (379)	2.3 (336)	2.1 (303)	2.0 (287)	1.9 (268)
		$h_{ef,min}$	mm (in.)	40 (1.57)	46 (1.80)	53 (2.10)	67 (2.62)	80 (3.15)	96 (3.78)	108 (4.25)	120 (4.72)
	Characteristic bond strength and minimum anchor embedment in un-cracked concrete ²	$\tau_{k,uncr}$	N/mm ² (psi)	5.4 (781)	5.4 (781)	5.4 (781)	5.1 (739)	4.9 (704)	4.7 (681)	4.6 (665)	4.5 (649)
		$h_{ef,min}$	mm (in.)	40 (1.57)	46 (1.80)	53 (2.10)	67 (2.62)	80 (3.15)	96 (3.78)	108 (4.25)	120 (4.72)
Permissible installation conditions	Dry concrete	Φ_d	–	0.65	0.65	0.65	0.65	0.65	0.55	0.55	0.55
	Water-saturated concrete	Φ_{ws}	–	0.55	0.55	0.55	0.45	0.45	0.45	0.45	0.45
		k_{ws}	–	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.95
	Water-filled hole	Φ_{wf}	–	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
		k_{wf}	–	1.00	1.00	1.00	0.96	0.90	0.86	0.83	0.81
	Underwater application	Φ_{uw}	–	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
		k_{uw}	–	0.95	0.95	0.95	0.94	0.93	0.92	0.92	0.91

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi ≤ f'_c ≤ 4,500 psi. For 4,500 psi ≤ f'_c ≤ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi ≤ f'_c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- For structures assigned to SDC C, D, E or F, bond strength values shall be multiplied by $\alpha_{N,seis}$ = 0.65.

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 14 — Bond Strength Design Information for Metric Threaded Rod in Holes Drilled with a Core drill^{1,4}

Design Information		Symbol	Units	Nominal Rod Diameter (mm)							
				8	10	12	16	20	24	27	30
Temperature range A ³	Characteristic bond strength and minimum anchor embedment in un-cracked concrete	$\tau_{k,uncr}$	N/mm ² (psi)	12.0 (1,740)	12.0 (1,740)	12.0 (1,740)	10.7 (1,553)	9.7 (1,413)	9.0 (1,310)	8.6 (1,254)	8.3 (1,197)
		$h_{ef,min}$	mm (in.)	56 (2.19)	63 (2.49)	69 (2.73)	80 (3.15)	89 (3.52)	98 (3.86)	108 (4.25)	120 (4.72)
Temperature range B ³	Characteristic bond strength and minimum anchor embedment in un-cracked concrete ²	$\tau_{k,uncr}$	N/mm ² (psi)	4.1 (601)	4.1 (601)	4.1 (601)	3.7 (536)	3.4 (488)	3.1 (452)	3.0 (433)	2.8 (413)
		$h_{ef,min}$	mm (in.)	40 (1.57)	41 (1.61)	48 (1.89)	64 (2.52)	80 (3.15)	96 (3.78)	108 (4.25)	120 (4.72)
Permissible installation conditions	Dry concrete	Φ_d	–	0.65	0.65	0.65	0.55	0.55	0.55	0.45	0.45
	Water-saturated concrete	Φ_{ws}	–	0.55	0.55	0.55	0.45	0.45	0.45	0.45	0.45
		k_{ws}	–	1.00	1.00	1.00	1.00	1.00	0.97	0.93	0.90

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi $\leq f'_c \leq$ 4,500 psi. For 4,500 psi $\leq f'_c \leq$ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi $\leq f'_c \leq$ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- Bond strength values applicable to SDC A and B only.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 15 — Steel Design Information for Fractional Hilti HIS-N and HIS-RN Inserts¹

Design Information		Symbol	Units	Nominal bolt/cap screw Diameter (in.)			
				3/8	1/2	5/8	3/4
HIS Insert O.D.		d	in. (mm)	0.65 (16.5)	0.81 (20.5)	1 (25.4)	1.09 (27.6)
Rod effective cross-sectional area		A _{se}	in. ² (mm ²)	0.0775 (50)	0.1419 (92)	0.2260 (146)	0.3345 (216)
HIS insert effective cross-sectional area		A _{insert}	in. ² (mm ²)	0.178 (115)	0.243 (157)	0.404 (260)	0.410 (265)
ASTM A 193 B7	Nominal strength as governed by steel strength — ASTM A193 B7 bolt/cap screw	N _{sa}	lb (kN)	9,296 (41.3)	17,020 (75.7)	27,108 (120.6)	40,122 (178.5)
		V _{sa}	lb (kN)	5,577 (24.8)	10,212 (45.4)	16,265 (72.3)	24,073 (107.1)
	Nominal strength as governed by steel strength — HIS-N insert	N _{sa}	lb (kN)	12,648 (56.3)	16,195 (72.0)	26,926 (119.8)	27,362 (121.7)
	Reduction for seismic shear	α _{V,seis}	—	0.70			
	Strength reduction factor Φ for tension ²	Φ	—	0.65			
	Strength reduction factor Φ for shear ²	Φ	—	0.60			
ASTM F 193 Grade B8M SS	Nominal strength as governed by steel strength — ASTM F A193 Grade B8M SS bolt/cap screw	N _{sa}	lb (kN)	7,750 (34.5)	14,190 (63.1)	22,599 (100.5)	28,432 (126.5)
		V _{sa}	lb (kN)	4,650 (20.7)	8,514 (37.9)	13,560 (60.3)	17,059 (75.9)
	Nominal strength as governed by steel strength — HIS-RN insert	N _{sa}	lb (kN)	18,068 (80.4)	24,645 (109.6)	40,974 (182.3)	41,638 (185.2)
	Reduction for seismic shear	α _{V,seis}	—	0.70			
	Strength reduction factor Φ for tension ²	Φ	—	0.65			
	Strength reduction factor Φ for shear ²	Φ	—	0.60			

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318-08 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible provided the design is adjusted accordingly. Use nuts and washers appropriate for the rod strength. Differing grades of steel may affect corrosion resistance.

2 For use with the load combinations of ACI 318-08 Section 9.2. See ACI 318-08 Section D.4.4.

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 16 — Concrete Breakout Design Information for Fractional Hilti HIS-N and HIS-RN Inserts¹

Design Information	Symbol	Units	Nominal bolt/cap screw diameter (in.)			
			3/8	1/2	5/8	3/4
Effective embedment depth	h_{ef}	in. (mm)	4-3/8 (110)	5 (125)	6-3/4 (170)	8-1/8 (205)
Effectiveness factor for cracked concrete	$k_{c,cr}$	in-lb (SI)	17 (7.1)			
Effectiveness factor for un-cracked concrete	$k_{c,c}$	in-lb (SI)	24 (10)			
Minimum anchor spacing	s_{min}	in. (mm)	3-1/4 (83)	4 (102)	5 (127)	5-1/2 (140)
Minimum edge distance	c_{min}	in. (mm)	3-1/4 (83)	4 (102)	5 (127)	5-1/2 (140)
Minimum member thickness	h_{min}	in. (mm)	5.9 (150)	6.7 (170)	9.1 (230)	10.6 (270)
Critical edge distance — splitting (for un-cracked concrete)	c_{ac}	—	See Strength Design provisions above			
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	—	0.65			
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	—	0.70			

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B without supplementary reinforcement.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 17 — Bond Strength Design Information for Fractional Hilti HIS-N and HIS-RN Inserts in Holes Drilled with a Hammer Drill and Carbide Bit^{1,4}

Design Information		Symbol	Units	Nominal bolt/cap screw Diameter (in.)			
				3/8	1/2	5/8	3/4
Effective embedment depth		h_{ef}	in. (mm)	4-3/8 (110)	5 (125)	6-3/4 (170)	8-1/8 (205)
HIS insert O.D.		d	in. (mm)	0.65 (16.5)	0.81 (20.5)	1 (25.4)	1.09 (27.6)
Temperature range A ³	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm ²)	1040 (7.2)	957 (6.6)	845 (5.8)	806 (5.6)
	Characteristic bond strength in un-cracked concrete	$\tau_{k,uncr}$	psi (N/mm ²)	2124 (14.6)	2030 (14.0)	1946 (13.4)	1908 (13.2)
Temperature range B ³	Characteristic bond strength in cracked concrete ²	$\tau_{k,cr}$	psi (N/mm ²)	374 (2.6)	330 (2.3)	292 (2.0)	278 (1.9)
	Characteristic bond strength in un-cracked concrete ²	$\tau_{k,uncr}$	psi (N/mm ²)	733 (5.1)	701 (4.8)	672 (4.6)	659 (4.5)
Permissible installation conditions	Dry concrete	Φ_d	—	0.65	0.65	0.55	0.55
	Water-saturated concrete	Φ_{ws}	—	0.45	0.45	0.45	0.45
		k_{ws}	—	1.00	1.00	0.99	0.97
	Water-filled hole	Φ_{wf}	—	0.45	0.45	0.45	0.45
		k_{wf}	—	0.95	0.89	0.84	0.82
	Underwater application	Φ_{uw}	—	0.45	0.45	0.45	0.45
		k_{uw}	—	0.93	0.93	0.92	0.92

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi ≤ f'_c ≤ 4,500 psi. For 4,500 psi ≤ f'_c ≤ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi ≤ f'_c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- For structures assigned to SDC C, D, E or F, bond strength values shall be multiplied by $\alpha_{N,seis} = 0.65$.

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 18 — Bond Strength Design Information for Fractional Hilti HIS-N and HIS-RN Inserts in Holes Drilled with a Core Drill^{1,4}

Design Information		Symbol	Units	Nominal bolt/cap screw diameter (in.)			
				3/8	1/2	5/8	3/4
Effective embedment depth		h_{ef}	in. (mm)	4-3/8 (110)	5 (125)	6-3/4 (170)	8-1/8 (205)
HIS insert O.D.		d	in. (mm)	0.65 (16.5)	0.81 (20.5)	1 (25.4)	1.09 (27.6)
Temperature range A ³	Characteristic bond strength in un-cracked concrete	$\tau_{k,uncr}$	psi (N/mm ²)	1534 (10.6)	1403 (9.7)	1282 (8.8)	1235 (8.5)
Temperature range B ³	Characteristic bond strength in un-cracked concrete ²	$\tau_{k,uncr}$	psi (N/mm ²)	530 (3.7)	484 (3.3)	442 (3.1)	426 (2.9)
Permissible installation conditions	Dry concrete	Φ_d	–	0.55	0.55	0.45	0.45
	Water-saturated concrete	Φ_{ws}	–	0.45	0.45	0.45	0.45
		k_{ws}	–	1.00	1.00	0.95	0.92

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi $\leq f'_c \leq$ 4,500 psi. For 4,500 psi $\leq f'_c \leq$ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi $\leq f'_c \leq$ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- Bond strength values applicable to SDC A and B only.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 19 — Steel Design Information for Metric Hilti HIS-N and HIS-RN Inserts¹

Design Information		Symbol	Units	Nominal bolt/cap screw Diameter (mm)				
				8	10	12	16	20
HIS insert O.D.		d	mm (in.)	12.5 (0.49)	16.5 (0.65)	20.5 (0.81)	25.4 (1.00)	27.6 (1.09)
Bolt effective cross-sectional area		A _{se}	mm ² (in. ²)	36.6 (0.057)	58 (0.090)	84.3 (0.131)	157 (0.243)	245 (0.380)
HIS insert effective cross-sectional area		A _{insert}	mm ² (in. ²)	51.5 (0.080)	108 (0.167)	169.1 (0.262)	256.1 (0.397)	237.6 (0.368)
ASTM A 193 B7	Nominal strength as governed by steel strength — ISO 898-1 Class 8.8 bolt/cap screw	N _{sa}	kN (lb)	29.3 (6,582)	46.4 (10,431)	67.4 (15,161)	125.6 (28,236)	196.0 (44,063)
		V _{sa}	kN (lb)	17.6 (3,949)	27.8 (6,259)	40.5 (9,097)	75.4 (16,942)	117.6 (26,438)
	Nominal strength as governed by steel strength — HIS-N insert	N _{sa}	kN (lb)	25.2 (5,669)	52.9 (11,894)	77.8 (17,488)	117.8 (26,483)	109.3 (24,573)
	Reduction for seismic shear	α _{V,seis}	—	0.70				
	Strength reduction factor Φ for tension ²	Φ	—	0.65				
	Strength reduction factor Φ for shear ²	Φ	—	0.60				
ASTM F 193 Grade B8M SS	Nominal strength as governed by steel strength — ISO 3506-1 Class A4-70 Stainless bolt/cap screw	N _{sa}	kN (lb)	25.6 (5,760)	40.6 (9,127)	59.0 (13,266)	109.9 (24,706)	171.5 (38,555)
		V _{sa}	kN (lb)	15.4 (3,456)	24.4 (5,476)	35.4 (7,960)	65.9 (14,824)	102.9 (23,133)
	Nominal strength as governed by steel strength — HIS-RN insert	N _{sa}	kN (lb)	36.0 (8,099)	75.6 (16,991)	118.4 (26,612)	179.3 (40,300)	166.3 (37,394)
	Reduction for seismic shear	α _{V,seis}	—	0.70				
	Strength reduction factor Φ for tension ²	Φ	—	0.65				
	Strength reduction factor Φ for shear ²	Φ	—	0.60				

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318-08 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible provided the design is adjusted accordingly. Use nuts and washers appropriate for the rod strength. Differing grades of steel may affect corrosion resistance.

2 For use with the load combinations of ACI 318-08 Section 9.2. See ACI 318-08 Section D.4.4. Values correspond to a ductile steel element.

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 20 — Concrete Breakout Design Information for Metric Hilti HIS-N and HIS-RN Inserts¹

Design Information	Symbol	Units	Nominal bolt/cap screw diameter (mm)				
			8	10	12	16	20
Effective embedment depth	h_{ef}	mm (in.)	90 (3.5)	110 (4.3)	125 (4.9)	170 (6.7)	205 (8.1)
Effectiveness factor for cracked concrete	$k_{c,cr}$	SI (in-lb)	7.1 (17)				
Effectiveness factor for un-cracked concrete	$k_{c,c}$	SI (in-lb)	10 (24)				
Minimum anchor spacing	s_{min}	mm (in.)	40 (1.6)	50 (2.0)	60 (2.4)	80 (3.2)	100 (3.9)
Minimum edge distance	c_{min}	mm (in.)	40 (1.6)	50 (2.0)	60 (2.4)	80 (3.2)	100 (3.9)
Minimum member thickness	h_{min}	mm (in.)	120 (4.7)	150 (5.9)	170 (6.7)	230 (9.1)	270 (10.6)
Critical edge distance — splitting (for un-cracked concrete)	c_{ac}	—	See Strength Design provisions above				
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	—	0.65				
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	—	0.70				

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B without supplementary reinforcement.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 21 — Bond Strength Design Information for Metric Hilti HIS-N and HIS-RN Inserts in Holes Drilled with a Hammer Drill and Carbide Bit^{1,4}

Design Information		Symbol	Units	Nominal bolt/cap screw Diameter (mm)				
				8	10	12	16	20
Effective embedment depth		h_{ef}	mm (in.)	90 (3.5)	110 (4.3)	125 (4.9)	170 (6.7)	205 (8.1)
HIS insert O.D.		d	mm (in.)	12.5 (0.49)	16.5 (0.65)	20.5 (0.81)	25.4 (1.00)	27.6 (1.09)
Temperature range A ³	Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	N/mm ² (psi)	7.4 (1,080)	7.2 (1,040)	6.6 (957)	5.8 (845)	5.6 (806)
	Characteristic bond strength in un-cracked concrete	$\tau_{k,uncr}$	N/mm ² (psi)	15.5 (2,245)	14.6 (2,124)	14.0 (2,030)	13.4 (1,946)	13.2 (1,908)
Temperature range B ³	Characteristic bond strength in cracked concrete ²	$\tau_{k,cr}$	N/mm ² (psi)	3.0 (433)	2.6 (374)	2.3 (330)	2.0 (292)	1.9 (278)
	Characteristic bond strength in un-cracked concrete ²	$\tau_{k,uncr}$	N/mm ² (psi)	5.3 (775)	5.1 (733)	4.8 (701)	4.6 (672)	4.5 (659)
Permissible installation conditions	Dry concrete	Φ_d	—	0.65	0.65	0.65	0.55	0.55
	Water-saturated concrete	Φ_{ws}	—	0.55	0.45	0.45	0.45	0.45
		k_{ws}	—	1.00	1.00	1.00	0.99	0.97
	Water-filled hole	Φ_{wf}	—	0.45	0.45	0.45	0.45	0.45
		k_{wf}	—	1.00	0.95	0.89	0.84	0.82
	Underwater application	Φ_{uw}	—	0.45	0.45	0.45	0.45	0.45
		k_{uw}	—	0.94	0.93	0.93	0.92	0.92

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi ≤ f'_c ≤ 4,500 psi. For 4,500 psi ≤ f'_c ≤ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi ≤ f'_c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- For structures assigned to SDC C, D, E or F, bond strength values shall be multiplied by $\alpha_{N,seis} = 0.65$.

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 22 — Bond Strength Design Information for Metric Hilti HIS-N and HIS-RN Inserts in Holes Drilled with a Core Drill^{1,4}

Design Information		Symbol	Units	Nominal bolt/cap screw diameter (mm)				
				8	10	12	16	20
Effective embedment depth		h_{ef}	mm (in.)	90 (3.5)	110 (4.3)	125 (4.9)	170 (6.7)	205 (8.1)
HIS insert O.D.		d	mm (in.)	12.5 (0.49)	16.5 (0.65)	20.5 (0.81)	25.4 (1.00)	27.6 (1.09)
Temperature range A ³	Characteristic bond strength in un-cracked concrete	$\tau_{k,uncr}$	N/mm ²	11.8	10.6	9.7	8.8	8.5
			(psi)	(1,712)	(1,534)	(1,403)	(1,282)	(1,235)
Temperature range B ³	Characteristic bond strength in un-cracked concrete ²	$\tau_{k,uncr}$	N/mm ²	4.1	3.7	3.3	3.1	2.9
			(psi)	(591)	(530)	(484)	(442)	(426)
Permissible installation conditions	Dry concrete	Φ_d	–	0.65	0.55	0.45	0.45	0.45
	Water-saturated concrete	Φ_{ws}	–	0.55	0.45	0.45	0.45	0.45
		k_{ws}	–	1.0	1.0	1.0	0.95	0.92

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi ≤ f'_c ≤ 4,500 psi. For 4,500 psi ≤ f'_c ≤ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi ≤ f'_c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- For structures assigned to SDC C, D, E or F, bond strength values shall be multiplied by $\alpha_{N,seis} = 0.65$.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 23 — Steel Design Information for Fractional Reinforcing Bars¹

Design Information		Symbol	Units	Bar Size							
				#3	#4	#5	#6	#7	#8	#9	#10
Nominal bar diameter		d	in. (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	7/8 (22.2)	1 (25.4)	1-1/8 (28.6)	1-1/4 (31.8)
Bar effective cross-sectional area		A _{se}	in. ² (mm) ²	0.11 (71)	0.2 (129)	0.31 (200)	0.44 (284)	0.6 (387)	0.79 (510)	1.0 (645)	1.27 (819)
ASTM A 615 Gr. 40	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	6,600 (17.6)	12,000 (32.0)	18,600 (49.6)	26,400 (70.5)	36,000 (96.1)	47,400 (126.5)	60,000 (160.1)	76,200 (203.4)
		V _{sa}	lb (kN)	3,960 (17.6)	7,200 (32.0)	11,160 (49.6)	15,840 (70.5)	21,600 (96.1)	28,440 (126.5)	36,000 (160.1)	45,720 (203.4)
	Reduction for seismic shear	α _{V,seis}	–	0.70							
	Strength reduction factor f for tension ²	Φ	–	0.75							
	Strength reduction factor f for shear ²	Φ	–	0.65							
ASTM A 615 Gr. 60	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	9,900 (44.0)	18,000 (80.1)	27,900 (124.1)	39,600 (176.2)	54,000 (240.2)	71,100 (316.3)	90,000 (400.4)	114,300 (508.5)
		V _{sa}	lb (kN)	5,940 (26.4)	10,800 (48.0)	16,740 (74.5)	23,760 (105.7)	32,400 (144.1)	42,660 (189.8)	54,000 (240.2)	68,580 (305.1)
	Reduction for seismic shear	α _{V,seis}	–	0.70							
	Strength reduction factor Φ for tension ²	Φ	–	0.65							
	Strength reduction factor Φ for shear ²	Φ	–	0.60							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

¹ Values provided for common rebar material types based on published strengths and calculated in accordance with ACI 318-08 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible provided the design is adjusted accordingly.

² For use with the load combinations of ACI 318-08 Section 9.2. See ACI 318-08 Section D.4.4.

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 24 — Concrete Breakout Design Information for Fractional Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information	Symbol	Units	Bar Size							
			#3	#4	#5	#6	#7	#8	#9	#10
Effectiveness factor for cracked concrete	k _{c,cr}	in-lb (SI)	17 (7.1)							
Effectiveness factor for un-cracked concrete	k _{c,uncr}	in-lb (SI)	24 (10)							
Minimum bar 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)
Minimum edge distance	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 member thickness	h _{min}	in. (mm)	h _{ef} + 1-1/4 (h _{ef} + 30)		h _{ef} + 2d _o					
Critical edge distance — splitting (for un-cracked concrete)	c _{ac}	–	See Strength Design provisions above							
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	–	0.65							
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	–	0.70							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B without supplementary reinforcement.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 25 — Bond Strength Design Information for Fractional Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit^{1,4}

Design Information		Symbol	Units	Bar Size							
				#3	#4	#5	#6	#7	#8	#9	#10
Temperature range A ³	Characteristic bond strength and minimum anchor embedment in cracked concrete	$\tau_{k,cr}$	psi (N/mm ²)	1,092 (7.5)	1,073 (7.4)	1,044 (7.2)	999 (6.9)	917 (6.3)	852 (5.9)	799 (5.5)	732 (5.0)
		$h_{ef,min}$	in. (mm)	2.43 (62)	2.81 (71)	3.14 (80)	3.44 (87)	3.71 (94)	4.00 (102)	4.50 (114)	5.00 (127)
	Characteristic bond strength and minimum anchor embedment in un-cracked concrete	$\tau_{k,uncr}$	psi (N/mm ²)	2,264 (15.6)	2,236 (15.4)	2,142 (14.8)	2,067 (14.3)	2,002 (13.8)	1,946 (13.4)	1,899 (13.1)	1,862 (12.8)
		$h_{ef,min}$	in. (mm)	2.43 (62)	2.81 (71)	3.14 (80)	3.44 (87)	3.71 (94)	4.00 (102)	4.50 (114)	5.00 (127)
Temperature range B ³	Characteristic bond strength and minimum anchor embedment in cracked concrete ²	$\tau_{k,cr}$	psi (N/mm ²)	444 (3.1)	431 (3.0)	379 (2.6)	345 (2.4)	316 (2.2)	294 (2.0)	276 (1.9)	260 (1.8)
		$h_{ef,min}$	in. (mm)	1.73 (44)	2.20 (56)	2.61 (66)	3.00 (76)	3.50 (89)	4.00 (102)	4.50 (114)	5.00 (127)
	Characteristic bond strength and minimum anchor embedment in un-cracked concrete ²	$\tau_{k,uncr}$	psi (N/mm ²)	781 (5.4)	772 (5.3)	739 (5.1)	714 (4.9)	691 (4.8)	672 (4.6)	656 (4.5)	643 (4.4)
		$h_{ef,min}$	in. (mm)	1.73 (44)	2.20 (56)	2.61 (66)	3.00 (76)	3.50 (89)	4.00 (102)	4.50 (114)	5.00 (127)
Permissible installation conditions	Dry concrete	Φ_d	–	0.65	0.65	0.65	0.65	0.55	0.55	0.55	0.55
	Water-saturated concrete	Φ_{ws}	–	0.55	0.55	0.45	0.45	0.45	0.45	0.45	0.45
		k_{ws}	–	1.00	1.00	1.00	1.00	1.00	0.99	0.97	0.94
	Water-filled hole	Φ_{wf}	–	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
		k_{wf}	–	1.00	1.00	0.96	0.91	0.87	0.84	0.82	0.79
	Underwater application	Φ_{uw}	–	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
		k_{uw}	–	0.95	0.94	0.94	0.93	0.92	0.92	0.92	0.91

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi $\leq f'c \leq$ 4,500 psi. For 4,500 psi $\leq f'c \leq$ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi $\leq f'c \leq$ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- For structures assigned to SDC C, D, E or F, bond strength values shall be multiplied by $\alpha_{N,seis} = 0.65$.

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 26 — Bond Strength Design Information for Fractional Reinforcing Bars in Holes Drilled with a Core Drill^{1,4}

Design Information		Symbol	Units	Bar Size							
				#3	#4	#5	#6	#7	#8	#9	#10
Temperature range A ³	Characteristic bond strength and minimum anchor embedment in un-cracked concrete	$\tau_{k,uncr}$	psi (N/mm ²)	1,740 (12.0)	1,703 (11.7)	1,553 (10.7)	1,441 (9.9)	1,356 (9.4)	1,282 (8.8)	1,226 (8.4)	1,169 (8.1)
		$h_{ef,min}$	in. (mm)	2.43 (62)	2.81 (71)	3.14 (80)	3.44 (87)	3.71 (94)	4.00 (102)	4.50 (114)	5.00 (127)
Temperature range B ³	Characteristic bond strength and minimum anchor embedment in un-cracked concrete ²	$\tau_{k,uncr}$	psi (N/mm ²)	601 (4.1)	588 (4.1)	536 (3.7)	497 (3.4)	468 (3.2)	442 (3.1)	423 (2.9)	404 (2.8)
		$h_{ef,min}$	in. (mm)	1.57 (40)	2.00 (51)	2.50 (64)	3.00 (76)	3.50 (89)	4.00 (102)	4.50 (114)	5.00 (127)
Permissible installation conditions	Dry concrete	Φ_d	–	0.65	0.65	0.55	0.55	0.55	0.45	0.45	0.45
	Water-saturated concrete	Φ_{ws}	–	0.65	0.55	0.55	0.55	0.45	0.45	0.45	0.45
		k_{ws}	–	1.00	1.00	1.00	1.00	1.00	0.95	0.91	0.88

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi ≤ f'_c ≤ 4,500 psi. For 4,500 psi ≤ f'_c ≤ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi ≤ f'_c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- Bond strength values applicable to SDC A and B only.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 27 — Steel Design Information for EU Metric Reinforcing Bars¹

Design Information		Symbol	Units	Bar Size								
				8	10	12	14	16	20	25	28	32
Nominal bar diameter		d	mm (in.)	8.0 (0.315)	10.0 (0.394)	12.0 (0.472)	14.0 (0.551)	16.0 (0.630)	20.0 (0.787)	25.0 (0.984)	28.0 (1.102)	32.0 (1.260)
Bar effective cross-sectional area		A _{se}	mm ² (in. ²)	50.3 (0.078)	78.5 (0.122)	113.1 (0.175)	153.9 (0.239)	201.1 (0.312)	314.2 (0.487)	490.9 (0.761)	615.8 (0.954)	804.2 (1.247)
DIN 488 BSt 550/500	Nominal strength as governedby steel strength	N _{sa}	kN (lb)	27.6 (6,215)	43.2 (9,711)	62.2 (13,984)	84.7 (19,034)	110.6 (24,860)	172.8 (38,844)	270.0 (60,694)	338.7 (76,135)	442.3 (99,441)
		V _{sa}	kN (lb)	16.6 (3,729)	25.9 (5,827)	37.3 (8,390)	50.8 (11,420)	66.4 (14,916)	103.7 (23,307)	162.0 (36,416)	203.2 (45,681)	265.4 (59,665)
	Reduction for seismic shear	α _{V,seis}	–	0.70								
	Strength reduction factor Φ for tension ²	Φ	–	0.65								
	Strength reduction factor Φ for shear ²	Φ	–	0.60								

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Values provided for common rebar material types based on published strengths and calculated in accordance with ACI 318-08 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible provided the design is adjusted accordingly.

2 For use with the load combinations of ACI 318-08 Section 9.2. See ACI 318-08 Section D.4.4.

Table 28 — Concrete Breakout Design Information for EU Metric Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information	Symbol	Units	Bar Size								
			8	10	12	14	16	20	25	28	32
Effectiveness factor for cracked concrete	$k_{c,cr}$	SI (in-lb)	7.1 (17)								
Effectiveness factor for un-cracked concrete	$k_{c,uncr}$	SI (in-lb)	10 (24)								
Minimum bar spacing	s_{min}	mm (in.)	40 (1.6)	50 (2)	60 (2.4)	70 (2.8)	80 (3.1)	100 (3.9)	125 (4.9)	140 (5.5)	160 (6.3)
Minimum edge distance	c_{min}	mm (in.)	40 (1.6)	50 (2)	60 (2.4)	70 (2.8)	80 (3.1)	100 (3.9)	125 (4.9)	140 (5.5)	160 (6.3)
Minimum member thickness	h_{min}	mm (in.)	$h_{ef} + 30$ ($h_{ef} + 1-1/4$)		$h_{ef} + 2d_o$						
Critical edge distance — splitting (for un-cracked concrete)	c_{ac}	–	See Strength Design provisions above								
Strength reduction factor for tension, concrete failure modes, Condition B²	Φ	–	0.65								
Strength reduction factor for shear, concrete failure modes, Condition B²	Φ	–	0.70								

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B without supplementary reinforcement.

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Table 29 — Bond Strength Design Information for EU Metric Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit^{1,4}

Design Information		Symbol	Units	Bar Size								
				8	10	12	14	16	20	25	28	32
Temperature range A ³	Characteristic bond strength and minimum anchor embedment in cracked concrete	τ _{k,cr}	N/mm ² (psi)	7.5 (1,092)	7.5 (1,092)	7.5 (1,092)	7.4 (1,068)	7.2 (1,044)	6.7 (972)	5.9 (862)	5.6 (806)	5.0 (732)
		h _{ef,min}	mm (in.)	57 (2.23)	63 (2.49)	69 (2.73)	75 (2.95)	80 (3.15)	89 (3.52)	100 (3.94)	112 (4.41)	128 (5.04)
	Characteristic bond strength and minimum anchor embedment in un-cracked concrete	τ _{k,uncr}	N/mm ² (psi)	15.6 (2,264)	15.6 (2,264)	15.6 (2,264)	15.2 (2,198)	14.8 (2,142)	14.1 (2,039)	13.5 (1,955)	13.2 (1,908)	12.8 (1,862)
		h _{ef,min}	mm (in.)	57 (2.23)	63 (2.49)	69 (2.73)	75 (2.95)	80 (3.15)	89 (3.52)	100 (3.94)	112 (4.41)	128 (5.04)
Temperature range B ³	Characteristic bond strength and minimum anchor embedment in cracked concrete ²	τ _{k,cr}	N/mm ² (psi)	3.1 (444)	3.1 (444)	3.1 (444)	2.8 (410)	2.6 (379)	2.3 (336)	2.1 (298)	1.9 (278)	1.8 (260)
		h _{ef,min}	mm (in.)	40 (1.57)	46 (1.80)	53 (2.10)	60 (2.37)	67 (2.62)	80 (3.15)	100 (3.94)	112 (4.41)	128 (5.04)
	Characteristic bond strength and minimum anchor embedment in un-cracked concrete ²	τ _{k,uncr}	N/mm ² (psi)	5.4 (781)	5.4 (781)	5.4 (781)	5.2 (759)	5.1 (739)	4.9 (704)	4.7 (675)	4.5 (659)	4.4 (643)
		h _{ef,min}	mm (in.)	40 (1.57)	46 (1.80)	53 (2.10)	60 (2.37)	67 (2.62)	80 (3.15)	100 (3.94)	112 (4.41)	128 (5.04)
Permissible installation conditions	Dry concrete	Φ _d	–	0.65	0.65	0.65	0.65	0.65	0.55	0.55	0.55	0.55
	Water-saturated concrete	Φ _{ws}	–	0.55	0.55	0.55	0.45	0.45	0.45	0.45	0.45	0.45
		k _{ws}	–	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.94	0.94
	Water-filled hole	Φ _{wf}	–	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
		k _{wf}	–	1.00	1.00	1.00	0.96	0.93	0.87	0.82	0.79	0.79
	Underwater application	Φ _{uw}	–	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
k _{uw}		–	0.95	0.95	0.94	0.94	0.93	0.92	0.92	0.91	0.91	

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi ≤ f'_c ≤ 4,500 psi. For 4,500 psi ≤ f'_c ≤ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi ≤ f'_c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- For structures assigned to SDC C, D, E or F, bond strength values shall be multiplied by $\alpha_{N,seis}$ = 0.65.

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Table 30 — Bond Strength Design Information for EU Metric Reinforcing Bars in Holes Drilled with a Core Drill^{1,4}

Design Information		Symbol	Units	Bar Size								
				8	10	12	14	16	20	25	28	32
Temperature range A ³	Characteristic bond strength and minimum anchor embedment in un-cracked concrete	$\tau_{k,uncr}$	N/mm ² (psi)	12.0 (1,740)	12.0 (1,740)	12.0 (1,740)	11.3 (1,637)	10.7 (1,553)	9.7 (1,413)	8.9 (1,291)	8.5 (1,235)	8.1 (1,169)
		$h_{ef,min}$	mm (in.)	56 (2.19)	63 (2.49)	69 (2.73)	75 (2.95)	80 (3.15)	89 (3.52)	100 (3.94)	112 (4.41)	128 (5.04)
Temperature range B ³	Characteristic bond strength and minimum anchor embedment in un-cracked concrete ²	$\tau_{k,uncr}$	N/mm ² (psi)	4.1 (601)	4.1 (601)	4.1 (601)	3.9 (565)	3.7 (536)	3.4 (488)	3.1 (446)	2.9 (426)	2.8 (404)
		$h_{ef,min}$	mm (in.)	40 (1.57)	41 (1.61)	48 (1.89)	56 (2.20)	64 (2.52)	80 (3.15)	100 (3.94)	112 (4.41)	128 (5.04)
Permissible installation conditions	Dry concrete	Φ_d	–	0.65	0.65	0.65	0.55	0.55	0.55	0.45	0.45	0.45
	Water-saturated concrete	Φ_{ws}	–	0.55	0.55	0.55	0.45	0.45	0.45	0.45	0.45	0.45
		k_{ws}	–	1.0	1.0	1.0	1.0	1.0	1.0	0.92	0.88	0.88

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi $\leq f'_c \leq$ 4,500 psi. For 4,500 psi $\leq f'_c \leq$ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi $\leq f'_c \leq$ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- Bond strength values applicable to SDC A and B only.

Table 31 — Steel Design Information for Canadian Metric Reinforcing Bars¹



Design Information		Symbol	Units	Bar Size				
				10 M	15 M	20 M	25 M	30 M
Nominal bar diameter		d	mm (in.)	11.3 (0.445)	16.0 (0.630)	19.5 (0.768)	25.2 (0.992)	29.9 (1.177)
Bar effective cross-sectional area		A_{se}	mm ² (in. ²)	100.3 (0.155)	201.1 (0.312)	298.6 (0.463)	498.8 (0.773)	702.2 (1.088)
CSA G30	Nominal strength as governed by steel strength	N_{sa}	kN (lb)	54.2 (12,175)	108.6 (24,408)	161.3 (36,255)	269.3 (60,548)	379.2 (85,239)
		V_{sa}	kN (lb)	32.5 (7,305)	65.1 (14,645)	96.8 (21,753)	161.6 (36,329)	227.5 (51,144)
	Reduction for seismic shear	$\alpha_{V,seis}$	–	0.70				
	Strength reduction factor Φ for tension ²	Φ	–	0.65				
	Strength reduction factor Φ for shear ²	Φ	–	0.60				

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Values provided for common rebar material types based on published strengths and calculated in accordance with ACI 318-08 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible provided the design is adjusted accordingly.
- For use with the load combinations of ACI 318-08 Section 9.2. See ACI 318-08 Section D.4.4.

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Table 32 — Concrete Breakout Design Information for Canadian Metric Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit¹



Design Information	Symbol	Units	Bar Size				
			10 M	15 M	20 M	25 M	30 M
Effectiveness factor for cracked concrete	$k_{c,cr}$	SI (in-lb)	7.1 (17)				
Effectiveness factor for un-cracked concrete	$k_{c,un-cr}$	SI (in-lb)	10 (24)				
Minimum bar spacing	s_{min}	mm (in.)	57 (2.2)	80 (3.1)	98 (3.8)	126 (5.0)	150 (5.9)
Minimum edge distance	c_{min}	mm (in.)	57 (2.2)	80 (3.1)	98 (3.8)	126 (5.0)	150 (5.9)
Minimum member thickness	h_{min}	mm (in.)	$h_{ef} + 30$ ($h_{ef} + 1-1/4$)	$h_{ef} + 2d_o$			
Critical edge distance — splitting (for un-cracked concrete)	c_{ac}	–	See Strength Design provisions above				
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	–	0.65				
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	–	0.70				

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B without supplementary reinforcement.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 33 — Bond Strength Design Information for Canadian Metric Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit^{1,4}



Design Information		Symbol	Units	Bar Size				
				10 M	15 M	20 M	25 M	30 M
Temperature range A ³	Characteristic bond strength and minimum anchor embedment in cracked concrete	$\tau_{k,cr}$	N/mm ² (psi)	7.5 (1,092)	7.2 (1,044)	6.8 (991)	5.9 (852)	5.4 (777)
		$h_{ef,min}$	mm (in.)	67 (2.65)	80 (3.15)	88 (3.48)	101 (3.97)	120 (4.71)
	Characteristic bond strength and minimum anchor embedment in un-cracked concrete	$\tau_{k,un-cr}$	N/mm ² (psi)	15.6 (2,264)	14.8 (2,142)	14.2 (2,058)	13.5 (1,955)	13.0 (1,880)
		$h_{ef,min}$	mm (in.)	67 (2.65)	80 (3.15)	88 (3.48)	101 (3.97)	120 (4.71)
Temperature range B ³	Characteristic bond strength and minimum anchor embedment in cracked concrete ²	$\tau_{k,cr}$	N/mm ² (psi)	3.1 (444)	2.6 (379)	2.4 (342)	2.0 (294)	1.9 (271)
		$h_{ef,min}$	mm (in.)	51 (2.00)	67 (2.62)	78 (3.07)	101 (3.97)	120 (4.71)
	Characteristic bond strength and minimum anchor embedment in un-cracked concrete ²	$\tau_{k,un-cr}$	N/mm ² (psi)	5.4 (781)	5.1 (739)	4.9 (710)	4.7 (675)	4.5 (649)
		$h_{ef,min}$	mm (in.)	51 (2.00)	67 (2.62)	78 (3.07)	101 (3.97)	120 (4.71)
Permissible installation conditions	Dry concrete	Φ_d	–	0.65	0.65	0.65	0.55	0.55
	Water-saturated concrete	Φ_{ws}	–	0.55	0.45	0.45	0.45	0.45
		k_{ws}	–	1.0	1.0	1.0	1.0	0.96
	Water-filled hole	Φ_{wf}	–	0.45	0.45	0.45	0.45	0.45
		k_{wf}	–	1.00	0.96	0.91	0.85	0.81
	Underwater application	Φ_{uw}	–	0.45	0.45	0.45	0.45	0.45
		k_{uw}	–	0.95	0.94	0.93	0.92	0.91

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi $\leq f'_c \leq$ 4,500 psi. For 4,500 psi $\leq f'_c \leq$ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi $\leq f'_c \leq$ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- For structures assigned to SDC C, D, E or F, bond strength values shall be multiplied by $\alpha_{N,seis} = 0.65$.

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Table 34 — Bond Strength Design Information for Canadian Metric Reinforcing Bars in Holes Drilled with a Core Drill^{1,4}



Design Information		Symbol	Units	Bar Size				
				10 M	15 M	20 M	25 M	30 M
Temperature range A ³	Characteristic bond strength and minimum anchor embedment in un-cracked concrete	$\tau_{k,uncr}$	N/mm ² (psi)	12.0 (1,740)	10.7 (1,553)	9.9 (1,431)	8.9 (1,291)	8.3 (1,197)
		$h_{ef,min}$	mm (in.)	67 (2.65)	80 (3.15)	88 (3.48)	101 (3.97)	120 (4.71)
Temperature range B ³	Characteristic bond strength and minimum anchor embedment in un-cracked concrete ²	$\tau_{k,uncr}$	N/mm ² (psi)	4.1 (601)	3.7 (536)	3.4 (494)	3.1 (446)	2.8 (413)
		$h_{ef,min}$	mm (in.)	45 (1.78)	64 (2.52)	78 (3.07)	101 (3.97)	120 (4.71)
Permissible installation conditions	Dry concrete	Φ_d	–	0.65	0.55	0.55	0.45	0.45
	Water-saturated concrete	Φ_{ws}	–	0.55	0.45	0.45	0.45	0.45
		k_{ws}	–	1.00	1.00	1.00	0.96	0.90

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Bond strength values correspond to concrete compressive strength range 2,500 psi ≤ f'_c ≤ 4,500 psi. For 4,500 psi ≤ f'_c ≤ 6,500 psi, tabulated characteristic bond strength may be increased by 6%. For 6,500 psi ≤ f'_c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.
- Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind and seismic, bond strengths may be increased 40%.
- Temperature range A: Max. short term temperature = 110°F (43°C), max. long term temperature = 80°F (26°C).
Temperature range B: Max. short term temperature = 162°F (72°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.
- Bond strength values applicable to SDC A and B only.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

3.2.4.5 Installation Instructions

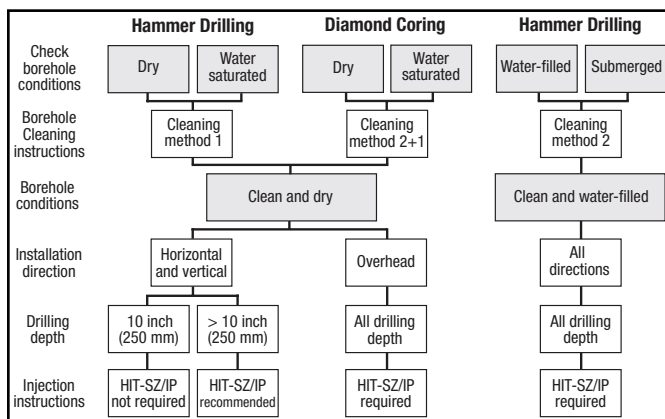
Adhesive anchoring system for fastenings in normal weight concrete

Prior to use of product follow instructions for use and recommended safety precautions.

- Check expiration date: See expiration date imprint on foilpack manifold. (Month/Year). Do not use expired product.
- Foil pack temperature: Must be between 41°F and 104°F (5°C - 40°C) when in use.
- Base material temperature at time of installation: Must be between 41°F and 110°F (5°C - 43°C).
- Instructions for transport and storage: Keep in a cool, dry and dark place between 41°F and 77°F (5°C - 25°C).
- Material Safety Data Sheet: Review the MSDS before use.

Installation Instructions: Follow the pictograms 1-14 for the sequence of operations and refer to tables 1-3 for setting details. For any application not covered by this document (e.g. "h_{ef}" beyond values specified in setting details), contact Hilti.

Installation flow Chart



1. Drill hole normal to the surface with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit, or with a core rig and an appropriately sized diamond core bit, to the required embedment depth. See tables describing setting details. **(Drill bits must conform to ANSI B212-1994.)**

- 2-4. **Clean hole:** Cleaning method has to be decided based on drilling method and borehole conditions (see flow chart above). Just before setting an anchor/rebar, the borehole must be free of dust and debris by one of the following methods:

Method 1 — for dry or water saturated concrete (refer to pictograms):

- **Blow** from the back of the borehole with oil-free compressed air (min. 90psi at 3.5 CFM (6 bar at 6 m³/h)) fully retracting the air extension 2 times until return air stream is free of noticeable dust.
- **Brush 2 times** with the specified brush size (brush Ø = borehole Ø) by inserting the round steel brush to the back of the borehole in a twisting motion and removing it. The brush should resist insertion into the borehole — if not, the brush is too small and must be replaced with the proper brush diameter.

- **Blow** again with compressed air 2 times until return air stream is free of noticeable dust.

Method 2 — for water filled boreholes, submerged concrete or diamond cored boreholes:

- **Flush hole 2 times** by inserting a water hose (water-line pressure) to the back of the borehole until water runs clear.
- **Brush 2 times** with the specified brush size (brush Ø = borehole Ø) by inserting the round steel brush to the back of the borehole with a twisting motion and removing it. The brush should resist insertion into the borehole — if not, the brush is too small and must be replaced with the proper brush diameter.
- **Flush again** 2 times until water runs clear.
- **Important!** For **diamond cored boreholes** and if a **dry borehole is required for injection (e.g. water flows into cleaned borehole)**, continue with borehole cleaning as described by method 1. **Remove all standing water** completely (i.e. vacuum, compressed air or other appropriate procedure). To attain a dried borehole, a Hilti HIT-DL air nozzle attachment is recommended for borehole depth up to 10 inch (250 mm) and required for borehole depth > 10 inch (250 mm).

The borehole must be free of dust, debris, ice, oil, grease and other contaminants prior to adhesive injection.

Inadequate borehole cleaning = poor load values

5. **Insert foil pack in foil pack holder.** Never use damaged foil packs and/or damaged or unclean foil pack holders.
6. **Tightly attach Hilti HIT-RE-M mixer to foil pack manifold.** Attach new mixer prior to dispensing a new foil pack (snug fit). Do not modify the mixer in any way. Make sure the mixing element is in the mixer. Use only the mixer supplied with the adhesive.
7. **Insert foil pack holder with foil pack into HIT-dispenser.** Push release trigger, retract plunger and insert foil pack holder into the appropriate Hilti dispenser.
8. **Discard initial adhesive.** The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive has to be discarded. See pictogram 8 for discard quantities. If a new mixer is installed onto a previously-opened foil pack, the first trigger pulls must also be discarded as described above. For each new foil pack a new mixer must be used.

- 9-10. **Inject adhesive from the back of the borehole without forming air voids:**

Verify if borehole conditions have changed (e.g. water in the borehole) after cleaning. If yes, repeat cleaning according points 2 - 4.

- **Inject** the adhesive starting at the back of the borehole (use the extension for deep boreholes), slowly withdraw the mixer with each trigger pull. Fill holes approximately 2/3 full, or as required to ensure that the annular gap between the anchor/rebar and the concrete is completely filled with adhesive along the embedment length. After injection is completed, depressurize the dispenser by pressing the release trigger. This will prevent further adhesive discharge from the mixer.
- **Piston plug injection — HIT-SZ/IP recommended for borehole depth > 10 inch/250 mm. For water filled boreholes or submerged concrete, and overhead installation the piston plugs are required. Assemble**

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HIT-RE-M mixer, extension(s) and appropriately sized piston plug

HIT-SZ/IP. Insert piston plug to back of the borehole and inject adhesive as described in the injection method above. During injection the piston plug will be naturally extruded out of the borehole by the adhesive pressure. (HILTI-SZ (IP) is not available or required for 7/16" or 10 mm diameter drilled hole.)

or

11. Insert anchor/rebar into borehole.

Mark and set anchor/rebar to the required embedment depth. Before use, verify that the anchor/rebar is dry and free of oil and other contaminants. To ease installation, anchor/rebar may be slowly twisted as they are inserted. After installing an anchor/rebar, the annular gap must be completely filled with adhesive. If the borehole is not completely filled along the embedment depth the installation should be rejected. Hilti should be contacted for further information.

Attention! For overhead applications take special care when inserting the anchor/rebar. Excess adhesive will be forced out of the borehole — take appropriate steps to prevent it from falling onto the installer. Position the anchor/rebar and secure it from moving/falling during the curing time (e.g. wedges). Observe the gel time “t gel”, which varies according to temperature of base material. Minor adjustments to the anchor/rebar position may be performed during the gel time. See table.

12. Do not disturb the anchor/rebar once the gel time “t gel” has elapsed until “t cure, ini” has passed.

13. Preparation work may continue for rebar applications. Between “t cure, ini” and “t cure, full” the adhesive has a limited load bearing capacity, do not apply a torque or load on the anchor/rebar during this time.

14. Apply load/torque after “t cure, full” has passed, and the fixture to be attached has been positioned.

Partly used foil packs must be used up within **four weeks**. Leave the mixer attached to the foil pack manifold and store under the recommended storage conditions. If reused, attach a new mixer and discard the initial quantity of anchor adhesive as described by point 8.

or

* Please refer to technical literature (approvals, setting instructions) for detail.

°F	°C	t work / tgel	t cure, ini	t cure, full	
41	5	2.5 hrs	18 hrs	72 hrs	
50	10	2 hrs	12 hrs	48 hrs	
59	15	1.5 hrs	8 hrs	24 hrs	
68	20	30 min	6 hrs	12 hrs	
86	30	20 min	4 hrs	8 hrs	
104	40	12 min	2 hrs	4 hrs	

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 1 — Setting Details of Hilti HIT-RE 500-SD with Threaded Rod

d		d _o	h _{ef} min-max		T _{inst}		d _f	h _{min}	
[inch]	[mm]	[inch]	[inch]	[mm]	[ft-lb]	[Nm]	[inch]	[inch]	
3/8	9.5	7/16	1-1/2 - 7 1/2	40 - 191	15	20	7/16	h _{ef} + 1-1/4 (30 mm)	
1/2	12.7	9/16	2 - 10	51 - 254	30	41	9/16		
5/8	15.9	3/4	2-1/2 - 12-1/2	64 - 318	60	81	11/16	h _{ef} + 2 d _o	
3/4	19.1	7/8	3 - 15	76 - 381	100	136	13/16		
7/8	22.2	1	3-1/2 - 17-1/2	89 - 445	125	169	15/16		
1	25.4	1-1/8	4 - 20	102 - 508	150	203	1-1/8		
1-1/4	31.8	1-3/8	5 - 25	127 - 635	200	271	1-3/8		
[mm]		[mm]	[mm]		[Nm]		[mm]	[mm]	
M8		10	40 - 160		10		9	h _{ef} + 30	
M10		12	41 - 200		20		12		
M12		14	48 - 240		40		14		
M16		18	64 - 320		80		18	h _{ef} + 2 d _o	
M20		24	80 - 400		150		22		
M24		28	96 - 480		200		26		
M27		30	108 - 540		270		30		
M30		35	120 - 600		300		33		

Table 2 — Setting Details of Hilti HIT-RE 500-SD with HIS-N and HIS-RN Inserts

d		d _o	h _{ef}		T _{inst}		d _f	h _{min}	
[inch]	[mm]	[inch]	[inch]	[mm]	[ft-lb]	[Nm]	[inch]	[inch]	[mm]
3/8	9.5	11/16	4 3/8	110	15	20	7/16	5-3/4	150
1/2	12.7	7/8	5	125	30	41	9/16	6-3/4	170
5/8	15.9	1-1/8	6 3/4	170	60	81	11/16	9	230
3/4	19.1	1-1/4	8-1/8	205	100	136	13/16	10-3/4	270
[mm]		[mm]	[mm]		[Nm]		[mm]	[mm]	
M8		14	90		10		9	120	
M10		18	110		20		12	150	
M12		22	125		40		14	170	
M16		28	170		80		18	230	
M20		32	205		150		22	270	

HIT-RE 500-SD Epoxy Adhesive Anchoring System 3.2.4

Table 3 — Setting Details of Hilti HIT-RE 500-SD with Reinforcement Bars

d	d _o ¹	h _{ef} min-max		h _{min}
US rebar	[inch]	[inch]	[mm]	[inch]
# 3	1/2	1-1/2 – 7-1/2	40 – 191	h _{ef} + 1-1/4
# 4	5/8	2 – 10	51 – 254	
# 5	3/4	2-1/2 – 12-1/2	64 – 318	
# 6	7/8	3 – 15	76 – 381	h _{ef} + 2 d _o
# 7	1	3-1/2 – 17-1/2	89 – 445	
# 8	1-1/8	4 – 20	102 – 508	
# 9	1-3/8	4-1/2 – 22-1/2	114 – 572	
# 10	1-1/2	5 – 25	127 – 635	
Rebar [mm]	[mm]	[mm]		[mm]
8	12	40 – 160		h _{ef} + 30
10	14	41 – 200		
12	16	48 – 240		
14	18	56 – 280		h _{ef} + 2 d _o
16	20	64 – 320		
20	25	80 – 400		
25	32	100 – 500		
28	35	112 – 560		
32	40	128 – 640		
CA rebar	[inch]	[mm]		[mm]
10 M	9/16	45 – 226		h _{ef} + 30 mm
15 M	3/4	64 – 320		h _{ef} + 2 d _o
20 M	1	78 – 390		
25 M	1-1/4	101 – 504		
30 M	1-1/2	120 – 598		

1 Rebar diameter may vary. Use smallest diameter which will accomodate rebar.

3.2.4 HIT-RE 500-SD Epoxy Adhesive Anchoring System

3.2.4.6 Ordering Information

HIT-RE 500-SD Epoxy Adhesive Anchor System

- First adhesive anchor to comply with the latest building code offering designers a strength design solution for anchors and rebar
- Enables threaded rod and dowelling applications in seismic design conditions under the latest building codes

Description

HIT-RE 500-SD (11.1 fl oz/330 ml) – 1 pack
Includes 1 mixer and 3/8" filler tube per package
HIT-RE 500-SD (11.1 fl oz/330 ml) MC – 25 packs
Includes 1 mixer and 3/8" filler tube per package
HIT-RE 500-SD (11.1 fl oz/330 ml)
Includes 1 MC and mixer and choice of MD 2000 or MD 2500 dispenser
HIT-RE 500-SD (16.9 fl oz/500 ml) MC – 20 packs
Includes 1 mixer and 3/8" filler tube per package
HIT-RE 500-SD (16.9 fl oz/500 ml)
Includes 2 MC and MD 2500 dispenser
HIT-RE 500-SD (16.9 fl oz/500 ml)
Includes 5 MC and ED 3500 dispenser 2.0 Ah Kit

Dispensers

Battery Powered

Description

ED 3500 2.0 Ah NiCd Kit
Includes dispenser, (2) 2.0-Ah NiCd battery, C 7/24 standard charger and accessories in an impact-resistant plastic tool box
ED 3500 Dispenser
Includes dispenser only in cardboard box
SFB 121 2.0-Ah NiCd Battery for ED 3500
C 7/24 Standard Charger for ED 3500
Manual

Description

MD 2500 Manual Dispenser with Foil Pack Holder
For use with HIT 11.1 fl oz/330ml and 16.9oz/500ml foil packs
MD 2500 Manual Dispenser with Foil Pack Holder
Replacement for MD 2500 and ED 3500

Hole Cleaning/Injection Accessories

Imperial

Hole Dia. (d _h)	Round Brush	Injection Piston	Air Nozzle
Ø [inch]	HIT-RB	HIT-SZ (IP)	HIT-DL
7/16	7/16"		–
1/2	1/2"	1/2"	1/2"
9/16	9/16"	9/16"	9/16"
5/8	5/8"	5/8"	9/16"
11/16	11/16"	11/16"	11/16"
3/4	3/4"	3/4"	3/4"
7/8	7/8"	7/8"	7/8"
1	1"	1"	1"
1-1/8	1-1/8"	1-1/8"	1"
1-1/4	1-1/4"	1-1/4"	1"
1-3/8	1-3/8"	1-3/8"	1-3/8"
1-1/2	1-1/2"	1-1/2"	1-3/8"
1-3/4	1-3/4"	1-3/4"	1-3/8"

Contact Hilti for

a complete listing of additional accessories and extensions for air nozzles, brushes and injection pistons to handle embedment.

Metric

Hole Dia. (d _h)	Round Brush	Injection Piston	Air Nozzle
Ø [mm]	HIT-RB	HIT-SZ (IP)	HIT-DL
10	10	–	–
12	8/12	8/12	8/12
14	10/14	10/14	10/14
16	12/16	12/16	12/16
18	14/18	14/18	14/18
20	16/20	16/20	16/20
22	18/22	18/22	16/20
24	24	24	16/20
25	20/25	20/25	20/25
28	28	28	20/25
30	30	30	20/25
32	25/32	25/32	25/32
35	35	35	25/32
37	37	37	25/32
40	40	40	25/32
42	42	42	25/32
45	45	45	25/32
47	47	47	25/32
52	52	52	25/32
55	55	55	25/32

HIT-RB
(Round Brush)

HIT-SZ (IP)
(Injection Piston)

HIT-DL
(Air Nozzle)

Introducing

Hilti Accredited
Adhesive Anchor
Installer Program –
call Hilti for details

Technical Data

Product	Epoxy Adhesive
Base material temperature	41°F to 120°F (+5°C to 49°C)
Diameter range	3/8" to 1-1/4"
Listings/Approvals	
ICC-ES	ESR 2322
NSF/ANSI standard 61	Certification for potable water
Package volume	
• Volume of HIT-RE 500-SD 11.1 fl oz/330 ml foil pack is 20.1 in ³	
• Volume of HIT-RE 500-SD 16.9 fl oz/500 ml foil pack is 30.5 in ³	

Gel/Full Cure Time Table (Approximate)

Base Material Temperature		tgel	tcure
°F	°C		
41	5	2.5 hrs	72 hrs
50	10	2 hrs	48 hrs
59	15	1.5 hrs	24 hrs
68	20	30 min	12 hrs
86	30	20 min	8 hrs
104	40	12 min	4 hrs

ED 3500 2.0 Ah Kit

Foil Pack Holder

MD 2500 Manual Dispenser

Refer to Section 3.2.6.5 for ordering information of HAS threaded rods and HIS inserts.

HIT-TZ with HIT-HY 150 MAX or HIT-ICE 3.2.5

3.2.5.1 Product Description

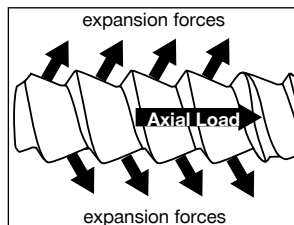
Please refer to Section 3.2.6 for HIT-HY 150 MAX or Section 3.2.8 for HIT-ICE Adhesive product specific information. The Hilti HIT-TZ is an innovative threaded rod installed with HIT-HY 150 MAX hybrid adhesive or HIT-ICE. With the combination of HIT-HY 150 MAX or HIT-ICE and the innovative design of the HIT-TZ rod, anchoring into uncleaned holes, wet holes (including standing water) and/or Hilti matched tolerance diamond-cored holes does not adversely affect tensile capacity. Use HIT-ICE in base material temperatures $\leq 40^{\circ}\text{F}$ (5°C).

How It Works

When an axial load is applied, the innovative HIT-TZ creates expansion forces which supplement the bonding power of HIT-HY 150 MAX or HIT-ICE and the concrete. This compensates for unfavorable hole conditions.

No more:

- removing water or drying holes
- roughening diamond cored holes.



Product Features of HIT-TZ Threaded Rods

- Full tensile capacity with installation in drilled holes without any hole cleaning procedures
- Develops the tensile strength of HAS-E (ISO898, Class 5.8) threaded rods and HAS-SS (F 593 and A 193, B8, Class 1 for stainless steel in Canada only) at 20% shallower embedment
- Full tensile capacity in Hilti matched tolerance diamond-cored holes
- Develops full tensile capacity when installed in wet holes (with standing water)

3.2.5.1 Product Description

3.2.5.2 Material Specifications

3.2.5.3 Technical Data

3.2.5.4 Installation Instructions

3.2.5.5 Ordering Information

Listings/Approvals

City of Los Angeles

RR 25652

NSF/ANSI Std 61

Certification for use of HIT-HY 150 MAX in potable water



Independent Code Evaluation

LEED®: Credit 4.1-Low Emitting Materials (For HY 150 MAX)

The Leadership in Energy and Environmental Design (LEED®) Green Building Rating system™ is the nationally accepted benchmark for the design, construction and operation of high performance green buildings.

3.2.5 HIT-TZ with HIT-HY 150 MAX or HIT-ICE

Guide Specifications

Master Format Section:

Previous 2004 Format

03250 03 16 00 (Concrete Anchors)

Related Sections:

03200 03 20 00 (Concrete Reinforcing)

05050 05 50 00 (Metal Fabrications)

05120 05 10 00 (Structural Metal Framing)

Anchor Rods Shall be furnished with a helical cone shaped thread on the embedded end and standard threads on the exposed end. Anchor rods shall be manufactured to meet the following requirements:

1. ASTM A 510 with chemical composition of AISI 1038; 2. AISI 316 stainless steel, meeting the requirements of ASTM A 493.

Nuts and Washers Shall be furnished to meet the requirements of the above anchor rod specifications.

Injectable adhesive shall be used for installation of all threaded anchor rods into existing concrete. Adhesive shall be furnished in containers which keep component A and component B separate. Containers shall be designed to accept static mixing nozzle which thoroughly blends component A and component B and allows injection directly into drilled hole. Only injection tools and static mixing nozzles as supplied by manufacturer shall be used. Manufacturer's instructions shall be followed. Injection adhesive shall be formulated to include resin and hardener to provide optimal curing speed as well as high strength and stiffness. Typical curing time at 68°F shall be 30 minutes for HIT-HY 150 MAX and 1 hour for HIT-ICE. Injection adhesive shall be HIT-HY 150 MAX or HIT-ICE, as furnished by Hilti.

3.2.5.2 Material Specifications

Material	Mechanical Properties			
	f_y ksi (MPa)		min. f_u ksi (MPa)	
Carbon steel HIT-TZ Rod meets requirements of ASTM A 510 with chemical composition of AISI 1038	70	(480)	87	(600)
Stainless Steel HIT-RTZ Rod meets requirements of AISI 316 conforming to ASTM F593	70	(480)	87	(600)
HIT-TZ Standard Nut material meets the requirements of ASTM A 563, Grade A conforming to ANSI B18.2.2				
HIT-TZ Carbon Steel Washers meet the requirements of ASTM F 844				
HIT-RTZ Stainless Steel Nut material meets the requirements of ASTM F594 conforming to ANSI B18.2.2				
HIT-RTZ Stainless Steel Washers meet the requirements of AISI 316 conforming to ASTM A 240				

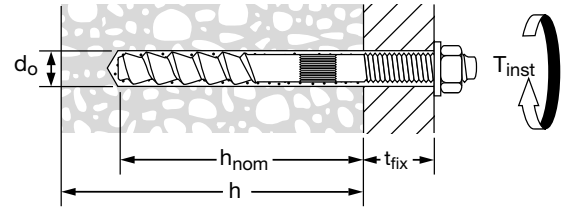
HIT-TZ with HIT-HY 150 MAX or HIT-ICE 3.2.5

3.2.5.3 Technical Data

HIT-HY 150 MAX/HIT-ICE Installation Specification

Table for HIT-TZ Rods

Details	HIT-TZ Rod Size	in. (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)
d_{bit} bit diameter ¹	in.		7/16	9/16	11/16	13/16
h_{nom} std. depth of embed. ²	in. (mm)		2-7/8 (73)	3-1/2 (89)	4 (102)	5-1/4 (133)
ℓ length of anchor	in. (mm)		4-1/2 (114)	5-11/16 (144)	7-1/16 (180)	10-1/2 (267)
T_{inst} HIT-TZ installation torque	ft-lb (Nm)		18 (24)	30 (40)	75 (100)	150 (200)
T_{inst} HIT-RTZ installation torque	ft-lb (Nm)		15 (20)	20 (28)	50 (65)	105 (140)
h min. base material thickness	in. (mm)		3-3/4 (95)	5-1/4 (133)	6 (153)	7-7/8 (200)
t_{fix} Maximum thickness fastened	in. (mm)		1 (25)	1-1/2 (37)	2-1/4 (56)	4-1/16 (103)



Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right)^{5/3} + \left(\frac{V_d}{V_{rec}} \right)^{5/3} \leq 1.0 \text{ (Ref. Section 3.1.8.3)}$$

- For Hilti matched tolerance carbide tipped drill bits. For Hilti diamond core bits, refer to the Hilti Catalog.
- For uncleaned holes in floor applications, add 3/8" (10 mm) to drilled hole depth (typical).

Allowable and Ultimate Bond/Concrete Capacity of HIT-TZ and HIT-RTZ Rods in Normal Weight Concrete with HIT-HY 150 MAX/HIT-ICE¹

Anchor Dia. in (mm)	Embed. Depth in (mm)	Allowable Bond/Concrete Capacity				Ultimate Bond/Concrete Capacity			
		Tensile		Shear		Tensile		Shear	
		$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)
3/8 (9.5)	2-7/8 (73)	1800 (8.0)	2255 (10.0)	1710 (7.6)	2415 (10.7)	7200 (32.0)	9020 (40.1)	6840 (30.4)	9660 (43.0)
1/2 (12.7)	3-1/2 (12.1)	2720 (12.1)	3020 (13.4)	2600 (11.6)	3680 (16.4)	10880 (48.4)	12080 (53.7)	10400 (46.3)	14720 (65.5)
5/8 (15.9)	4 (102)	3850 (17.1)	5750 (25.6)	3490 (15.5)	4935 (22.0)	15400 (68.5)	23000 (102.3)	13960 (62.1)	19740 (87.8)
3/4 (19.1)	5-1/4 (133)	5405 (24.0)	7275 (32.4)	5850 (26.0)	8275 (36.8)	21620 (96.2)	29100 (129.4)	23400 (104.1)	33100 (147.2)

- Influence factors for spacing and/or edge distance are applied to the allowable concrete/bond values above, and then compared to the allowable steel values below. The lesser of the values is to be used for the design.

Allowable¹ & Ultimate² Steel Strengths for HIT-TZ & HIT-RTZ Rods

Rod Diameter in (mm)	Allowable Steel Strength		Ultimate Steel Strength		
	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	3170 (14.1)	1635 (7.3)	5690 (25.3)	7210 (32.1)	4325 (19.2)
1/2 (12.7)	5636 (25.0)	2900 (12.9)	10105 (44.9)	12810 (56.9)	7685 (34.2)
5/8 (15.9)	8805 (39.1)	4535 (20.1)	15795 (70.2)	20020 (89.0)	12010 (53.4)
3/4 (19.1)	12685 (56.4)	6535 (29.1)	22750 (101.2)	28825 (128.2)	17295 (76.9)

- Allowable Steel strength as defined in AISC Manual of Steel Construction (ASD):
Tensile = $0.33 \times F_u \times \text{Nominal Area}$; Shear = $0.17 \times F_u \times \text{Nominal Area}$
- Ultimate Steel strength as defined in AISC Manual of Steel Construction (LRFD):
Yield = $F_y \times \text{Tensile Stress Area}$; Tensile = $0.75 \times F_u \times \text{Nominal Area}$; Shear = $0.45 \times F_u \times \text{Nominal Area}$

3.2.5 HIT-TZ with HIT-HY 150 MAX or HIT-ICE

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-TZ and HIT-RTZ Threaded Rods

Load Adjustment Factors for 3/8" and 1/2" Diameter Anchors								
Anchor Diameter	3/8" diameter				1/2" diameter			
	Spacing	Edge Distance			Spacing	Edge Distance		
Adjustment Factor	Tension or Shear f_A	Tension f_{RN}	Shear (⊥ toward edge) f_{RV1}	Shear (to or away from edge) f_{RV2}	Tension or Shear f_A	Tension f_{RN}	Shear (⊥ toward edge) f_{RV1}	Shear (to or away from edge) f_{RV2}
Embedment Depth, in	2-7/8	2-7/8	2-7/8	2-7/8	3-1/2	3-1/2	3-1/2	3-1/2
Spacing (s)/Edge Distance (c), in.	2	0.77	0.63	0.25	0.53			
	2-7/16	0.79	0.68	0.35	0.59	0.77	0.63	0.25
	3	0.81	0.74	0.46	0.67	0.79	0.68	0.35
	3-3/8	0.83	0.78	0.55	0.72	0.80	0.71	0.42
	4	0.86	0.84	0.68	0.80	0.83	0.77	0.53
	4-3/8	0.87	0.88	0.76	0.85	0.84	0.80	0.59
	5	0.90	0.95	0.90	0.94	0.86	0.85	0.71
	5-1/4	0.91	1.98	0.95	0.97	0.87	0.88	0.75
	5-7/16	0.92	1.00	1.00	1.00	0.88	0.89	0.79
	6	0.95				0.90	0.94	0.88
	6-11/16	0.98				0.92	1.00	1.00
	7	0.99				0.94		
	7-3/16	1.00				0.94		
	8-1/2					0.99		
	8-3/4					1.00		

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-TZ and HIT-RTZ Threaded Rods

Load Adjustment Factors for 5/8" and 3/4" Diameter Anchors								
Anchor Diameter	5/8" diameter				3/4" diameter			
	Spacing	Edge Distance			Spacing	Edge Distance		
Adjustment Factor	Tension or Shear f_A	Tension f_{RN}	Shear (⊥ toward edge) f_{RV1}	Shear (to or away from edge) f_{RV2}	Tension or Shear f_A	Tension f_{RN}	Shear (⊥ toward edge) f_{RV1}	Shear (to or away from edge) f_{RV2}
Embedment Depth, in	4	4	4	4	5-1/4	5-1/4	5-1/4	5-1/4
Spacing (s)/Edge Distance (c), in.	2-13/16	0.77	0.63	0.25	0.53			
	3	0.78	0.65	0.36	0.55			
	3-11/16	0.80	0.70	0.44	0.62	0.77	0.63	0.25
	4-5/16	0.82	0.75	0.52	0.68	0.79	0.67	0.33
	4-1/2	0.82	0.76	0.60	0.70	0.79	0.68	0.35
	4-3/4	0.83	0.78	0.68	0.72	0.80	0.69	0.38
	5	0.84	0.80	0.76	0.75	0.80	0.71	0.42
	5-3/4	0.86	0.86	0.83	0.82	0.82	0.75	0.50
	6-3/4	0.90	0.93	0.91	0.92	0.84	0.81	0.62
	7-3/16	0.91	0.97	1.00	0.96	0.86	0.84	0.67
	7-5/8	0.92	1.00	1.00	1.00	0.87	0.86	0.72
	8	0.94				0.88	0.88	0.76
	8-7/16	0.95				0.89	0.91	0.82
	9	0.97				0.90	0.94	0.88
	10	1.00				0.92	1.00	1.00
	11-1/4					0.95		
	12					0.97		
	13-1/8					1.00		

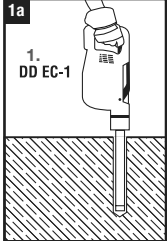
NOTE: Tables apply for listed embedments. Reduction factors for other embedment depths must be calculated using equations below.

Spacing Tension/Shear $s_{\min} = 0.7 h_{ef}$, $s_{cr} = 2.5 h_f$ $f_A = 0.128(s/h_{ef}) + 0.68$ for $s_{cr} > s > s_{\min}$	Edge Distance Tension $c_{\min} = 0.7 h_{ef}$, $c_{cr} = 1.9 h_{ef}$ $f_{RN} = 0.308(c/h_{ef}) + 0.414$ for $c_{cr} > c > c_{\min}$	Edge Distance Shear (⊥ toward edge) $c_{\min} = 0.7 h_{ef}$, $c_{cr} = 1.9 h_{ef}$ $f_{RV1} = 0.625(c/h_{ef}) - 0.1875$ for $c_{cr} > c > c_{\min}$	Edge Distance Shear (to or away from edge) $c_{\min} = 0.7 h_{ef}$, $c_{cr} = 1.9 h_{ef}$ $f_{RV2} = 0.392(c/h_{ef}) + 0.256$ for $c_{cr} > c > c_{\min}$
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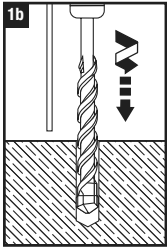
HIT-TZ with HIT-HY 150 MAX or HIT-ICE 3.2.5

3.2.5.4 Installation Instructions

HIT-TZ and HIT-RTZ Installation Instructions

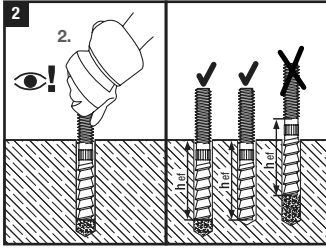


1. DD EC-1




1b

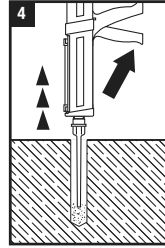
Drill hole using a rotohammer or Hilti diamond coring machine.



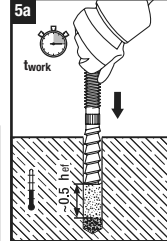
2. Push the HIT-TZ in the hole to verify sufficient hole depth (only threads visible). For floor applications pushing the rod compacts the drill dust.



3. Hilti HIT-HY 150 MAX and HIT-ICE

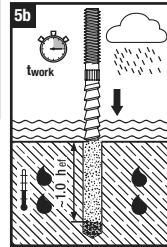


4. Inject adhesive starting from the bottom of the hole.

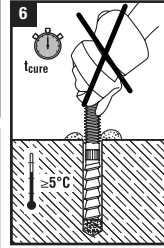


5a

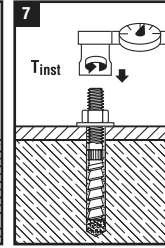
Fill the hole 1/2 to 2/3 full. If the hole is full of water, it is suggested to start injecting from the bottom of the hole and fill entirely with adhesive.



5b



6. Do not adjust the HIT-TZ rod between the gel and cure times. Apply a load only after the appropriate cure time has elapsed.



7. Apply a load after the appropriate cure time.

3.2.5.5 Ordering Information

Description	Threaded Rod Diameter (in.)	Drill Bit Diameter (in.)	Depth of Embedment (in.)	Maximum Fastening Thickness (in.)	Overall Length (in.)	Quantity per Box
HIT-TZ 3/8x2-7/8	3/8	7/16	2-7/8	1	4-1/2	40
HIT-TZ 1/2x3-1/2	1/2	9/16	3-1/2	1-1/2	5-11/16	24
HIT-TZ 5/8x4	5/8	11/16	4	2-1/4	7-1/16	16
HIT-TZ 3/4x5-1/4	3/4	13/16	5-1/4	4-1/16	10-1/2	8

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

3.2.6.1 Product Description

3.2.6.2 Material Specifications

3.2.6.3 Strength Design

3.2.6.4 Technical Data

3.2.6.5 Installation Instructions

3.2.6.6 Ordering Information

HY 150 MAX
Foil Pack

Listings/Approvals

ICC-ES (International Code Council)

ESR-1967, ESR-2262

City of Los Angeles

RR 25652

NSF/ANSI Standard 61

Certification for use of HIT-HY 150 MAX
in potable water

Metro-Dade County

NOA No. 09-0224.06



Independent Code Evaluation

IBC®/IRC® 2009 (ICC-ES AC58/AC308)

IBC®/IRC® 2006 (ICC-ES AC58/AC308)

IBC®/IRC® 2003 (ICC-ES AC58/AC308)

IBC®/IRC® 2000 (ICC-ES AC58/AC308)

UBC® 1997 (ICC-ES AC58)

LEED®: Credit 4.1-Low Emitting
Materials

3.2.6.1 Product Description

Hilti HIT-HY 150 MAX is a hybrid adhesive mortar combining urethane methacrylate resin, hardener, cement and water. The components are kept separate from the hardener and water by means of a dual-cylinder foil cartridge attached to a manifold. It is formulated for fast curing and installation in a wide range of solid and hollow base material temperatures from 14°F (-10°C) up to 104°F (40°C).

The system consists of adhesive cartridges, a mixing nozzle, a HIT dispenser and either a threaded rod, rebar, HIS internally threaded inserts or other fastening element. HIT-HY 150 MAX is designed for fastenings into solid base materials such as concrete, stone, and grout-filled block.

The Hilti HIT-TZ is an innovative threaded rod installed with HIT-HY 150 MAX hybrid adhesive. With the combination of HIT-HY 150 MAX and the innovative design of the HIT-TZ rod, anchoring into uncleaned holes, wet holes (including standing water) and/or Hilti matched tolerance diamond-cored holes does not adversely affect tensile capacity.

Product Features of HIT-HY 150 MAX

- May be used for oversized holes up to 1/4" larger than threaded rod size (ASD Tables only)
- Quick cure saves time
- Complete system available, including HAS-E, HIS, HIT-TZ
- Contains no styrene, virtually odorless
- Extended temperature range IBC®/IRC® 2009
- Seismic qualified per IBC®/IRC® 2009, IBC®/IRC® 2006, IBC®/IRC® 2003, IBC®/IRC® 2003, IBC®/IRC® 2000 and UBC® 1997. Please refer to ESR-1967 and ESR-2262

The Leadership in Energy and Environmental Design (LEED®) Green Building Rating system™ is the nationally accepted benchmark for the design, construction and operation of high performance green buildings.

Fastener Components

HAS Threaded Rod

HIS Internally
Threaded Inserts

HIT Mixing Nozzle

HIT-HY 150 MAX
Foil Pack

HIT Foil
Pack Holder

ED 3500
Battery
Dispenser

MD 2000
Dispenser

P 3500
Dispenser

P 8000
Dispenser

HIT-TZ and HIT-RTZ Rods

Rebar
(supplied by contractor)

HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

Guide Specifications

Master Format Section:

Previous 2004 Format

03250 03 16 00 (Concrete Anchors)

Related Sections:

03200 03 20 00 (Concrete Reinforcing)

05050 05 50 00 (Metal Fabrications)

05120 05 10 00 (Structural Metal Framing)

Injectable adhesive: Shall be used for installation of all reinforcing steel dowels or threaded rods and inserts into new or existing solid concrete or masonry. For hollow base materials an injectable adhesive shall be used with a cylindrical mesh screen tube per the adhesive manufacturer's specifications.

Adhesive: Shall be furnished in containers which keep component A and component B separate. Containers shall be designed to accept static mixing nozzle which thoroughly blends component A and component B and allows injection directly into drilled hole. Only injection tools and static mixing nozzles supplied by manufacturer shall be used. Manufacturer's installation instructions shall be followed. Injection adhesives shall be formulated to include resin and hardener to provide optimal curing speed as well as high strength and stiffness. Typical curing time at 68°F shall be 30 minutes. Injection adhesive shall be HIT-HY 150 MAX, as furnished by Hilti.

Anchor Rods: Shall be furnished with chamfered ends so that either end will accept a nut and washer. Alternatively, anchor rods shall be furnished with a 45 degree chisel point on one end to allow for easy installation into the adhesive-filled hole. Anchor rods shall be manufactured to meet the following requirements:

1. ISO 898 Class 5.8;
2. ASTM A 193, Grade B7 (high strength carbon steel anchor);
3. AISI 304 or AISI 316 stainless steel, meeting the requirements of ASTM F 593 (condition CW).
4. Special order of HAS or HIT rods may vary from standard product.

Nuts and Washers: Shall be furnished to meet the requirements of the above anchor rod specifications.

3.2.6.2 Material Specifications

Material Properties For Cured Adhesive

Compressive Strength ASTM C 579	> 50 MPa	>7252 psi
Flexural Strength ASTM C 580	> 20 MPa	> 2900 psi
Modulus of Elasticity ASTM C 307	> 3500 MPa	> 5.07 x 10 ⁵ psi
Water Absorption ASTM D 570	< 2%	< 2%
Electrical Resistance DIN/VDE 0303T3	~ 2 x 10 ¹¹ OHM/cm	~ 5.1 x 10 ¹¹ OHM/in.

Material Properties for Steel Elements

	Mechanical Properties			
	f_y ksi (MPa)		min. f_u ksi (MPa)	
Standard HAS-E rod material meets the requirements of ISO 898 Class 5.8	58	(400)	72.5	(500)
High Strength or 'Super HAS' rod material meets the requirements of ASTM A 193, Grade B7	105	(724)	125	(862)
HIS-R Insert X5CrNiMo17122 K700 Stainless Steel conforming to DIN EN 10088-3	50.8	(350)	101.5	(700)
HIS Insert 11SMnPb30+C Carbon Steel conforming to DIN 10277-3	54.4	(375)	66.7	(460)
Stainless HAS Rod material meets the requirements of ASTM F 593 (AISI 304/316) Condition CW 3/8" to 5/8"	65	(448)	100	(689)
Stainless HAS Rod material meets the requirements of ASTM F 593 (AISI 304/316) Condition CW 3/4" to 1-1/4"	45	(310)	85	(586)
HAS Super & HAS-E Standard Nut Material meets the requirements of SAE J995 Grade 5				
HAS Stainless Steel Nut material meets the requirements of ASTM F 594				
HAS Standard and Stainless Steel Washers meet dimensional requirements of ANSI B18.22.1 Type A Plain				
HAS Stainless Steel Washers meet the requirements of AISI 304 or AISI 316 conforming to ASTM A 240				
HAS Super & HAS-E Standard Washers meet the requirements of ASTM F 884, HV				
All HAS Super Rods (except 7/8"), HAS-E Standard, HIS inserts, Nuts & Washers are zinc plated to ASTM B 633 SC 1				
7/8" HAS Super Rods hot-dip galvanized in accordance with ASTM A 153				
HAS-E Nut material meets dimensional requirements of ASTM A 563				

Note: Special Order threaded rods may vary from standard materials.

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

3.2.6.3 Strength Design^{1,2}

3.2.6.3.1 General: Design strengths are determined in accordance with ACI 318-08 Appendix D (ACI 318) and supplemented by ICC-ES ESR-3013.

Design parameters are provided in Table 7 through Table 27. Strength reduction factors, Φ , as given in ACI 318 D.4.4 must be used for load combinations calculated in accordance with Section 1605.2.1 of the IBC or ACI 318.

Strength reduction factors, Φ , as given in ACI 318 D.4.5 must be used for load combinations calculated in accordance with ACI 318 Appendix C.

The following amendments to ACI 318 Appendix D must be used as required for the strength design of adhesive anchors. In conformance with ACI 318, all equations are expressed in inch-pound units.

Modify ACI 318 D.4.1.2 as follows:

D.4.1.2 – In Eq. (D-1) and (D-2), ΦN_n and ΦV_n are the lowest design strengths determined from all appropriate failure modes. ΦN_n is the lowest design strength in tension of an anchor or group of anchors as determined from consideration of ΦN_{sa} , either ΦN_a or ΦN_{ag} and either ΦN_{cb} or ΦN_{cbg} . ΦV_n is the lowest design strength in shear of an anchor or a group of anchors as determined from consideration of: ΦV_{sa} , either ΦV_{cb} or ΦV_{cbg} , and either ΦV_{cp} or ΦV_{cpg} . For adhesive anchors subjected to tension resulting from sustained loading, refer to D.4.1.4 for additional requirements.

Add ACI 318 D.4.1.4 as follows:

D.4.1.4 – For adhesive anchors subjected to tension resulting from sustained loading, a supplementary check shall be performed using Eq. (D-1), whereby N_{ua} is determined from the sustained load alone, e.g., the

dead load and that portion of the live load acting that may be considered as sustained and ΦN_n is determined as follows:

D.4.1.4.1 – For single anchors,
 $\Phi N_n = 0.75\Phi N_{a0}$.

D.4.1.4.2 – For anchor groups, Eq. (D-1) shall be satisfied by taking $\Phi N_n = 0.75\Phi N_{a0}$ for that anchor in an anchor group that resists the highest tension load.

D.4.1.4.3 – Where shear loads act concurrently with the sustained tension load, the interaction of tension and shear shall be analyzed in accordance with D.4.1.3.

Modify ACI 318 D.4.2.2 in accordance with 2009 IBC Section 1908.1.10 as follows:

D.4.2.2 – The concrete breakout strength requirements for anchors in tension shall be considered satisfied by the design procedure of D.5.2 provided Equation D-8 is not used for the anchor embedments exceeding 25 inches. The concrete breakout strength requirements for anchors in shear with diameters not exceeding 2 inches shall be considered satisfied by the design procedure of D.6.2. For anchors in shear with diameters exceeding 2 inches, shear anchor reinforcement shall be provided in accordance with the procedure of D.6.2.9.

3.2.6.3.2. Static Steel Strength in

Tension: The nominal static steel strength of a single anchor in tension, N_{sa} , in accordance with ACI 318 D.5.1.2 and strength reduction factor, Φ , in accordance with ACI D.4.4 are given in the tables outlined in Table 1a for the corresponding anchor steel.

3.2.6.3.3 Static Concrete Breakout

Strength in Tension: The nominal static concrete breakout strength of a single anchor or group of anchors in tension, N_{cb} or N_{cbg} , must be calculated in

accordance with ACI 318 D.5.2 with the following addition:

D.5.2.10 (2009 IBC) or D.5.2.9 (2006 IBC) – The limiting concrete strength of adhesive anchors in tension shall be calculated in accordance with D.5.2.1 to D.5.2.9 under the 2009 IBC or D.5.2.1 to D.5.2.8 under the 2006 IBC where the value of $k_{c,uncr}$ to be used in Eq. (D-7) shall be:

$k_{c,uncr}$ where analysis indicates no cracking at service load levels in the anchor vicinity (uncracked concrete). The values of $k_{c,uncr}$ are given in the tables of this section.

The basic concrete breakout strength of a single anchor in tension, N_b , must be calculated in accordance with ACI 318 D.5.2.2 using the values of h_{ef} and $k_{c,uncr}$ as given in Tables 8, 9, 11, 12, 14, 15, 17, 18, 20, 21, 23, 24, 26, and 27, as applicable for the corresponding steel element, of this report. The modification factor “ λ ” shall be taken as 1.0. Anchors shall not be installed in lightweight concrete. The value of f'_c must be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318 D.3.5.

Additional information for the determination of the nominal concrete breakout strength (N_{cb} or N_{cbg}) is given in the tables outlined in Table 1a for the corresponding anchor steel.

3.2.6.3.4 Static Pullout Strength

in Tension: In lieu of determining the nominal static pullout strength in accordance with ACI 318 D.5.3, nominal bond strength in tension must be calculated in accordance with the following sections added to ACI 318:

D.5.3.7 – The nominal bond strength of an adhesive anchor N_a or group of adhesive anchors, N_{ag} , in tension shall not exceed

HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

(a) for a single anchor

$$N_a = \frac{A_{Na}}{A_{Na0}} \cdot \Phi_{ed,Na} \cdot \Phi_{p,Na} \cdot N_{a0} \quad (D-16a)$$

(b) for a group of anchors

$$N_{ag} = \frac{A_{Na}}{A_{Na0}} \cdot \Phi_{ed,Na} \cdot \Phi_{g,Na} \cdot \Phi_{ec,Na} \cdot \Phi_{p,Na} \cdot N_{a0} \quad (D-16b)$$

where:

A_{Na} is the projected area of the failure surface for the single anchor or group of anchors that shall be approximated as the base of the rectilinear geometrical figure that results from projecting the failure surface outward a distance, $c_{cr,Na}$, from the centerline of the anchor, or in the case of a group of anchors, from a line through a row of adjacent anchors. A_{Na} shall not exceed nA_{Na0} where n is the number of anchors in tension in the group. In ACI 318 Figures RD.5.2.1a and RD.5.2.1b, the terms $1.5h_{ef}$ and $3.0h_{ef}$ shall be replaced with $c_{cr,Na}$ and $s_{cr,Na}$, respectively.

A_{Na0} is the projected area of the failure surface of a single anchor without the influence of proximate edges in accordance with Eq. (D-16c):

$$A_{Na0} = (s_{cr,Na})^2 \quad (D-16c)$$

with

$s_{cr,Na}$ = as given by Eq. (D-16d).

D.5.3.8 - The critical spacing $s_{cr,Na}$ and critical edge distance $c_{cr,Na}$ shall be calculated as follows:

$$s_{cr,Na} = 20 \cdot d \sqrt{\frac{\tau_{k,uncr}}{1,450}} \leq 3 \cdot h_{ef} \quad (D-16d)$$

$$c_{cr,Na} = \frac{s_{cr,Na}}{2} \quad (D-16e)$$

D.5.3.9 - The basic strength of a single adhesive anchor in tension in uncracked concrete shall not exceed:

$$N_{a0} = \tau_{k,uncr} \cdot \pi \cdot d \cdot h_{ef} \quad (D-16f)$$

D.5.3.10 - The modification factor for the influence of the failure surface of a group of adhesive anchors is:

$$\Psi_{g,Na} = \Psi_{g,Na0} + \left[\left(\frac{S}{S_{cr,Na}} \right)^{0.5} \cdot (1 - \Psi_{g,Na0}) \right] \quad (D-16g)$$

where

$$\Psi_{g,Na0} = \sqrt{n} - \left[(\sqrt{n} - 1) \left(\frac{\tau_{k,cr}}{\tau_{k,max,cr}} \right)^{1.5} \right] \geq 1.0 \quad (D-16h)$$

where:

n = the number of tension-loaded adhesive anchors in a group.

$$\tau_{k,max,cr} = \frac{k_{c,cr}}{\pi \cdot d} \sqrt{h_{ef} \cdot f'_c} \quad (D-16i)$$

The value of f'_c must be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318 D.3.5.

D.5.3.11 - The modification factor for eccentrically loaded adhesive anchor groups is:

$$\Psi_{ec,Na} = 1 + \frac{1}{\frac{2e'_N}{S_{cr,Na}}} \leq 1.0 \quad (D-16j)$$

Eq. (D-16j) is valid for $e'_N \leq \frac{s}{2}$

If the loading on an anchor group is such that only certain anchors are in tension, only those anchors that are in tension shall be considered when determining the eccentricity e'_N for use in Eq. (D-16j).

In the case where eccentric loading exists about two orthogonal axes, the modification factor $\Psi_{ec,Na}$ shall be computed for each axis individually and the product of these factors used as $\Psi_{ec,Na}$ in Eq. (D-16b).

D.5.3.12 - The modification factor for the edge effects for a single adhesive anchor or anchor groups loaded in tension is:

$$\Psi_{ed,Na} = 1.0 \text{ when } c_{a,min} \geq c_{cr,Na} \quad (D-16l)$$

or

$$\Psi_{ed,Na} = \left(0.7 + 0.3 \cdot \frac{c_{a,min}}{c_{cr,Na}} \right) \geq 1.0 \text{ when } c_{a,min} < c_{cr,Na} \quad (D-16m)$$

D.5.3.14 - When an adhesive anchor or a group of adhesive anchors is located in a region of a concrete member where analysis indicates no cracking at service load levels, the modification factor $\Psi_{p,Na}$ shall be taken as:

$$\Psi_{p,Na} = 1.0 \text{ when } c_{a,min} \geq c_{ac} \quad (D-16o)$$

$$\Psi_{p,Na} = \frac{\max |c_{a,min}; c_{cr,Na}|}{c_{ac}} \text{ when } c_{a,min} < c_{ac} \quad (D-16p)$$

Where:

c_{ac} shall be determined in accordance with Section 3.2.6.3.10 of this section.

Additional information for the determination of nominal bond strength in tension is given in Section 3.2.6.3.8 of this report.

3.2.6.3.5 Static Steel Strength in

Shear: The nominal static steel strength of a single anchor in shear as governed by the steel, V_{sa} , in accordance with ACI 318 D.6.1.2 and strength reduction factor, Φ , in accordance with ACI 318 D.4.4 are given in the tables outlined in Table 1a of this report for the corresponding anchor steel.

3.2.6.3.6 Static Concrete Breakout

Strength in Shear: The nominal static concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg} , must be calculated in accordance with ACI 318 D.6.2 based on information given in the tables outlined in Table 1a of this report for the corresponding anchor steel. The basic concrete breakout strength of a single anchor in shear, V_b , must be calculated in accordance with ACI 318 D.6.2.2 using the values of d and h_{ef} given in the tables outlined in Table 1a for the corresponding anchor steel in lieu of d_a (2009 IBC) and d_o (2006 IBC). In addition, h_{ef} must be substituted for ℓ_e . In no case must h_{ef} exceed $8d$. The value of f'_c must be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318 D.3.5.

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

3.2.6.3.7 Static Concrete Pryout

Strength in Shear: In lieu of determining the nominal static pryout strength in accordance with ACI 318 D.6.3.1, the nominal pryout strength in shear must be calculated in accordance with the following sections added to ACI 318:

D.6.3.2—The nominal pryout strength of an adhesive anchor or group of adhesive anchors shall not exceed:

(a) for single anchors:

$$V_{cp} = \min | k_{cp} \cdot N_a; k_{cp} \cdot N_{cb} | \quad (D-30a)$$

(b) for groups:

$$V_{cpg} = \min | k_{cp} \cdot N_{ag}; k_{cp} \cdot N_{cbg} | \quad (D-30b)$$

where:

$$k_{cp} = 1.0 \text{ for } h_{ef} < 2.5 \text{ inches (64 mm)}$$

$$k_{cp} = 2.0 \text{ for } h_{ef} \geq 2.5 \text{ inches (64 mm)}$$

N_a shall be calculated in accordance with Eq. (D-16a)

N_{ag} shall be calculated in accordance with Eq. (D-16b)

N_{cb} and N_{cbg} shall be determined in accordance with D.5.2

3.2.6.3.8 Bond Strength

Determination: Bond strength values are a function of installation conditions (dry, water-saturated concrete). The resulting characteristic bond strength must be multiplied by the associated strength reduction factor Φ_{nn} as follows:

Concrete Type	Permissible Installation Conditions	Bond Strength	Associated Strength Reduction Factor
Uncracked	Dry	$\tau_{k,uncr}$	Φ_d
	Water-saturated	$\tau_{k,uncr}$	Φ_{ws}

Figure 2 of this section presents a bond strength design selection flowchart.

Strength reduction factors for determination of the bond strength are given in the tables outlined in Table 1a of this report. Adjustments to the bond strength may also be taken for increased concrete compressive strength. These factors are given in the corresponding tables as well.

3.2.6.3.9 Minimum Member

Thickness, h_{min} , Anchor Spacing, s_{min} , and Edge Distance, c_{min} : In lieu of ACI 318 D.8.3, values of c_{min} and s_{min} described in this report must be observed for anchor design and installation. Likewise, in lieu of ACI 318 D.8.5, the minimum member thicknesses, h_{min} , described in this report must be observed for anchor design and installation. In determining minimum edge distance, c_{min} , the following section must be added to ACI 318:

D.8.8—For adhesive anchors that will remain untorqued, the minimum edge distance shall be based on minimum cover requirements for reinforcement in 7.7. For adhesive anchors that will be torqued, the minimum edge distance and spacing are given in the Tables 8, 11, 14, 17, 20, 23, and 26 of this report.

For the edge distance c_{ai} and anchor spacing, s_{ai} , and maximum torque, T_{max} shall comply with the following requirements:

Reduced Installation Torque T_{max} for Edge Distances $c_{ai} < (5 \times d)$		
Edge Distance c_{ai}	Minimum Anchor Spacing, s_{ai}	Max. Torque, T_{max}
1.75 in. (45 mm)	$5 \cdot d \leq s_{ai} < 16 \text{ in.}$	$0.3 \cdot T_{max}$
$\leq c_{ai} < 5 \times d$	$s_{ai} \geq 16 \text{ in. (406 mm)}$	$0.5 \cdot T_{max}$

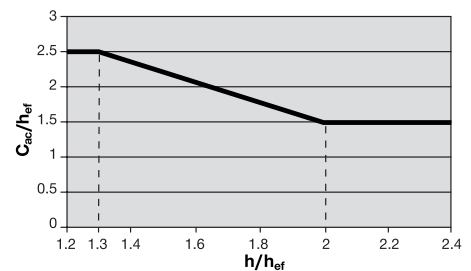
3.2.6.3.10 Critical Edge Distance, c_{ac} :

For the calculation of N_{cb} , N_{cbg} , N_a and N_{ag} in accordance with ACI 318 D.5.2.7 and Section 3.2.6.3.4 of this report, the critical edge distance, c_{ac} , must be taken as follows:

$$i. \quad c_{ac} = 1.5 h_{ef} \text{ for } h/h_{ef} \geq 2$$

$$ii. \quad c_{ac} = 2.5 h_{ef} \text{ for } h/h_{ef} \leq 1.3$$

For definition of h and h_{ef} , see Figure 1 of this section.



Linear interpolation is permitted to determine the ratio c_{ac}/h_{ef} for values of h/h_{ef} between 2 and 1.3 as illustrated in the preceding graph.

3.2.6.3.11 Requirements for Seismic

Design: The anchors may be used to resist seismic loads for structures classified as Seismic Design Categories A and B under the IBC or IRC only.

3.2.6.3.12 Interaction of Tensile and

Shear Forces: For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 D.7.

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

Figure 1 — Installation Parameters

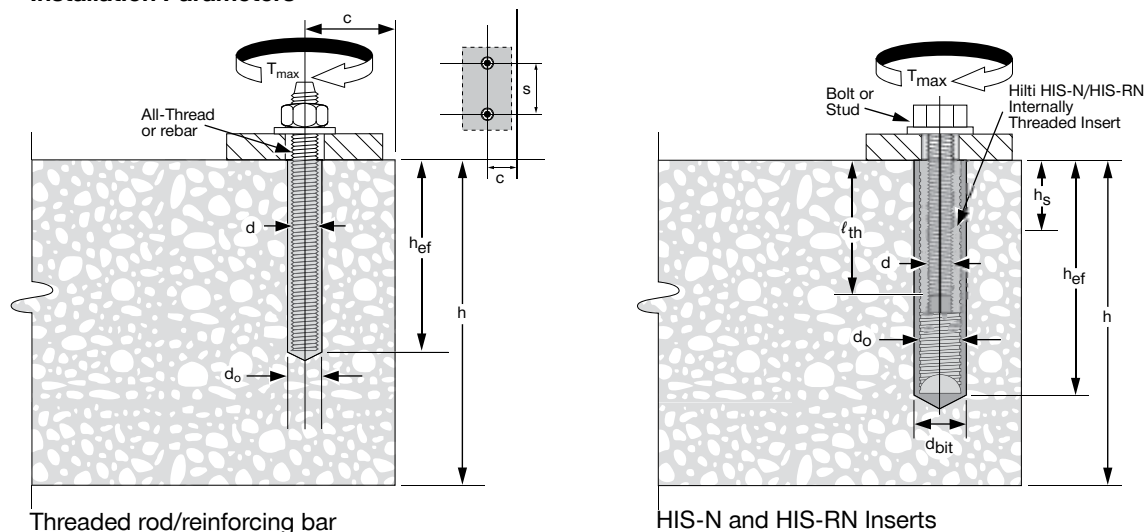


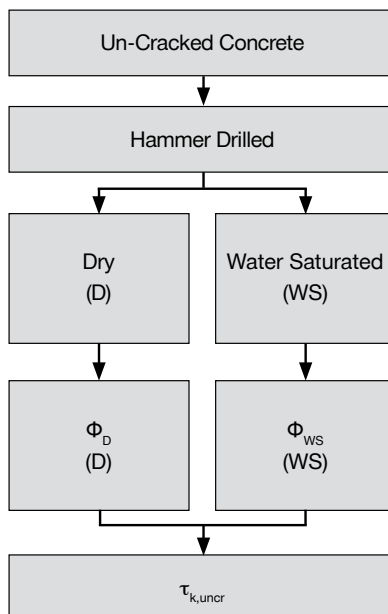
Table 1a — Design Table Index

Design strength ¹		Threaded rod		Hilti HIS Internally Threaded Insert		Deformed reinforcement bar		
		Fractional	Metric	Fractional	Metric	U.S. (imperial)	EU (metric)	Canadian (metric)
Steel	N_{sa}, V_{sa}	Table 7	Table 10	Table 13	Table 16	Table 19	Table 22	Table 25
Concrete	$N_{cb}, N_{cbg}, V_{cb}, V_{cbg}, V_{cp}, V_{cpg}$	Table 8	Table 11	Table 14	Table 17	Table 20	Table 23	Table 26
Bond ²	N_a, N_{ag}	Table 9	Table 12	Table 15	Table 18	Table 21	Table 24	Table 27

1 Design strengths are as set forth in ACI 318 D.4.1.2.

2 See Section 3.2.6.3.4 of this report for bond strength information.

Figure 2 — Flowchart for Establishment of Design Bond Strength



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Table 1b — Example Allowable Stress Design Values for Illustrative Purposes

Nominal Anchor Diameter	Effective Embedment Depth	f'_c	$k_{c,uncr}$	α	Φ	N_n	Allowable Tension Load N_n/α
d	h_{ef}						
(in)	(in)	(psi)	(-)	(-)	(-)	(lb)	(lb)
3/8	2-3/8	2,500	24	1.48	0.65	4,392	1,928
1/2	2-3/4	2,500	24	1.48	0.65	5,472	2,403
5/8	3-1/8	2,500	24	1.48	0.65	6,629	2,911
3/4	3-1/2	2,500	24	1.48	0.65	7,857	3,450
7/8	3-1/2	2,500	27	1.48	0.65	8,840	3,882
1	4	2,500	27	1.48	0.65	10,800	4,743
1-1/4	5	2,500	30	1.48	0.65	16,771	7,365

For SI: 1 lb = 4.45 kN, 1 psi = 0.00689 MPa, 1 in. = 25.4 mm, °C = [(°F) - 32]/1.8

Design Assumptions:

- Single anchor with static tension load only; ASTM A 193 Grade B7 threaded rod, ductile.
- Vertical downward installation direction.
- Inspection Regimen = Periodic.
- Installation temperature = 14 – 104 °F.
- Long term temperature = 80 °F.
- Short term temperature = 110 °F.
- Dry hole condition — carbide drilled hole.
- Embedment depth = $h_{ef, min}$.
- Concrete determined to remain uncracked for the life of the anchorage.
- Load combination from ACI 318 Section 9.2 (no seismic loading).
- 30 percent Dead Load (D) and 70 percent Live Load (L); Controlling load combination 1.2 D + 1.6 L.
- Calculation of α based on weighted average: $\alpha = 1.2 D + 1.6 L = 1.2 (0.30) + 1.6 (0.70) = 1.48$.
- Normal weight concrete: $f'_c = 2,500$ psi
- Edge distance: $c_{a1} = c_{a2} > c_{ac}$
- Member thickness: $h \geq h_{min}$.

Capacity	ACI 318 reference	Formula	Calculation	Φ	fN_n
Steel	D.5.1	$N_{sa} = nA_{se,N} f_{uta}$	$N_{sa} = 0.3345 \cdot 125,000$	0.75	31,360 lb
Concrete	D.5.2	$N_{cb} = k_{c,uncr} (f'_c)^{0.5} h_{ef}^{1.5}$	$N_{cb} = 24 \cdot (2,500)^{0.5} \cdot 3^{1.5}$	0.65	5,107 lb
Bond	D.5.3**	$N_a = \pi d h_{ef} t_{k,uncr}$	$N_a = \pi \cdot 3/4 \cdot 3.5 \cdot 1,710$	0.65	9,166 lb
<p>→ Concrete breakout is decisive; hence the ASD value will be calculated as $\frac{5,107 \text{ lb}}{1.48} = 3,451 \text{ lb}$</p>					

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Table 2 — Tensile Properties of Common Carbon Steel Threaded Rod Materials¹

Threaded rod specification		Minimum Specified Ultimate Strength f_{uta}	Minimum Specified Yield Strength 0.2% Offset f_{ya}	f_{uta}/f_{ya}	Minimum Elongation, Percent ⁵	Minimum Reduction of Area, Percent	Specification for Nuts ⁶
ASTM A 193 ² Grade B7 ≤ 2-1/2 in (≤ 64 mm)	psi (MPa)	125,000 (860)	105,000 (725)	1.19	16	50	ASTM A 563 Grade DH
ASTM F 568M ³ Class 5.8 M5 (1/4 in) to M24 (1 in) (equivalent to ISO 898-1)	MPa (psi)	500 (72,500)	400 (58,000)	1.25	10	35	DIN 934 (8-A2K) ASTM A563 Grade DH ⁷
ISO 898-1 ⁴ Class 5.8	MPa (psi)	500 (72,500)	400 (58,000)	1.25	22	-	DIN 934 (8-A2K)
ISO 898-1 ⁴ Class 8.8	MPa (psi)	800 (116,000)	640 (92,800)	1.25	12	52	DIN 934 (8-A2K)

¹ Hilti HIT-HY 150 MAX adhesive may be used in conjunction with all grades of continuously threaded carbon steel rod (all-thread) that comply with the code reference standards and that have thread characteristics comparable with ANSI B1.1 UNC Coarse Thread Series or ANSI B1.13M M Profile Metric Thread Series. Values for threaded rod types and associated nuts supplied by Hilti are provided here.

² Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

³ Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.

⁴ Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs.

⁵ Based on 2-in. (50 mm) gauge length except ASTM A 193, which are based on a gauge length of 4d and ISO 898 which is based on 5d.

⁶ Nuts of other grades and styles having specified proof load stresses greater than the specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than the minimum tensile strength of the specified threaded rod.

⁷ Nuts for fractional rods.

Table 3 — Tensile Properties of Common Stainless Steel Threaded Rod Materials¹

Threaded rod specification		Minimum specified ultimate strength f_{uta}	Minimum specified yield strength 0.2% offset f_{ya}	f_{uta}/f_{ya}	Minimum elongation, percent	Minimum reduction of Area, percent	Specification for nuts ⁴
ASTM F 593 ² CW1 (316) 1/4 to 5/8 in	psi (MPa)	100,000 (690)	65,000 (450)	1.54	20	-	F 594
ASTM F 593 ² CW2 (316) 3/4 to 1-1/2 in	psi (MPa)	85,000 (585)	45,000 (310)	1.89	25	-	F 594
ISO 3506-1 ³ A4-70 M8 – M24	MPa (psi)	700 (101,500)	450 (65,250)	1.56	40	-	ISO 4032
ISO 3506-13 A4-50 M27 – M30	MPa (psi)	500 (72,500)	210 (30,450)	2.38	40	-	ISO 4032

¹ Hilti HIT-HY 150 MAX may be used in conjunction with all grades of continuously threaded stainless steel rod (all-thread) that comply with the code reference standards and that have thread characteristics comparable with ANSI B1.1 UNC Coarse Thread Series or ANSI B1.13M M Profile Metric Thread Series. Values for threaded rod types and associated nuts supplied by Hilti are provided here.

² Standard Steel Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

³ Mechanical properties of corrosion-resistant stainless steel fasteners – Part 1: Bolts, screws and studs.

⁴ Nuts of other grades and styles having specified proof load stresses greater than the specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than the minimum tensile strength of the specified threaded rod. Use of different grades of steel may affect corrosion resistance.

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Table 4 — Tensile Properties of Fractional and Metric HIS-N and HIS-RN Inserts

Hilti HIS and HIS-R Inserts		Minimum specified ultimate strength f_{uta}	Minimum specified yield strength f_{ya}
Carbon Steel DIN EN 10277-3 11SMnPb30+c or DIN 1561 9SMnPb28K 3/8 and M8 to M10	MPa (psi)	490 (71,050)	410 (59,450)
Carbon Steel DIN EN 10277-3 11SMnPb30+c or DIN 1561 9SMnPb28K 1/2 to 3/4 and M12 to M20	MPa (psi)	460 (66,700)	375 (54,375)
Stainless Steel DIN 17440 (EN 10088-3) X5CrNiMo 17-12-2	MPa (psi)	700 (101,500)	350 (50,750)

Table 5 — Tensile Properties of Common Bolts, Cap Screws and Studs for use with HIS-N and HIS-RN Inserts^{1,2}

Bolt, Cap Screw or Stud Specification		Minimum specified ultimate strength f_{uta}	Minimum specified yield strength 0.2% offset f_{ya}	f_{uta}/f_{ya}	Minimum Elongation, Percent	Minimum Reduction of Area, Percent	Specification for nuts ⁵
SAE J429 ³ Grade 5	psi (MPa)	120,000 (830)	92,000 (634)	1.30	14	35	SAE J995
ASTM A 325 ⁴ 1/2 to 1-in.	psi (MPa)	120,000 (830)	92,000 (634)	1.30	14	35	A 563 C, C3, D, DH, DH3 Heavy Hex
ASTM A193 ⁵ GRADE B8M (AISI 316) for use with HIS-RN	psi (MPa)	110,000 (760)	95,000 (655)	1.16	15	45	F 594 ⁷
ASTM A193 ⁵ GRADE B8T (AISI 321) for use with HIS-RN	psi (MPa)	125,000 (860)	100,000 (690)	1.25	12	35	F 594 ⁷

1 Minimum Grade 5 bolts, cap screws or studs must be used with carbon steel HIS inserts.

2 Only stainless steel bolts, cap screws or studs are permitted with HIS-RN inserts.

3 Mechanical and Material Requirements for Externally Threaded Fasteners.

4 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

5 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

6 Nuts must have specified minimum proof load stresses equal to or greater than the specified minimum full-size tensile strength of the specified stud.

7 Nuts for stainless steel studs must be of the same alloy group as the specified stud.

Table 6 — Tensile Properties of Common Reinforcing Bars

Reinforcing Bar Specification		Minimum specified ultimate strength f_{uta}	Minimum specified yield strength f_{ya}
ASTM A 615 ¹ Gr. 60	psi (MPa)	90,000 (620)	60,000 (414)
ASTM A 615 ¹ Gr. 40	psi (MPa)	60,000 (415)	40,000 (275)
DIN 488 ² BSt 500	MPa (psi)	550 (79,750)	500 (72,500)
CAN/CSA-G30.18 ³ Gr. 400	MPa (psi)	540 (78,300)	400 (58,000)

1 Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement

2 Reinforcing steel; reinforcing steel bars; dimensions and masses

3 Billet-Steel Bars for Concrete Reinforcement

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Table 7 — Steel Design Information for Fractional Threaded Rod^{1,3}

Design Information		Symbol	Units	Nominal Rod Diameter (in.)					
				3/8	1/2	5/8	3/4	7/8	1
Rod O.D.		d	in. (mm)	0.375 (9.5)	0.5 (12.7)	0.625 (15.9)	0.75 (19.1)	0.875 (22.2)	1 (25.4)
Rod effective cross-sectional area		A _{se}	in. ² (mm ²)	0.0775 (50)	0.1419 (92)	0.2260 (146)	0.3345 (216)	0.4617 (298)	0.6057 (391)
ISO 898-1 Class 5.8 ²	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	5,619 (25.0)	10,288 (45.8)	16,385 (72.9)	24,251 (107.9)	33,472 (148.9)	43,912 (195.3)
		V _{sa}	lb (kN)	2,809 (12.5)	6,173 (27.5)	9,831 (43.7)	14,550 (64.7)	20,083 (89.3)	26,347 (117.2)
	Strength reduction factor Φ for tension ²	Φ	–	0.65					
	Strength reduction factor Φ for shear ²	Φ	–	0.60					
ASTM A 193 B7 ²	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	9,687 (43.1)	17,737 (78.9)	28,249 (125.7)	41,812 (186.0)	57,711 (256.7)	75,711 (336.8)
		V _{sa}	lb (kN)	4,844 (21.5)	10,642 (47.3)	16,950 (75.4)	25,087 (111.6)	34,627 (154.0)	45,426 (202.1)
	Strength reduction factor Φ for tension ²	Φ	–	0.75					
	Strength reduction factor Φ for shear ²	Φ	–	0.65					
ASTM F593, CW Stainless ²	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	28,432 (126.5)	39,244 (174.6)	51,483 (229.0)
		V _{sa}	lb (kN)	3,875 (17.2)	8,514 (37.9)	13,560 (60.3)	17,059 (75.9)	23,546 (104.7)	30,890 (137.4)
	Strength reduction factor Φ for tension ²	Φ	–	0.65					
	Strength reduction factor Φ for shear ²	Φ	–	0.60					

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- 1 Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official. Nuts and washers must be appropriate for the rod strength.
- 2 For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.
- 3 For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5. Values correspond to a ductile steel element.

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Table 8 — Concrete Breakout Design Information for Fractional Threaded Rod in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information	Symbol	Units	Nominal Rod Diameter (in.)						
			3/8	1/2	5/8	3/4	7/8	1	1-1/4
Effectiveness factor for un-cracked concrete	k _{c,uncr}	in-lb (SI)	24 (10)	24 (10)	24 (10)	24 (10)	27 (11.3)	27 (12.6)	30 (12.6)
Min. anchor spacing ⁴	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)
Min. edge distance ⁴	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 member thickness	h _{min}	in. (mm)	h _{ef} + 1-1/4 (h _{ef} + 30)		h _{ef} + 2d _o ³				
Critical edge distance – splitting (for un-cracked concrete)	c _{ac}	–	See Section 3.2.6.3.10.						
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	–	0.65						
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	–	0.70						

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions in Figure 5.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5.

3 d_o = hole diameter.

4 For installations with 1-3/4 inch edge distance, refer to section 3.2.6.3.9 for spacing and maximum torque requirements.

Table 9 — Bond Strength Design Information for Fractional Threaded Rod in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information			Symbol	Units	Nominal Rod Diameter (in.)					
					3/8	1/2	5/8	3/4	7/8	1
Temperature range ²	A	Characteristic bond strength	$\tau_{k,uncr}$	psi (MPa)	1,985 (13.7)	1,985 (13.7)	1,850 (12.7)	1,710 (11.8)	1,575 (10.9)	1,440 (9.9)
	B	Characteristic bond strength	$\tau_{k,uncr}$	psi (MPa)	1,610 (11.1)	1,610 (11.1)	1,495 (10.3)	1,385 (9.6)	1,275 (8.8)	1,170 (8.1)
	C	Characteristic bond strength	$\tau_{k,uncr}$	psi (MPa)	930 (6.4)	930 (6.4)	865 (6.0)	805 (5.5)	740 (5.1)	675 (4.7)
Minimum anchor embedment depth			$h_{ef,min}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (80)	3-1/2 (89)	3-1/2 (89)	4 (102)
Maximum anchor embedment depth			$h_{ef,max}$	in. (mm)	7-1/2 (191)	10 (254)	12-1/2 (318)	15 (381)	17-1/2 (445)	20 (508)
Permissible installation conditions	Dry concrete & Water-saturated concrete		Anchor Category	–	1					2
			Φ_d & Φ_{ws}	–	0.65					0.55

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Bond strength values correspond to concrete compressive strength range 2,500 psi ≤ f'_c ≤ 4,500 psi. For 4,500 psi < f'_c ≤ 6,500 psi, tabulated characteristic bond strengths may be increased by 6 percent. For 6,500 psi < f'_c ≤ 8,000 psi, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).

Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).

Temperature range C: Maximum short term temperature = 248°F (120°C), maximum 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.

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Table 10 — Steel Design Information for Metric Threaded Rod¹

Design Information		Symbol	Units	Nominal Rod Diameter (mm)							
				8	10	12	16	20	24	27	30
Rod O.D.		d	mm (in.)	8 (0.31)	10 (0.39)	12 (0.47)	16 (0.63)	20 (0.79)	24 (0.94)	27 (1.06)	30 (1.18)
Rod effective cross-sectional area		A _{se}	mm ² (in. ²)	36.6 (0.057)	58 (0.090)	84.3 (0.131)	157 (0.243)	245 (0.380)	353 (0.547)	459 (0.711)	561 (0.870)
ISO 898-1 Class 5.8	Nominal strength as governed by steel strength	N _{sa}	kN (lb)	18.3 (4,115)	29.0 (6,520)	42.2 (9,475)	78.5 (17,650)	122.5 (27,540)	176.5 (39,680)	229.5 (51,595)	280.5 (63,060)
		V _{sa}	kN (lb)	9.2 (2,060)	14.5 (3,260)	25.3 (5,685)	47.1 (10,590)	73.5 (16,525)	105.9 (23,810)	137.7 (30,955)	168.3 (37,835)
	Strength reduction factor Φ for tension ²	Φ	–	0.65							
	Strength reduction factor Φ for shear ²	Φ	–	0.60							
ISO 898-1 Class 8.8	Nominal strength as governed by steel strength	N _{sa}	kN (lb)	29.3 (6,580)	46.4 (10,430)	67.4 (15,160)	125.6 (28,235)	196.0 (44,065)	282.4 (63,485)	367.2 (82,550)	448.8 (100,895)
		V _{sa}	kN (lb)	14.6 (3,290)	23.2 (5,215)	40.5 (9,100)	75.4 (16,940)	117.6 (26,440)	169.4 (38,090)	220.3 (49,530)	269.3 (60,540)
	Strength reduction factor Φ for tension ²	Φ	–	0.65							
	Strength reduction factor Φ for shear ²	Φ	–	0.60							
ISO 3506-1 Class A4 Stainless ³	Nominal strength as governed by steel strength	N _{sa}	kN (lb)	25.6 (5,760)	40.6 (9,127)	59.0 (13,266)	109.9 (24,706)	171.5 (38,555)	247.1 (55,550)	229.5 (51,594)	280.5 (63,059)
		V _{sa}	kN (lb)	12.8 (2,880)	20.3 (4,564)	35.4 (7,960)	65.9 (14,824)	102.9 (23,133)	148.3 (33,330)	137.7 (30,956)	168.3 (37,835)
	Strength reduction factor Φ for tension ²	Φ	–	0.75							
	Strength reduction factor Φ for shear ²	Φ	–	0.65							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official. Nuts and washers must be appropriate for the rod strength.

2 For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.

3 A4-70 Stainless (M8 - M24 diameters); A4-502 Stainless (M27 - M30 diameters)

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Table 11 — Concrete Breakout Design Information for Metric Threaded Rod in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information	Symbol	Units	Nominal Rod Diameter (mm)							
			8	10	12	16	20	24	27	30
Effectiveness factor for uncracked concrete	k _{c,uncr}	SI (in-lb)	10 (24)	10 (24)	10 (24)	10 (24)	10 (24)	11.3 (27)	11.3 (27)	12.6 (30)
Min. anchor spacing ⁴	s _{min}	mm (in.)	40 (1.6)	50 (2.0)	60 (2.4)	80 (3.2)	100 (3.9)	120 (4.7)	135 (5.3)	150 (5.9)
Min. edge distance ⁴	c _{min}	mm (in.)	40 (1.6)	50 (2.0)	60 (2.4)	80 (3.2)	100 (3.9)	120 (4.7)	135 (5.3)	150 (5.9)
Minimum member thickness	h _{min}	mm (in.)	h _{ef} + 30 (h _{ef} + 1-1/4)		h _{ef} + 2d ₀ ⁽³⁾					
Critical edge distance – splitting (for uncracked concrete)	c _{ac}	–	See Section 3.2.6.3.10.							
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	–	0.65							
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	–	0.70							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions in Figure 5.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5.

3 $3d_0$ = drill bit diameter.

4 For installations with 1-3/4 inch edge distance, refer to Section 3.2.6.3.9 for spacing and maximum torque requirements.

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Table 12 — Bond Strength Design Information for Metric Threaded Rod in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information			Symbol	Units	Nominal Rod Diameter (mm)							
					8	10	12	16	20	24	27	30
Temperature range ²	A	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	13.7 (1,985)	13.7 (1,985)	13.7 (1,985)	12.7 (1,850)	11.8 (1,710)	10.9 (1,575)	9.9 (1,440)	8.1 (1,175)
	B	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	11.1 (1,610)	11.1 (1,610)	11.1 (1,610)	10.3 (1,500)	9.6 (1,390)	8.8 (1,275)	8.1 (1,170)	6.6 (950)
	C	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	6.4 (930)	6.4 (930)	6.4 (930)	6.0 (865)	5.5 (805)	5.1 (740)	4.7 (675)	3.8 (550)
Minimum anchor embedment depth			$h_{ef,min}$	mm (in.)	60 (2.4)	60 (2.4)	70 (2.8)	80 (3.1)	90 (3.5)	96 (3.8)	108 (4.3)	120 (4.7)
Maximum anchor embedment depth			$h_{ef,max}$	mm (in.)	160 (6.3)	200 (7.9)	240 (9.4)	320 (12.6)	400 (15.7)	480 (18.9)	540 (21.3)	600 (23.6)
Permissible installation conditions	Dry concrete & Water-saturated concrete		Anchor Category	–	1							2
			Φ_d & Φ_{ws}	–	0.65							0.55

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Bond strength values correspond to concrete compressive strength range 2,500 psi \leq $f'_c \leq$ 4,500 psi. For 4,500 psi < $f'_c \leq$ 6,500 psi, tabulated characteristic bond strengths may be increased by 6 percent. For 6,500 psi < $f'_c \leq$ 8,000 psi, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).

Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).

Temperature range C: Maximum short term temperature = 248°F (120°C), maximum 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.

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Table 13 — Steel Design Information for Fractional Hilti HIS-N and HIS-RN Inserts¹

Design Information		Symbol	Units	Nominal Bolt/Cap Screw Diameter (in)			
				3/8	1/2	5/8	3/4
HIS insert O.D.		D	in. (mm)	0.65 (16.5)	0.81 (20.5)	1 (25.4)	1.09 (27.6)
Bolt effective cross-sectional area		A _{se}	in. ² (mm ²)	0.0775 (50)	0.1419 (92)	0.2260 (146)	0.3345 (216)
HIS insert effective cross-sectional area		A _{insert}	in. ² (mm ²)	0.178 (115)	0.243 (157)	0.404 (260)	0.410 (265)
ASTM A 193 B7	Nominal strength as governed by steel strength – ASTM A193 B7 ³ bolt/cap screw	N _{sa}	lb (kN)	9,690 (43.1)	17,740 (78.9)	28,250 (125.7)	41,815 (186.0)
		V _{sa}	lb (kN)	5,815 (25.9)	10,645 (47.3)	16,950 (75.4)	25,090 (111.6)
	Nominal strength as governed by steel strength – HIS-N insert	N _{sa}	lb (kN)	12,650 (56.3)	16,195 (72.0)	26,925 (119.8)	27,360 (121.7)
	Strength reduction factor Φ for tension ²	Φ	–	0.65			
	Strength reduction factor Φ for shear ²	Φ	–	0.60			
ASTM A 193 Gr. B8M SS	Nominal strength as governed by steel strength – ASTM A193 Grade B8M SS bolt/cap screw	N _{sa}	lb (kN)	8,525 (37.9)	15,610 (69.4)	24,860 (110.6)	36,795 (163.7)
		V _{sa}	lb (kN)	5,115 (22.8)	9,365 (41.7)	14,915 (66.3)	22,075 (98.2)
	Nominal strength as governed by steel strength – HIS-RN insert	N _{sa}	lb (kN)	17,165 (76.3)	23,430 (104.2)	38,955 (173.3)	39,535 (175.9)
	Strength reduction factor Φ for tension ²	Φ	–	0.65			
	Strength reduction factor Φ for shear ²	Φ	–	0.60			

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official. Nuts and washers must be appropriate for the rod strength.
- For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.
- For the calculation of the design steel strength in tension and shear for the bolt or screw, the Φ factor for ductile steel failure according to ACI 318 D4.4 may be used.

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Table 14 — Concrete Breakout Design Information for Fractional Hilti HIS-N and HIS-RN Inserts¹

Design Information	Symbol	Units	Nominal Bolt/Cap Screw Diameter (in)			
			3/8	1/2	5/8	3/4
Effective embedment depth	h_{ef}	in. (mm)	4-3/8 (110)	5 (125)	6-3/4 (170)	8-1/8 (205)
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	in.-lb (SI)	24 (10)			
Min. anchor spacing ³	s_{min}	in. (mm)	3-1/4 (83)	4 (102)	5 (127)	5-1/2 (140)
Min. edge distance ³	c_{min}	in. (mm)	3-1/4 (83)	4 (102)	5 (127)	5-1/2 (140)
Minimum member thickness	h_{min}	in. (mm)	5.9 (150)	6.7 (170)	9.1 (230)	10.6 (270)
Critical edge distance – splitting (for uncracked concrete)	c_{ac}	–	See Section 3.2.6.3.10.			
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	–	0.65			
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	–	0.70			

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions in Figure 5.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5.

3 For installations with 1-3/4 inch edge distance, refer to Section 3.2.6.3.9 for spacing and maximum torque requirements.

Table 15 — Bond Strength Design Information for Fractional Hilti HIS-N and HIS-RN Inserts in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information			Symbol	Units	Nominal Rod Diameter (in.)			
					3/8	1/2	5/8	3/4
Effective embedment depth			h_{ef}	in. (mm)	4 3/8 (110)	5 (125)	6 3/4 (170)	8 1/8 (205)
HIS insert O.D.			D	in. (mm)	0.65 (16.5)	0.81 (20.5)	1 (25.4)	1.09 (27.6)
Temperature range ²	A	Characteristic bond strength	$\tau_{k,uncr}$	psi (MPa)	1,565 (10.8)	1,440 (9.9)	1,255 (8.7)	1,170 (8.1)
	B	Characteristic bond strength	$\tau_{k,uncr}$	psi (MPa)	1,270 (8.7)	1,170 (8.1)	1,020 (7.0)	950 (6.5)
	C	Characteristic bond strength	$\tau_{k,uncr}$	psi (MPa)	735 (5.1)	675 (4.7)	590 (4.1)	550 (3.8)
Permissible installation conditions	Dry concrete & Water-saturated concrete		Anchor Category	–	1			2
			Φ_d & Φ_{ws}	–	0.65			0.55

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Bond strength values correspond to concrete compressive strength range 2,500 psi ≤ f'_c ≤ 4,500 psi. For 4,500 psi < f'_c ≤ 6,500 psi, tabulated characteristic bond strengths may be increased by 6 percent. For 6,500 psi < f'_c ≤ 8,000 psi, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).

Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).

Temperature range C: Maximum short term temperature = 248°F (120°C), maximum 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.

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Table 16 — Steel Design Information for Metric Hilti HIS-N and HIS-RN Inserts¹

Design Information		Symbol	Units	Nominal Rod Diameter (mm)				
				8	10	12	16	20
HIS insert O.D.		D	mm (in.)	12.5 (0.49)	16.5 (0.65)	20.5 (0.81)	25.4 (1.00)	27.6 (1.09)
Bolt effective cross-sectional area		A _{se}	mm ² (in. ²)	36.6 (0.057)	58 (0.090)	84.3 (0.131)	157 (0.243)	245 (0.380)
HIS insert effective cross-sectional area		A _{insert}	mm ² (in. ²)	51.5 (0.080)	108 (0.167)	169.1 (0.262)	256.1 (0.397)	237.6 (0.368)
ISO 898-1 Class 8.8	Nominal strength as governed by steel strength – ISO 898-1 Class 8.8 bolt/cap screw	N _{sa}	kN (lb)	29.3 (6,580)	46.4 (10,430)	67.4 (15,160)	125.6 (28,235)	196.0 (44,065)
		V _{sa}	kN (lb)	17.6 (3,950)	27.8 (6,260)	40.5 (9,100)	75.4 (16,940)	117.6 (26,440)
	Nominal strength as governed by steel strength – HIS-N insert	N _{sa}	kN (lb)	25.2 (5,670)	52.9 (11,895)	77.8 (17,490)	117.8 (26,485)	109.3 (24,575)
	Nominal strength as governed by steel strength – HIS-N insert	Φ	–	0.65				
	Strength reduction factor Φ for tension ²	Φ	–	0.60				
ISO 3506-1 Class A4-70 Stainless	Nominal strength as governed by steel strength – ISO 3506-1 Class A4-70 Stainless bolt/cap screw	N _{sa}	kN (lb)	25.6 (5,760)	40.6 (9,130)	59.0 (13,265)	109.9 (24,705)	171.5 (38,555)
		V _{sa}	kN (lb)	15.4 (3,455)	24.4 (5,475)	35.4 (7,960)	65.9 (14,825)	102.9 (23,135)
	Nominal strength as governed by steel strength – HIS-RN insert	N _{sa}	kN (lb)	36.0 (8,100)	75.6 (16,990)	118.4 (26,610)	179.3 (40,300)	166.3 (37,395)
	Strength reduction factor Φ for tension ²	Φ	–	0.65				
	Strength reduction factor Φ for shear ²	Φ	–	0.60				

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official. Nuts and washers must be appropriate for the rod strength
- For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.

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Table 17 — Concrete Breakout Design Information for Metric Hilti HIS-N and HIS-RN Inserts¹

Design Information	Symbol	Units	Nominal Bolt/Cap Screw Diameter (mm)				
			8	10	12	16	20
Effective embedment depth	h_{ef}	mm (in.)	90 (3.5)	110 (4.3)	125 (4.9)	170 (6.7)	205 (8.1)
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	SI (in.-lb)	10 (24)				
Min. anchor spacing ³	s_{min}	mm (in.)	63 (2.5)	83 (3.25)	102 (4.0)	127 (5.0)	140 (5.5)
Min. edge distance ³	c_{min}	mm (in.)	63 (2.5)	83 (3.25)	102 (4.0)	127 (5.0)	140 (5.5)
Minimum member thickness	h_{min}	mm (in.)	120 (4.7)	150 (5.9)	170 (6.7)	230 (9.1)	270 (10.6)
Critical edge distance – splitting (for uncracked concrete)	c_{ac}	–	See Section 3.2.6.3.10.				
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	–	0.65				
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	–	0.70				

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions in Figure 5.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5.

3 For installations with 1-3/4 inch edge distance, refer to Section 3.2.6.3.9 for spacing and maximum torque requirements.

Table 18 — Bond Strength Design Information for Metric Hilti HIS-N and HIS-RN Inserts in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information			Symbol	Units	Nominal Rod Diameter (mm)				
					8	10	12	16	20
Effective embedment depth			h_{ef}	mm (in.)	90 (3.5)	110 (4.3)	125 (4.9)	170 (6.7)	205 (8.1)
HIS insert O.D.			D	mm (in.)	12.5 (0.49)	16.5 (0.65)	20.5 (0.81)	25.4 (1.00)	27.6 (1.09)
Temperature range ²	A	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	10.8 (1,565)	10.8 (1,565)	9.9 (1,440)	8.7 (1,255)	8.1 (1,170)
	B	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	8.7 (1,270)	8.7 (1,270)	8.1 (1,170)	7.0 (1,020)	6.5 (950)
	C	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	5.1 (735)	5.1 (735)	4.7 (675)	4.1 (590)	3.8 (550)
Permissible installation conditions	Dry concrete & Water-saturated concrete		Anchor Category	–	1				2
			Φ_d & Φ_{ws}	–	0.65				0.55

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Bond strength values correspond to concrete compressive strength range 2,500 psi \leq $f'_c \leq$ 4,500 psi. For 4,500 psi $< f'_c \leq$ 6,500 psi, tabulated characteristic bond strengths may be increased by 6 percent. For 6,500 psi $< f'_c \leq$ 8,000 psi, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).

Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).

Temperature range C: Maximum short term temperature = 248°F (120°C), maximum 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.

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Table 19 — Steel Design Information for Imperial Reinforcing Bars¹

Design Information		Symbol	Units	Bar Size							
				No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
Nominal bar diameter		D	in. (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	7/8 (22.2)	1 (25.4)	1-1/8 (28.6)	1-1/4 (31.8)
Bar effective cross-sectional area		A _{se}	in. ² (mm ²)	0.11 (71)	0.2 (129)	0.31 (200)	0.44 (284)	0.6 (387)	0.79 (510)	1.0 (645)	1.27 (819)
ASTM A 615 Gr. 40	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	36,000 (160.1)	47,400 (210.9)	60,000 (266.9)	76,200 (339.0)
		V _{sa}	lb (kN)	3,960 (17.6)	7,200 (32.0)	11,160 (49.6)	15,840 (70.5)	21,600 (96.1)	28,440 (126.5)	36,000 (160.1)	45,720 (203.4)
	Strength reduction factor Φ for tension ²	Φ	–	0.65							
	Strength reduction factor Φ for shear ²	Φ	–	0.60							
ASTM A 615 Gr. 60	Nominal strength as governed by steel strength	N _{sa}	lb (kN)	9,900 (44.0)	18,000 (80.1)	27,900 (124.1)	39,600 (176.2)	54,000 (240.2)	71,100 (316.3)	90,000 (400.4)	114,300 (508.5)
		V _{sa}	lb (kN)	5,940 (26.4)	10,800 (48.0)	16,740 (74.5)	23,760 (105.7)	32,400 (144.1)	42,660 (189.8)	54,000 (240.2)	68,580 (305.1)
	Strength reduction factor Φ for tension ²	Φ	–	0.65							
	Strength reduction factor Φ for shear ²	Φ	–	0.60							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Values provided for common rebar material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official.
- For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.

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Table 20 — Concrete Breakout Design Information for Fractional Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information	Symbol	Units	Bar Size							
			No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	in-lb (SI)	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)	27 (11.3)	30 (12.6)
Min. bar spacing ⁴	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)
Min. edge distance ⁴	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 member thickness	h_{min}	in. (mm)	$h_{ef} + 1\text{''}^{-1/4}$ ($h_{ef} + 30$)		$h_{ef} + 2d_0^{(3)}$					
Critical edge distance – splitting (for uncracked concrete)	c_{ac}	–	See Section 3.2.6.3.10.							
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	–	0.65							
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	–	0.70							

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions in Figure 5.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5.

3 d_0 = drill bit diameter.

4 For installations with 1-3/4 inch edge distance, refer to Section 3.2.6.3.9 for spacing and maximum torque requirements.

Table 21 — Bond Strength Design Information for Fractional Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information			Symbol	Units	Bar Size								
					No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	
Temperature range ²	A	Characteristic bond strength	$\tau_{k,uncr}$	psi (MPa)	1,290								
					(8.9)								
	B	Characteristic bond strength	$\tau_{k,uncr}$	psi (MPa)	1,045								
					(7.2)								
	C	Characteristic bond strength	$\tau_{k,uncr}$	psi (MPa)	605								
					(4.2)								
Minimum anchor embedment depth			$h_{ef,min}$	in. (mm)	2-3/8	2-3/4	3-1/8	3-1/2	3-1/2	4	4-1/2	5	
					(60)	(70)	(80)	(89)	(89)	(102)	(114)	(127)	
Maximum anchor embedment depth			$h_{ef,max}$	in. (mm)	7-1/2	10	12-1/2	15	17-1/2	20	22-1/2	25	
					(191)	(254)	(318)	(381)	(445)	(508)	(572)	(635)	
Permissible installation conditions	Dry concrete & Water-saturated concrete		Anchor Category	–	1								2
			Φ_d & Φ_{ws}	–	0.65								0.55

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Bond strength values correspond to concrete compressive strength range 2,500 psi $\leq f'c \leq$ 4,500 psi. For 4,500 psi $< f'c \leq$ 6,500 psi, tabulated characteristic bond strengths may be increased by 6 percent. For 6,500 psi $< f'c \leq$ 8,000 psi, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).

Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).

Temperature range C: Maximum short term temperature = 248°F (120°C), maximum 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.

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Table 22 — Steel Design Information for EU Metric Reinforcing Bars¹

Design Information		Symbol	Units	Bar Size								
				8	10	12	14	16	20	25	28	32
Nominal bar diameter		D	mm (in.)	8.0 (0.315)	10.0 (0.394)	12.0 (0.472)	14.0 (0.551)	16.0 (0.630)	20.0 (0.787)	25.0 (0.984)	28.0 (1.102)	32.0 (1.260)
Bar effective cross-sectional area		A _{se}	mm ² (in. ²)	50.3 (0.078)	78.5 (0.122)	113.1 (0.175)	153.9 (0.239)	201.1 (0.312)	314.2 (0.487)	490.9 (0.761)	615.8 (0.954)	804.2 (1.247)
DIN 488 BSt 550/500	Nominal strength as governed by steel strength	N _{sa}	kN (lb)	27.6 (6,215)	43.2 (9,710)	62.2 (13,985)	84.7 (19,035)	110.6 (24,860)	172.8 (38,845)	270.0 (60,695)	338.7 (76,135)	442.3 (99,440)
		V _{sa}	kN (lb)	16.6 (3,730)	25.9 (5,830)	37.3 (8,390)	50.8 (11,420)	66.4 (14,915)	103.7 (23,310)	162.0 (36,415)	203.2 (45,680)	265.4 (59,665)
	Strength reduction factor Φ for tension ²	Φ	–	0.65								
	Strength reduction factor Φ for shear ²	Φ	–	0.60								

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- Values provided for common rebar material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official.
- For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.

Table 23 — Concrete Breakout Design Information for EU Metric Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit¹

Design Information	Symbol	Units	Bar Size								
			8	10	12	14	16	20	25	28	32
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	SI (in-lb)	10 (24)						12.6 (30)		
Min. bar spacing ⁴	s_{min}	mm (in.)	40 (1.6)	50 (2)	60 (2.4)	70 (2.8)	80 (3.1)	100 (3.9)	125 (4.9)	140 (5.5)	160 (6.3)
Min. edge distance ⁴	c_{min}	mm (in.)	40 (1.6)	50 (2)	60 (2.4)	70 (2.8)	80 (3.1)	100 (3.9)	125 (4.9)	140 (5.5)	160 (6.3)
Minimum member thickness	h_{min}	mm (in.)	$h_{ef} + 30$ ($h_{ef} + 1-1/4$)		$h_{ef} + 2d_0^{(3)}$						
Critical edge distance – splitting (for uncracked concrete)	c_{ac}	–	See Section 3.2.6.3.10.								
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	–	0.65								
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	–	0.70								

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

- For additional setting information, see installation instructions in Figure 5.
- Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5.
- d₀ = drill bit diameter.
- For installations with 1-3/4 inch edge distance, refer to Section 3.2.6.3.9 for spacing and maximum torque requirements.

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

Table 24 — Bond Strength Design Information for EU Metric Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit¹



Design Information			Symbol	Units	Bar Size								
					8	10	12	14	16	20	25	28	32
Temperature range ²	A	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	8.9 (1,290)								
	B	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	7.2 (1,045)								
	C	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	4.2 (605)								
Minimum anchor embedment depth			$h_{ef,min}$	mm (in.)	60 (2.4)	60 (2.4)	70 (2.8)	75 (3.0)	80 (3.1)	90 (3.5)	100 (3.9)	112 (4.4)	128 (5.0)
Maximum anchor embedment depth			$h_{ef,max}$	mm (in.)	160 (6.3)	200 (7.9)	240 (9.4)	320 (12.6)	400 (15.7)	440 (17.3)	500 (19.7)	560 (22.0)	635 (25)
Permissible installation conditions	Dry concrete & Water-saturated concrete		Anchor Category	–	1						2		
			Φ_d & Φ_{ws}	–	0.65						0.55		

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Bond strength values correspond to concrete compressive strength range 2,500 psi ≤ f'c ≤ 4,500 psi. For 4,500 psi < f'c ≤ 6,500 psi, tabulated characteristic bond strengths may be increased by 6 percent. For 6,500 psi < f'c ≤ 8,000 psi, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).

Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).

Temperature range C: Maximum short term temperature = 248°F (120°C), maximum 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 25 — Steel Design Information for Canadian Metric Reinforcing Bars¹



Design Information			Symbol	Units	Bar Size				
					10 M	15 M	20 M	25 M	30 M
Nominal bar diameter			d	mm (in.)	11.3 (0.445)	16.0 (0.630)	19.5 (0.768)	25.2 (0.992)	29.9 (1.177)
Bar effective cross-sectional area			A_{se}	mm ² (in. ²)	100.3 (0.155)	201.1 (0.312)	298.6 (0.463)	498.8 (0.773)	702.2 (1.088)
G30CSA	Nominal strength as governed by steel strength		N_{sa}	kN (lb)	54.2 (12,175)	108.6 (24,410)	161.3 (36,255)	269.3 (60,550)	379.2 (85,240)
			V_{sa}	kN (lb)	32.5 (7,305)	65.1 (14,645)	96.8 (21,755)	161.6 (36,330)	227.5 (51,145)
	Strength reduction factor Φ for tension ²		Φ	-	0.65				
	Strength reduction factor Φ for shear ²		Φ	-	0.60				

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Values provided for common rebar material types based on published strengths and calculated in accordance with ACI 318 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible, subject to the approval of the code official.

2 For use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5. Values correspond to a brittle steel element.

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Table 26 — Concrete Breakout Design Information for Canadian Metric Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit¹



Design Information	Symbol	Units	Bar Size				
			10 M	15 M	20 M	25 M	30 M
Effectiveness factor for uncracked concrete	k _{c,uncr}	SI (in-lb)	10 (24)	10 (24)	10 (24)	11.3 (27)	12.6 (30)
Min. bar spacing ⁴	s _{min}	mm (in.)	57 (2.2)	80 (3.1)	98 (3.8)	126 (5.0)	150 (5.9)
Min. edge distance ⁴	c _{min}	mm (in.)	57 (2.2)	80 (3.1)	98 (3.8)	126 (5.0)	150 (5.9)
Minimum member thickness	h _{min}	mm (in.)	h _{ef} + 30 (h _{ef} + 1-1/4)		h _{ef} + 2d ₀ ⁽³⁾		
Critical edge distance – splitting (for uncracked concrete)	c _{ac}	–	See Section 3.2.6.3.10.				
Strength reduction factor for tension, concrete failure modes, Condition B ²	Φ	–	0.65				
Strength reduction factor for shear, concrete failure modes, Condition B ²	Φ	–	0.70				

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 For additional setting information, see installation instructions in Figure 5.

2 Values provided for post-installed anchors with category as determined from ACI 355.2 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D.4.4, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 as set forth in ACI 318 D.4.4. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5.

3 d_0 = drill bit diameter.

4 For installations with 1-3/4 inch edge distance, refer to Section 3.2.6.3.9 for spacing and maximum torque requirements.

Table 27 — Bond Strength Design Information for Canadian Metric Reinforcing Bars in Holes Drilled with a Hammer Drill and Carbide Bit¹



Design Information			Symbol	Units	Bar Size				
					10 M	15 M	20 M	25 M	30 M
Temperature range ²	A	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	8.9 (1,290)				
	B	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	7.2 (1,045)				
	C	Characteristic bond strength	$\tau_{k,uncr}$	MPa (psi)	4.2 (605)				
Minimum anchor embedment depth			$h_{ef,min}$	mm (in.)	60 (2.4)	80 (3.1)	90 (3.5)	101 (4.0)	120 (4.7)
Maximum anchor embedment depth			$h_{ef,max}$	mm (in.)	226 (8.9)	320 (12.6)	390 (15.4)	504 (19.8)	598 (23.5)
Permissible installation conditions	Dry concrete & Water-saturated concrete		Anchor Category	–	1				2
			Φ_d & Φ_{ws}	–	0.65				0.55

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa

For pound-inch units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi

1 Bond strength values correspond to concrete compressive strength range 2,500 psi $\leq f'_c \leq$ 4,500 psi. For 4,500 psi $< f'_c \leq$ 6,500 psi, tabulated characteristic bond strengths may be increased by 6 percent. For 6,500 psi $< f'_c \leq$ 8,000 psi, tabulated characteristic bond strengths may be increased by 10 percent.

2 Temperature range A: Maximum short term temperature = 104°F (40°C), maximum long term temperature = 75°F (24°C).

Temperature range B: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C).

Temperature range C: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 162°F (72°C).

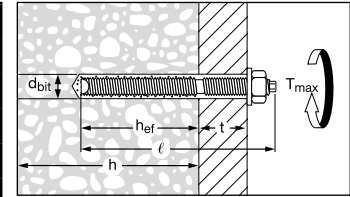
Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

3.2.6.4 Technical Data

HIT-HY 150 MAX Installation Specification Table for HAS Rods

HAS Rod Size		in.	3/8	1/2	5/8	3/4	7/8	1	1-1/4
Details		(mm)	(9.5)	(12.7)	(15.9)	(19.1)	(22.2)	(25.4)	(31.8)
d_{bit} bit diameter ¹		in.	7/16	9/16	3/4	7/8	1	1-1/8	1-3/8
$h_{ef} = h_{nom}$ standard embedment ²		in.	3-3/8	4-1/2	5-5/8	6-3/4	7-7/8	9	11-1/4
		(mm)	(86)	(114)	(143)	(172)	(200)	(229)	(286)
T_{max} max. tightening torque	All HILTI	$h_{ef} \geq h_{nom}$	ft-lb (Nm)	18 (24)	30 (41)	75 (102)	150 (203)	235 (319)	400 (540)
	Threaded Rods	$h_{ef} < h_{nom}$	ft-lb (Nm)	15 (20)	20 (27)	50 (68)	105 (142)	165 (224)	280 (375)
h minimum base material thickness ³		$h_{ef} = h_{nom}$	in. (mm)	5-3/8 (136)	6-1/2 (165)	7-5/8 (195)	8-3/4 (222)	9-7/8 (250)	11-1/4 (286)
		$h_{ef} \neq h_{nom}$	in. (mm)	1.0 $h_{ef}+$ 2 (51)	1.0 $h_{ef}+$ 2 (51)	1.0 $h_{ef}+$ 2 (51)	1.0 $h_{ef}+$ 2 (51)	1.0 $h_{ef}+$ 2 (51)	1.0 $h_{ef}+$ 2-1/4 (57)



1 Use Hilti matched tolerance carbide tipped drill bits.

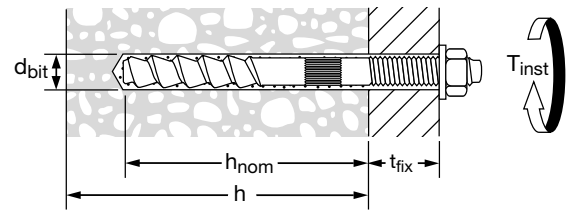
2 Data available for varying embedment depths, see load tables.

3 Minimum base material thickness given to minimize back side blowout during drilling process. Ability of base material to withstand loads applied (e.g. bending of concrete slab) should be determined by design engineer.

HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

HIT-HY 150 MAX Installation Specification Table for HIT-TZ Rods¹

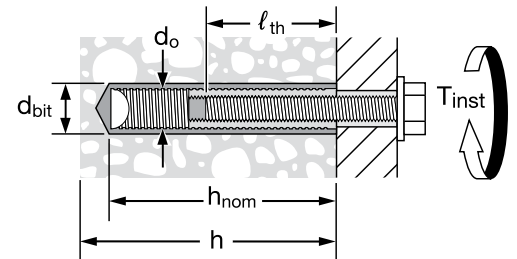
HIT-TZ Rod	in.	3/8	1/2	5/8	3/4
Details	(mm)	(9.5)	(12.7)	(15.9)	(19.1)
d_{bit} bit diameter	in.	7/16	9/16	11/16	13/16
h_{nom} standard depth of embedment ¹	in.	2-7/8	3-1/2	4	5-1/4
	(mm)	(73)	(89)	(102)	(133)
ℓ length of anchor	in.	4-1/2	5-11/16	7-1/16	10-1/2
	(mm)	(114.3)	(144.5)	(179.4)	(267)
T_{inst} installation torque	ft-lb	18	30	75	150
	(Nm)	(24)	(40)	(100)	(200)
h min. base material thickness	in.	3-3/4	5-1/4	6	7-7/8
	(mm)	(95)	(133)	(152)	(200)
t_{fix} max. thickness fastened	in.	1	1-1/2	2-1/4	4-1/16
	(mm)	(25.4)	(38.1)	(57.2)	(57.2)



1 For uncleaned holes in floor applications, add 3/8" (10 mm) to drilled hole depth. (typical)

HIT-HY 150 MAX Installation Specification Table for HIS Inserts

HIS Insert	in.	3/8	1/2	5/8	3/4
Details	(mm)	(9.5)	(12.7)	(15.9)	(19.1)
d_{bit} bit diameter	in.	11/16	7/8	1-1/8	1-1/4
d_o outside diameter	in.	0.65	0.81	1	1.09
h_{nom} standard depth of embedment	in.	4-3/8	5	6-5/8	8-1/4
	(mm)	(110)	(127)	(168)	(210)
ℓ_{th} usable thread length	in.	1	1-3/16	1-1/2	2
	(mm)	(25)	(30)	(38)	(51)
T_{inst} installation torque	ft-lb	18	35	80	160
	(Nm)	(24)	(47)	(108)	(217)
h min. base material thickness	in.	6-3/8	7-1/2	10	12-3/8
	(mm)	(162)	(191)	(254)	(314)



HIT-HY 150 MAX Installation Specification Table for Rebar in Concrete

Rebar Size	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
Details								
d_{bit} bit diameter ^{1,2}	in.	1/2	5/8	3/4	7/8	1	1-1/8	1-3/8

1 Rebar diameters may vary. Use smallest drill bit which will accommodate rebar.
2 Use Hilti matched tolerance carbide tipped drill bits.

HIT-HY 150 MAX Installation Specification Table for Metric Rebar in Concrete (Canada Only)



Rebar Size	10M	15M	20M	25M	30M	35M
Details						
d_{bit} bit diameter ^{1,2}	14 mm	3/4"	24mm	1-1/8"	37mm	1-9/16"

1 Rebar diameters may vary. Use smallest drill bit which will accommodate rebar.
2 Use Hilti matched tolerance carbide tipped drill bits.

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right)^{5/3} + \left(\frac{V_d}{V_{rec}} \right)^{5/3} \leq 1.0 \text{ (Ref. Section 3.1.8.3)}$$

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

HIT-HY 150 MAX Allowable and Ultimate Bond/Concrete Capacity for HAS Rods in Normal Weight Concrete^{1,2}

Anchor Diameter in (mm)	Embedment Depth in (mm)	HIT-HY 150 MAX Allowable Bond/Concrete Capacity				HIT-HY 150 MAX Ultimate Bond/Concrete Capacity			
		Tensile		Shear		Tensile		Shear	
		$f'_c = 2000$ psi (13.8 MPa)	$f'_c = 4000$ psi (27.6 MPa)	$f'_c = 2000$ psi (13.8 MPa)	$f'_c = 4000$ psi (27.6 MPa)	$f'_c = 2000$ psi (13.8 MPa)	$f'_c = 4000$ psi (27.6 MPa)	$f'_c = 2000$ psi (13.8 MPa)	$f'_c = 4000$ psi (27.6 MPa)
		lb (kN)	lb (kN)	lb (kN)	lb (kN)	lb (kN)	lb (kN)	lb (kN)	lb (kN)
3/8 (9.5)	1 3/4 (44)	725 (3.2)	1155 (5.1)	1675 (7.5)	2360 (10.5)	2900 (12.9)	4620 (20.6)	5020 (22.3)	7080 (31.5)
	3 3/8 (86)	2110 (9.4)	3055 (13.6)	3155 (14.0)	4460 (19.8)	8440 (37.5)	12220 (54.4)	9460 (42.1)	13380 (59.5)
	4 1/2 (114)	2150 (9.6)	3055 (13.6)	4855 (21.6)	6860 (30.5)	8600 (38.3)	12220 (54.4)	14560 (64.8)	20580 (91.5)
1/2 (12.7)	2 1/4 (57)	1385 (6.2)	2090 (9.3)	2750 (12.2)	3890 (17.3)	5540 (24.6)	8360 (37.2)	8240 (36.7)	11660 (51.9)
	4 1/2 (114)	4000 (17.8)	4980 (22.2)	5610 (25.0)	7935 (35.3)	16000 (71.2)	19920 (88.6)	16820 (74.8)	23800 (105.9)
	6 (152)	4705 (20.9)	4980 (22.2)	8635 (38.4)	12210 (54.3)	18820 (83.7)	19920 (88.6)	25900 (115.2)	36620 (162.9)
5/8 (15.9)	2 7/8 (73)	1940 (8.6)	2730 (12.1)	4095 (18.2)	5790 (25.8)	7760 (34.5)	10920 (48.6)	12280 (54.6)	17360 (77.2)
	5 5/8 (143)	5955 (26.5)	8410 (37.4)	8760 (39.0)	12395 (55.1)	23820 (106.0)	33640 (149.6)	26280 (116.9)	37180 (165.4)
	7 1/2 (190)	7320 (32.6)	8410 (37.4)	13495 (60.0)	19080 (84.9)	29280 (130.2)	33640 (149.6)	40480 (180.1)	57240 (254.6)
3/4 (19.1)	3 3/8 (86)	2625 (11.7)	4295 (19.1)	6110 (27.2)	8635 (38.4)	10500 (46.7)	17180 (76.4)	18320 (81.5)	25900 (115.2)
	6 3/4 (172)	6460 (28.7)	9985 (44.4)	12615 (56.1)	17840 (79.4)	25840 (114.9)	39940 (177.7)	37840 (168.3)	53520 (238.1)
	9 (229)	11175 (49.7)	11175 (49.7)	19430 (86.4)	27470 (122.2)	44700 (198.8)	44700 (198.8)	58280 (259.2)	82400 (366.5)
7/8 (22.2)	4 (101)	3375 (15.0)	5300 (23.6)	7670 (34.1)	10840 (48.2)	13500 (60.1)	21200 (94.3)	23000 (102.3)	32520 (144.7)
	7 7/8 (200)	9910 (44.1)	14815 (65.9)	17175 (76.4)	24290 (108.0)	39640 (176.3)	59260 (263.6)	51520 (229.2)	72860 (324.1)
	10 1/2 (267)	14385 (64.0)	15345 (68.3)	26440 (117.6)	37390 (166.3)	57540 (255.9)	61380 (273.0)	79320 (352.8)	112160 (498.9)
1 (25.4)	4 1/2 (114)	5210 (23.2)	6570 (29.2)	9990 (44.4)	14120 (62.8)	20840 (92.7)	26280 (116.9)	29960 (133.3)	42360 (188.4)
	9 (229)	11595 (51.6)	17475 (77.7)	22435 (99.8)	31720 (141.1)	46380 (206.3)	69900 (310.9)	67300 (299.4)	95160 (423.3)
	12 (305)	17340 (77.1)	18685 (83.1)	34535 (153.6)	48830 (217.2)	69360 (308.5)	74740 (332.5)	103600 (460.8)	146480 (651.6)
1-1/4 (31.8)	5 5/8 (143)	6985 (31.1)	9935 (44.2)	13180 (58.6)	18640 (82.9)	27940 (124.3)	39740 (176.8)	39540 (175.9)	55920 (248.7)
	11 1/4 (286)	18345 (81.6)	30085 (133.8)	35050 (155.9)	49570 (220.5)	73380 (326.4)	120340 (535.3)	105140 (467.7)	148700 (661.4)
	15 (381)	25575 (113.8)	30085 (133.8)	53960 (240.0)	76300 (339.4)	102300 (455.1)	120340 (535.3)	161880 (720.1)	228900 (1018.2)

1 Influence factors for spacing and edge distance are applied to allowable concrete/bond values above, and then compared to the steel value. The lesser of the values is to be used for the design.

2 For $h_{ef} \geq h_{nom}$ average ultimate concrete shear capacity based on Strength Design method. For $h_{ef} < h_{nom}$ average ultimate concrete shear values based on testing.

HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

Allowable Steel Strength for HAS Rods, HIT-TZ (ASTM A 510) and HIT-RTZ Rods¹

Anchor Diameter in (mm)	HAS-E Standard ISO 898 Class 5.8		HAS Super ASTM A 193 B7		HAS SS AISI 304/316 SS		HIT-TZ (ASTM A 510 & HIT-RTZ Rods)	
	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	2640 (11.7)	1360 (6.0)	4555 (20.3)	2345 (10.4)	3645 (16.2)	1875 (8.3)	3170 (14.1)	1635 (7.3)
1/2 (12.7)	4700 (20.9)	2420 (10.8)	8100 (36.0)	4170 (18.5)	6480 (28.8)	3335 (14.8)	5636 (25.1)	2900 (12.9)
5/8 (15.9)	7340 (32.6)	3780 (16.8)	12655 (56.3)	6520 (29.0)	10125 (45.0)	5215 (23.2)	8805 (39.2)	4535 (20.2)
3/4 (19.1)	10570 (47.0)	5445 (24.2)	18225 (81.1)	9390 (41.8)	12390 (55.1)	6385 (28.4)	12685 (56.4)	6535 (29.1)
7/8 (22.2)	14385 (64.0)	7410 (33.0)	24805 (110.3)	12780 (56.9)	16865 (75.0)	8690 (38.7)	-	-
1 (25.4)	18790 (83.6)	9680 (43.1)	32400 (144.1)	16690 (74.2)	22030 (98.0)	11350 (50.5)	-	-
1-1/4 (31.8)	29360 (130.6)	15125 (67.3)	50620 (225.2)	26080 (116.0)	34425 (153.1)	17735 (78.9)	-	-

¹ Steel strength as defined in AISC Manual of Steel Construction (ASD):

Tensile = $0.33 \times F_u \times \text{Nominal Area}$

Shear = $0.17 \times F_u \times \text{Nominal Area}$

Ultimate Steel Strength for HAS Rods, HIT-TZ (ASTM A 510) and HIT-RTZ Rods¹

Anchor Diameter in (mm)	HAS-E Standard ISO 898 Class 5.8			HAS Super ASTM A 193 B7			HAS SS AISI 304/316 SS			HIT-TZ (ASTM A 510) & HIT-RTZ Rods		
	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	4495 (20.0)	6005 (26.7)	3605 (16.0)	8135 (36.2)	10350 (46.0)	6210 (27.6)	5035 (22.4)	8280 (36.8)	4970 (22.1)	5690 (25.3)	7210 (32.1)	4325 (19.2)
1/2 (12.7)	8230 (36.6)	10675 (47.5)	6405 (28.5)	14900 (66.3)	18405 (81.9)	11040 (49.1)	9225 (41.0)	14720 (65.5)	8835 (39.3)	10105 (44.9)	12810 (57.0)	7685 (34.2)
5/8 (15.9)	13110 (58.3)	16680 (75.1)	10010 (44.5)	23730 (105.6)	28760 (127.9)	17260 (76.8)	14690 (65.3)	23010 (102.4)	13805 (61.4)	15795 (70.3)	20020 (89.1)	12010 (53.4)
3/4 (19.1)	19400 (86.3)	24020 (106.8)	14415 (64.1)	35120 (156.2)	41420 (184.2)	24850 (110.5)	15050 (66.9)	28165 (125.3)	16800 (74.7)	22750 (101.2)	28825 (128.2)	17295 (76.9)
7/8 (22.2)	26780 (119.1)	32695 (145.4)	19620 (87.3)	48480 (215.6)	56370 (250.7)	33825 (150.5)	20775 (92.3)	38335 (170.5)	23000 (102.3)	-	-	-
1 (25.4)	35130 (156.3)	42705 (190.0)	25625 (114.0)	63600 (282.9)	73630 (327.5)	44180 (196.5)	27255 (121.2)	50070 (222.7)	30040 (133.6)	-	-	-
1-1/4 (31.8)	56210 (250.0)	66730 (296.8)	40035 (178.1)	101755 (452.6)	115050 (511.8)	69030 (307.1)	43610 (194.0)	78235 (348.0)	46940 (208.8)	-	-	-

¹ Steel strength as defined in AISC Manual of Steel Construction 2nd Ed. (LRFD):

Yield = $F_y \times \text{Tensile Stress Area}$

Tensile = $0.75 \times F_u \times \text{Nominal Area}$

Shear = $0.45 \times F_u \times \text{Nominal Area}$

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

HIT-HY 150 MAX Allowable and Ultimate Bond/Concrete Capacity for HIT-TZ and HIT-RTZ Rods in Normal Weight Concrete¹

Anchor Diameter in (mm)	Embedment Depth in (mm)	HIT-HY 150 MAX Allowable Bond/Concrete Capacity				HIT-HY 150 MAX Ultimate Bond/Concrete Capacity			
		Tensile		Shear		Tensile		Shear	
		$f'_c = 2000$ psi (13.8 MPa)	$f'_c = 4000$ psi (27.6 MPa)	$f'_c = 2000$ psi (13.8 MPa)	$f'_c = 4000$ psi (27.6 MPa)	$f'_c = 2000$ psi (13.8 MPa)	$f'_c = 4000$ psi (27.6 MPa)	$f'_c = 2000$ psi (13.8 MPa)	$f'_c = 4000$ psi (27.6 MPa)
		lb (kN)	lb (kN)	lb (kN)	lb (kN)	lb (kN)	lb (kN)	lb (kN)	lb (kN)
3/8 (9.5)	2-7/8 (73)	1800 (8.0)	2255 (10.0)	1710 (7.6)	2415 (10.7)	7200 (32.0)	9020 (40.1)	6840 (30.4)	9660 (43.0)
1/2 (12.7)	3-1/2 (89)	2720 (12.1)	3020 (13.4)	2600 (11.6)	3680 (16.4)	10880 (48.4)	12080 (53.7)	10400 (46.3)	14720 (65.5)
5/8 (15.9)	4 (102)	3850 (17.1)	5750 (25.6)	3490 (15.5)	4935 (22.0)	15400 (68.5)	23000 (102.3)	13960 (62.1)	19740 (87.8)
3/4 (19.1)	5-1/4 (133)	5405 (24.0)	7275 (32.4)	5850 (26.0)	8275 (36.8)	21620 (96.2)	29100 (129.4)	23400 (104.1)	33100 (147.2)

¹ Influence factors for spacing and edge distance are applied to allowable concrete/bond values above, and then compared to the steel value. The lesser of the values is to be used for the design.

HIT-HY 150 MAX Allowable Bond/Concrete Capacity and Steel Strength for HIS Carbon Steel and HIS-R Stainless Steel Internally Threaded Inserts

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	HIT-HY 150 MAX Allowable Bond/Concrete Capacity ²		Allowable Bolt Strength ^{1,2}			
		Tensile $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	Shear $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	ASTM A 325 Carbon Steel		ASTM F 593 Stainless Steel	
				Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	4-3/8 (110)	2875 (12.8)	1605 (7.1)	4370 (19.4)	2250 (10.0)	3645 (16.2)	1875 (8.3)
1/2 (12.7)	5 (127)	4890 (21.8)	3040 (13.5)	7775 (34.6)	4005 (17.8)	6480 (28.8)	3335 (14.8)
5/8 (15.9)	6-5/8 (168)	7430 (33.1)	4575 (20.4)	12150 (54.0)	6260 (27.8)	10125 (45.0)	5215 (23.2)
3/4 (19.1)	8-1/4 (210)	9920 (44.1)	6305 (28.0)	17495 (77.8)	9010 (40.1)	12395 (55.1)	6385 (28.4)

HIT-HY 150 MAX Ultimate Bond/Concrete Capacity and Steel Strength for HIS Carbon Steel and HIS-R Stainless Steel Internally Threaded Inserts

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	HIT-HY 150 MAX Ultimate Bond/Concrete Capacity ²		Ultimate Bolt Strength ^{1,2}			
		Tensile $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	Shear $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	ASTM A 325 Carbon Steel		ASTM F 593 Stainless Steel	
				Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	4-3/8 (110)	11495 (51.1)	6425 (28.6)	9935 (44.2)	5960 (26.5)	8280 (36.8)	4970 (22.1)
1/2 (12.7)	5 (127)	19570 (87.1)	12170 (54.1)	17665 (78.6)	10600 (47.2)	14720 (65.5)	8835 (39.3)
5/8 (15.9)	6-5/8 (168)	29720 (132.2)	18310 (81.4)	27610 (122.8)	16565 (73.7)	23010 (102.4)	13805 (61.4)
3/4 (19.1)	8-1/4 (210)	39675 (176.5)	25215 (112.2)	39760 (176.9)	23855 (106.1)	28165 (125.3)	16900 (75.2)

¹ Steel values in accordance with AISC

ASTM A 325 bolts: $F_u = 92$ ksi, $F_y = 120$ ksi
ASTM F 593 (AISI 304/316): $F_y = 65$ ksi, $F_u = 100$ ksi for 3/8" thru 5/8"
 $F_y = 45$ ksi, $F_u = 85$ ksi for 3/4"

Ultimate Load Values

Tension = $0.75 \times F_u \times A_{nom}$
Shear = $0.45 \times F_u \times A_{nom}$

Allowable Load Values

Tension = $0.33 \times F_u \times A_{nom}$
Shear = $0.17 \times F_u \times A_{nom}$

² Use lower value of either allowable bond/concrete capacity or steel strength.

HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

HIT-HY 150 MAX Allowable and Ultimate Bond/Concrete Capacity for HAS Rods Installed in Lightweight Concrete ≥ 3000 psi (20.7 MPa)^{1,2}

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Allowable Bond/Concrete Capacity lb (kN)		Ultimate Bond/Concrete Capacity lb (kN)	
		Tensile	Shear	Tensile	Shear
3/8 (9.5)	1-3/4 (44)	855 (3.8)	1510 (6.7)	3420 (15.2)	6040 (26.9)
	3-3/8 (86)	2210 (9.8)	1590 (7.1)	8840 (39.3)	6360 (28.3)
1/2 (12.7)	2-1/4 (57)	1515 (6.7)	2405 (10.7)	6060 (27.1)	9620 (42.8)
	4-1/2 (114)	3815 (17.0)	2440 (10.9)	15260 (67.9)	9760 (43.4)
5/8 (15.9)	2-7/8 (73)	2110 (9.4)	4755 (21.2)	8440 (37.5)	19020 (84.6)
	5-5/8 (143)	4655 (20.7)	4755 (21.2)	18620 (82.8)	19020 (84.6)
3/4 (19.1)	3-3/8 (86)	2560 (11.4)	6160 (27.4)	10240 (45.5)	24640 (109.6)
	6-3/4 (172)	6765 (30.1)	6160 (27.4)	27060 (120.4)	24640 (109.6)

1 Influence factors for spacing and edge distance are applied to allowable concrete/bond values above, and then compared to the allowable steel value. The lesser of these values is to be used for design.

2 All values based on holes drilled with carbide tipped bit.

HIT-HY 150 MAX Allowable Bond/Concrete Capacity for Sill Plate Applications

Allowable Loads for Attachment of Sill Plates to $f'_c = 2000$ psi Normal Weight Concrete with HIT-HY 150 MAX¹

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Edge Distance in. (mm)	Tension lb (kN)	Shear lb (kN)	
				Load to Edge	Load \perp toward Edge
1/2 (12.7)	4-1/2 (114)	1-3/4 (44.5)	1790 (8.0)	1555 (6.9)	555 (2.5)
		2-3/4 (69.9)	2240 (10.0)	1815 (8.1)	940 (4.2)
5/8 (15.9)	5-5/8 (143)	1-3/4 (44.5)	2275 (10.1)	2550 (11.3)	555 (2.5)
		2-3/4 (69.9)	2525 (11.2)	2670 (11.9)	940 (4.2)
	10 (254)	1-3/4 (44.5)	4410 (19.6)	2550 (11.3)	855 (3.8)
		2-3/4 (69.9)	5045 (22.4)	2670 (11.9)	975 (4.3)
3/4 (19.1)	6-3/4 (172)	1-3/4 (44.5)	2660 (11.8)	2620 (11.7)	910 (4.0)
		2-3/4 (69.9)	3150 (14.0)	3375 (15.0)	1105 (4.9)
7/8 (22.2)	7-7/8 (200)	1-3/4 (44.5)	3420 (15.2)	3980 (17.7)	1070 (4.8)
		2-3/4 (69.9)	4320 (19.2)	4320 (19.2)	1300 (5.8)
	15 (381)	1-3/4 (44.5)	7980 (35.5)	3980 (17.7)	1070 (4.8)
		2-3/4 (69.9)	8085 (36.0)	4320 (19.2)	1300 (5.8)

Allowable Loads for Attachment of Sill Plates to Top of Grout Filled Block Wall with HIT-HY 150 MAX¹

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Edge Distance in. (mm)	Tension lb (kN)	Shear lb (kN)	
				Load to Edge	Load \perp toward Edge
1/2 (12.7)	4-1/2 (114)	1-3/4 (44.5)	1095 (4.8)	815 (3.6)	295 (1.3)
5/8 (15.9)	5-5/8 (143)	1-3/4 (44.5)	1240 (5.5)	965 (4.3)	400 (1.8)

1 Loads are based on concrete or masonry failure. Steel strength must be checked separately. Values based on safety factor of 5.0.

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

HIT-HY 150 MAX Allowable Loads for Threaded Rods in Grout-Filled Concrete Masonry Units (ASTM C 90 Block)^{1,2,3,4}

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Distance from Edge in. (mm)	Tension ⁵ lb (kN)	Shear ⁵ lb (kN)
3/8 (9.5)	3-3/8 (86)	4 (102)	880 (3.9)	1135 (5.0)
		≥ 20 (508)	950 (4.2)	1135 (5.0)
1/2 (12.7)	4-1/2 (114)	4 (102)	1055 (4.7)	1745 (7.8)
		≥ 20 (508)	1265 (5.6)	1870 (8.3)
5/8 (15.9)	5-5/8 (143)	4 (102)	1370 (6.1)	2120 (9.4)
		≥ 20 (508)	1850 (8.2)	2590 (11.5)
3/4 (19.1)	6-3/4 (172)	4 (102)	1580 (7.0)	2205 (9.8)
		≥ 20 (508)	2440 (13.6)	2785 (12.4)

HIT-HY 150 MAX Ultimate Loads for Threaded Rods in Grout-Filled Concrete Masonry Units (ASTM C 90 Block)^{1,2,3,4}

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Distance from Edge in. (mm)	Tension ⁵ lb (kN)	Shear ⁵ lb (kN)
3/8 (9.5)	3-3/8 (86)	4 (102)	4400 (19.6)	5675 (25.2)
		≥ 20 (508)	4750 (21.1)	5675 (25.2)
1/2 (12.7)	4-1/2 (114)	4 (102)	5275 (23.5)	8725 (38.8)
		≥ 20 (508)	6325 (28.1)	9350 (41.6)
5/8 (15.9)	5-5/8 (143)	4 (102)	6850 (30.5)	10600 (47.2)
		≥ 20 (508)	9250 (41.1)	12950 (57.6)
3/4 (19.1)	6-3/4 (172)	4 (102)	7900 (35.1)	11025 (49.0)
		≥ 20 (508)	12200 (54.3)	13925 (61.9)

1 Values are for lightweight, medium weight or normal weight concrete masonry units conforming to ASTM C 90 with minimum 1500 psi grout conforming to ASTM C 476.

2 Embedment depth is measured from the outside face of the concrete masonry unit.

3 Anchors must be installed a minimum of 1 inch from any vertical mortar joint (see figure).

4 Values for edge distance between 4 inches and 20 inches can be calculated by linear interpolation.

5 Loads are based on the lesser of bond strength, steel strength or base material strength.

Anchor Spacing and Edge Distance Guidelines for Grout-Filled Block

Edge Distance for Shear and Tension:

Grout Filled, Normal Weight and Lightweight Block

c_e = 20 in. (508 mm) minimum from free edge

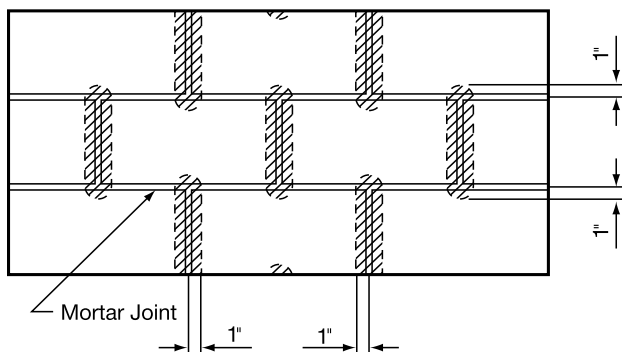
c_{min} = 4 in. (102 mm) minimum from free edge

Anchor Spacing for Shear and Tension:

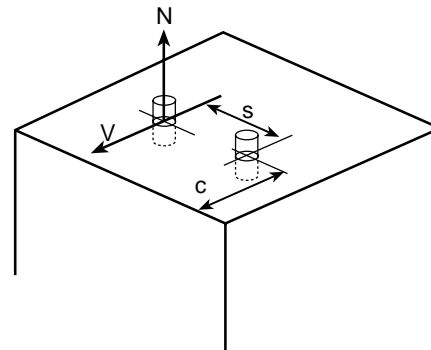
Grout Filled, Normal Weight and Lightweight Block

s_e = s_{min} = One (1) anchor per cell (max), and 8 in. (203mm) (min)

Installation in grout-filled concrete masonry unit



1 Anchor installation is allowed in all non-shaded areas.



HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

HIT-HY 150 MAX Ultimate Bond Capacity and Steel Strength for Rebar in Concrete

Nominal Rebar Size	Embedment Depth in. (mm)	Concrete Compressive Strength						Grade 60 Rebar	
		$f'_c = 2000$ psi (13.8 MPa)			$f'_c = 4000$ psi (27.6 MPa)				
		Ultimate Bond Strength lb (kN)	Embed. to Develop Yield Strength ¹ in. (mm)	Embed. to Develop Tensile Strength ¹ in. (mm)	Ultimate Bond Strength lb (kN)	Embed. to Develop Yield Strength ¹ in. (mm)	Embed. to Develop Tensile Strength ¹ in. (mm)	Yield Strength lb (kN)	Tensile Strength lb (kN)
#3	3-3/8 (86)	8100 (36.0)	3-3/8 (86)	5 (127)	8240 (36.7)	3-3/8 (86)	4 (102)	6600 (29.4)	9900 (44.0)
	4-1/2 (114)	8700 (38.7)			11380 (50.6)				
#4	4-1/2 (114)	13840 (61.6)	4-1/2 (114)	5-7/8 (149)	14840 (66.0)	4-1/2 (114)	5 3/8 (137)	12000 (53.4)	18000 (80.1)
	6 (152)	18800 (83.6)			20620 (91.7)				
#5	5-5/8 (143)	20200 (89.9)	5-5/8 (143)	7-3/8 (187)	25060 (111.5)	5-5/8 (143)	6 3/4 (172)	18600 (82.7)	27900 (124.1)
	7-1/2 (190)	28600 (127.2)			29900 (133.0)				
#6	6-3/4 (172)	27080 (120.5)	6-3/4 (172)	10 (254)	27080 (120.5)	6-3/4 (172)	8 1/2 (216)	26400 (117.4)	39600 (176.2)
	9 (229)	36680 (163.2)			43820 (194.9)				
#7	7-7/8 (200)	36200 (161.0)	7-7/8 (200)	11-5/8 (295)	40360 (179.5)	7-7/8 (200)	10 (254)	36000 (160.1)	54000 (240.2)
	10-1/2 (267)	49940 (222.1)			57760 (256.9)				
#8	9 (229)	45860 (204.0)	9-3/8 (238)	13-3/8 (340)	58860 (261.8)	9 (229)	11 1/2 (292)	47450 (211.1)	71100 (316.3)
	12 (305)	66680 (296.6)			73800 (328.3)				
#9	10-1/8 (257)	54660 (243.1)	10-3/4 (273)	15 (381)	68580 (305.1)	10-1/8 (257)	14 3/8 (365)	60000 (266.9)	90000 (400.3)
	13-1/2 (343)	88000 (391.4)			88000 (391.4)				
#10	11-1/4 (286)	68200 (303.4)	12-1/4 (311)	16-7/8 (429)	80520 (358.2)	11-1/4 (286)	15 (381)	76200 (339.0)	114300 (508.4)
	15 (381)	101720 (452.5)			115160 (512.3)				

1 Based on comparison of average ultimate adhesive bond values versus ultimate tensile strength of rebar. For more information, contact Hilti.

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

HIT-HY 150 MAX Bond Capacity and Steel Strength for Canadian Rebar in Concrete^{1,4,5}



Rebar Size	Embedment Depth (mm)	Concrete Compressive Strength ^{2,3,4}				Strength Properties of Metric Rebar ^{2,3}	
		$f'_c = 14 \text{ MPa}$		$f'_c = 28 \text{ MPa}$		$f_y = 400 \text{ MPa}$	
		Ultimate Bond (kN)	Allowable Bond (kN)	Ultimate Bond (kN)	Allowable Bond (kN)	Yield Strength (kN)	Tensile Strength (kN)
10M	85	36.0	9.0	36.7	9.2	40	60
	115	38.7	9.7	50.6	12.7		
15M	145	89.9	22.5	111.5	27.9	80	120
	190	127.2	31.8	133.0	33.3		
20M	170	120.5	30.1	120.5	30.1	120	180
	230	163.2	40.8	194.9	48.7		
25M	230	204.0	51.0	261.8	65.5	200	300
	305	296.6	74.2	328.3	82.1		
30M	260	243.1	60.8	305.1	76.3	280	420
	345	391.4	97.9	391.4	97.9		

1 For anchoring to grout filled block or bond beams, please refer to table for loads in grout filled concrete masonry units for HIT-HY 150 MAX.

2 Use lesser values of allowable bond strength or rebars steel strength.

3 Actual bond test data developed for imperial-sized rebar. Yield and ultimate rebar strengths are for metric sizes.

4 Test data developed for hammer drilled holes. For diamond drilled holes contact Hilti.

HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-HY 150 MAX

Load Adjustment Factors for 3/8" and 1/2" Diameter Anchors																									
Anchor Diameter		3/8" diameter												1/2" diameter											
Adjustment Factor		Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}		
Embedment Depth, in		1-3/4	3-3/8	4-1/2	1-3/4	3-3/8	4-1/2	1-3/4	3-3/8	4-1/2	1-3/4	3-3/8	4-1/2	2-1/4	4-1/2	6	2-1/4	4-1/2	6	2-1/4	4-1/2	6	2-1/4	4-1/2	6
Spacing (s)/Edge Distance (c), in.	7/8	0.75			0.60			0.17			0.45														
	1	0.76			0.63			0.20			0.47														
	1-1/8	0.78			0.66			0.23			0.49			0.75			0.60			0.17			0.45		
	1-11/16	0.83	0.75		0.79	0.60		0.36	0.17		0.58	0.45		0.80			0.70			0.27			0.52		
	2	0.86	0.77		0.86	0.64		0.44	0.22		0.63	0.48		0.82			0.76			0.33			0.56		
	2-1/4	0.88	0.78	0.75	0.91	0.67	0.60	0.50	0.26	0.17	0.67	0.51	0.45	0.84	0.75		0.80	0.60		0.38	0.17		0.59	0.45	
	2-1/2	0.91	0.79	0.76	0.97	0.70	0.62	0.56	0.30	0.20	0.70	0.54	0.47	0.86	0.76		0.84	0.62		0.42	0.20		0.62	0.47	
	2-5/8	0.92	0.80	0.77	1.00	0.71	0.63	0.59	0.32	0.22	0.72	0.55	0.48	0.87	0.77		0.87	0.63		0.45	0.22		0.63	0.48	
	3	0.95	0.82	0.78		0.76	0.67	0.67	0.39	0.26	0.78	0.59	0.51	0.90	0.78	0.75	0.93	0.67	0.60	0.52	0.26	0.17	0.68	0.51	0.45
	3-3/8	1.00	0.84	0.79		0.80	0.70	0.76	0.45	0.31	0.84	0.63	0.54	0.92	0.79	0.76	1.00	0.70	0.63	0.59	0.31	0.20	0.72	0.54	0.47
	4		0.87	0.82		0.87	0.76	0.91	0.55	0.39	0.94	0.70	0.59	0.97	0.82	0.78		0.76	0.67	0.70	0.39	0.26	0.80	0.59	0.51
	4-3/8		0.88	0.83		0.92	0.79	1.00	0.61	0.43	1.00	0.74	0.62	1.00	0.83	0.79		0.79	0.69	0.77	0.43	0.30	0.85	0.62	0.53
	5		0.91	0.85		0.99	0.84		0.71	0.51		0.81	0.67		0.85	0.81		0.84	0.73	0.88	0.51	0.35	0.92	0.67	0.57
	5-1/16		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68		0.86	0.81		0.85	0.74	0.90	0.52	0.36	0.93	0.68	0.58
	5-1/4		0.93	0.86			0.87		0.75	0.54		0.84	0.69		0.86	0.81		0.87	0.75	0.93	0.54	0.38	0.95	0.69	0.59
	5-5/8		0.95	0.88			0.90		0.82	0.59		0.88	0.72		0.88	0.82		0.90	0.78	1.00	0.59	0.41	1.00	0.72	0.61
	6		0.96	0.89			0.93		0.88	0.63		0.92	0.76		0.89	0.84		0.93	0.80		0.63	0.45		0.76	0.63
	6-3/4		1.00	0.92		1.00		1.00	0.72		1.00	0.82		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68	
	7			0.93					0.75			0.84		0.93	0.86			0.87	0.75	0.54		0.84	0.69		
	8			0.96					0.88			0.92		0.96	0.89			0.93	0.88	0.63		0.92	0.76		
	8-1/2			0.98					0.94			0.96		0.98	0.90			0.97	0.94	0.68		0.96	0.79		
	9			1.00					1.00			1.00		1.00	0.92			1.00	1.00	0.72		1.00	0.82		
	10														0.95					0.82			0.88		
	11														0.97					0.91			0.94		
	12														1.00					1.00			1.00		

Note:

Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing for $s_{cr} > s > s_{min}$	Edge Distance for $c_{cr} > c > c_{min}$
Tension and Shear $s_{min} = 0.5 h_{ef}$, $s_{cr} = 2.0 h_{ef}$ $f_A = 0.165 (s/h_{ef}) + 0.67$	Tension $c_{min} = 0.5 h_{ef}$, $c_{cr} = 1.5 h_{ef}$ $f_{RN} = 0.40 (c/h_{ef}) + 0.4$
	Shear, where $h_{ef} < 9.0 \times d^1$ $c_{min} = 0.5 h_{ef}$, $c_{cr} = 2.5 h_{ef}$
	<div>⊥ toward edge $f_{RV1} = 0.415 (c/h_{ef}) - 0.0375$</div> <div> or away from edge $f_{RV2} = 0.275 (c/h_{ef}) + 0.312$</div>
	Shear, where $h_{ef} \geq 9.0 \times d^1$ $c_{min} = 0.5 h_{ef}$, $c_{cr} = 2.0 h_{ef}$
	<div>⊥ toward edge $f_{RV1} = 0.554 (c/h_{ef}) - 0.107$</div> <div> or away from edge $f_{RV2} = 0.366 (c/h_{ef}) + 0.267$</div>

1 d = nominal bolt diameter

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-HY 150 MAX

Load Adjustment Factors for 5/8" and 3/4" Diameter Anchors																										
Anchor Diameter		5/8" diameter												3/4" diameter												
Adjustment Factor		Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}			
Embedment Depth, in		2-7/8	5-5/8	7-1/2	2-7/8	5-5/8	7-1/2	2-7/8	5-5/8	7-1/2	2-7/8	5-5/8	7-1/2	3-3/8	6-3/4	9	3-3/8	6-3/4	9	3-3/8	6-3/4	9	3-3/8	6-3/4	9	
Spacing (s)/Edge Distance (c), in.	1-7/16	0.75			0.60			0.17			0.45															
	1-11/16	0.77			0.63			0.21			0.47			0.75			0.60			0.17			0.45			
	2	0.78			0.68			0.25			0.50			0.77			0.64			0.21			0.47			
	2-1/4	0.80			0.71			0.29			0.53			0.79			0.67			0.24			0.50			
	2-1/2	0.81			0.75			0.32			0.55			0.80			0.70			0.27			0.52			
	2-13/16	0.83	0.75		0.79	0.60		0.37	0.17		0.58	0.45		0.81			0.73			0.31			0.54			
	3	0.84	0.76		0.82	0.61		0.40	0.19		0.60	0.46		0.82			0.76			0.33			0.56			
	3-3/8	0.86	0.77		0.87	0.64		0.45	0.23		0.63	0.49		0.84	0.75		0.80	0.60		0.38	0.17		0.59	0.45		
	3-3/4	0.89	0.78	0.75	0.92	0.67	0.60	0.50	0.26	0.17	0.67	0.51	0.45	0.86	0.76		0.84	0.62		0.42	0.20		0.62	0.47		
	4-5/16	0.92	0.80	0.76	1.00	0.71	0.63	0.59	0.32	0.21	0.72	0.55	0.48	0.89	0.78		0.91	0.66		0.49	0.25		0.66	0.50		
	4-1/2	0.93	0.80	0.77		0.72	0.64	0.61	0.34	0.23	0.74	0.56	0.49	0.90	0.78	0.75	0.93	0.67	0.60	0.52	0.26	0.17	0.68	0.51	0.45	
	4-3/4	0.94	0.81	0.77		0.74	0.65	0.65	0.36	0.24	0.77	0.58	0.50	0.91	0.79	0.76	0.96	0.68	0.61	0.55	0.28	0.19	0.70	0.52	0.46	
	5-1/16	0.96	0.82	0.78		0.76	0.67	0.69	0.39	0.27	0.80	0.60	0.51	0.92	0.79	0.76	1.00	0.70	0.63	0.59	0.31	0.20	0.72	0.54	0.47	
	5-3/4	1.00	0.84	0.80		0.81	0.71	0.79	0.46	0.32	0.86	0.64	0.55	0.96	0.81	0.78		0.74	0.66	0.67	0.36	0.25	0.78	0.58	0.50	
	6-3/4		0.87	0.82		0.88	0.76	0.94	0.56	0.39	0.96	0.71	0.60	1.00	0.84	0.79		0.80	0.70	0.79	0.45	0.31	0.86	0.63	0.54	
	7-3/16		0.88	0.83		0.91	0.78	1.00	0.60	0.42	1.00	0.73	0.62		0.85	0.80		0.83	0.72	0.85	0.48	0.34	0.90	0.66	0.56	
	7-1/2		0.89	0.84		0.93	0.80		0.63	0.45		0.76	0.63		0.85	0.81		0.84	0.73	0.88	0.51	0.35	0.92	0.67	0.57	
	8		0.90	0.85		0.97	0.83		0.68	0.48		0.79	0.66		0.87	0.82		0.87	0.76	0.95	0.55	0.39	0.96	0.70	0.59	
	8-7/16		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68		0.88	0.82		0.90	0.78	1.00	0.59	0.41	1.00	0.72	0.61	
	9		0.93	0.87			0.88		0.78	0.56		0.85	0.71		0.89	0.84		0.93	0.80		0.63	0.45		0.76	0.63	
	10-1/8		0.97	0.89		0.94			0.89	0.64		0.93	0.76		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68	
	11-1/4		1.00	0.92			1.00		1.00	0.72		1.00	0.82		0.95	0.88			0.90		0.82	0.59		0.88	0.72	
	12			0.93						0.78			0.85		0.96	0.89			0.93		0.88	0.63		0.92	0.72	
	13			0.96						0.85			0.90		0.99	0.91			0.98		0.96	0.69		0.97	0.80	
	13-1/2			0.97						0.89			0.93		1.00	0.92			1.00		1.00	0.72		1.00	0.82	
14			0.98						0.93			0.95			0.93						0.75			0.84		
15			1.00						1.00			1.00			0.95						0.82			0.88		
16															0.96						0.88			0.92		
18															1.00						1.00			1.00		

Note:

Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing for $s_{cr} > s > s_{min}$	Edge Distance for $c_{cr} > c > c_{min}$
Tension and Shear $s_{min} = 0.5 h_{ef}$, $s_{cr} = 2.0 h_{ef}$ $f_A = 0.165 (s/h_{ef}) + 0.67$	Tension $c_{min} = 0.5 h_{ef}$, $c_{cr} = 1.5 h_{ef}$ $f_{RN} = 0.40 (c/h_{ef}) + 0.4$
	Shear, where $h_{ef} < 9.0 \times d^1$ $c_{min} = 0.5 h_{ef}$, $c_{cr} = 2.5 h_{ef}$
	<div> \perp toward edge $f_{RV1} = 0.415 (c/h_{ef}) - 0.0375$ </div> <div> II or away from edge $f_{RV2} = 0.275 (c/h_{ef}) + 0.312$ </div>
	Shear, where $h_{ef} \geq 9.0 \times d^1$ $c_{min} = 0.5 h_{ef}$, $c_{cr} = 2.0 h_{ef}$
	<div> \perp toward edge $f_{RV1} = 0.554 (c/h_{ef}) - 0.107$ </div> <div> II or away from edge $f_{RV2} = 0.366 (c/h_{ef}) + 0.267$ </div>

1 d = nominal bolt diameter

HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-HY 150 MAX

Load Adjustment Factors for 7/8" Diameter Anchors												
Anchor Diameter	7/8" diameter											
Adjustment Factor	Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}		
Embedment Depth, in	4	7-7/8	10-1/2	4	7-7/8	10-1/2	4	7-7/8	10-1/2	4	7-7/8	10-1/2
Spacing (s)/Edge Distance (c), in.	2	0.75		0.60			0.17			0.45		
	2-1/4	0.76		0.63			0.20			0.47		
	2-1/2	0.77		0.65			0.22			0.48		
	3	0.79		0.70			0.27			0.52		
	3-1/2	0.81		0.75			0.33			0.55		
	3-15/16	0.83	0.75	0.79	0.60		0.37	0.17		0.58	0.45	
	4-1/2	0.86	0.76	0.85	0.63		0.43	0.21		0.62	0.48	
	4-3/4	0.87	0.77	0.88	0.64		0.46	0.23		0.64	0.49	
	5	0.88	0.77	0.90	0.65		0.48	0.24		0.66	0.50	
	5-1/4	0.89	0.78	0.93	0.67	0.60	0.51	0.26	0.17	0.67	0.51	0.45
	6	0.92	0.80	0.76	1.00	0.70	0.59	0.32	0.21	0.72	0.55	0.48
	6-3/4	0.95	0.81	0.78		0.74	0.66	0.37	0.25	0.78	0.58	0.50
	7-1/2	0.98	0.83	0.79		0.78	0.69	0.42	0.29	0.83	0.62	0.53
	8	1.00	0.84	0.80		0.81	0.70	0.46	0.32	0.86	0.64	0.55
	8-1/2		0.85	0.80		0.83	0.72	0.49	0.34	0.90	0.66	0.56
	9		0.86	0.81		0.86	0.74	0.53	0.37	0.93	0.69	0.58
	10		0.88	0.83		0.91	0.78	1.00	0.60	1.00	0.73	0.62
	11		0.90	0.84		0.96	0.82		0.67		0.78	0.65
	11-1/2		0.91	0.85		0.98	0.84		0.70	0.50	0.80	0.67
	11-13/16		0.92	0.86		1.00	0.85		0.72	0.52	0.82	0.68
	12		0.92	0.86			0.86		0.74	0.53	0.82	0.69
	13		0.94	0.87			0.90		0.81	0.58	0.87	0.72
	14		0.96	0.89			0.93		0.88	0.63	0.92	0.76
	15		0.98	0.91			0.97		0.95	0.68	0.96	0.79
	15-3/4		1.00	0.92			1.00		1.00	0.72	1.00	0.82
	18			0.95					0.84			0.89
	20			0.98					0.95			0.96
	21			1.00					1.00			1.00

Note:

Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

<p>Spacing for $s_{cr} > s > s_{min}$</p> <p>Tension and Shear $s_{min} = 0.5 h_{ef}$, $s_{cr} = 2.0 h_{ef}$ $f_A = 0.165 (s/h_{ef}) + 0.67$</p>	<p>Edge Distance for $c_{cr} > c > c_{min}$</p> <p>Tension $c_{min} = 0.5 h_{ef}$, $c_{cr} = 1.5 h_{ef}$ $f_{RN} = 0.40 (c/h_{ef}) + 0.4$</p> <p>Shear, where $h_{ef} < 9.0 \times d^1$ $c_{min} = 0.5 h_{ef}$, $c_{cr} = 2.5 h_{ef}$</p> <table> <tr> <td>⊥ toward edge $f_{RV1} = 0.415 (c/h_{ef}) - 0.0375$</td><td> or away from edge $f_{RV2} = 0.275 (c/h_{ef}) + 0.312$</td></tr> </table> <p>Shear, where $h_{ef} \geq 9.0 \times d^1$ $c_{min} = 0.5 h_{ef}$, $c_{cr} = 2.0 h_{ef}$</p> <table> <tr> <td>⊥ toward edge $f_{RV1} = 0.554 (c/h_{ef}) - 0.107$</td><td> or away from edge $f_{RV2} = 0.366 (c/h_{ef}) + 0.267$</td></tr> </table>	⊥ toward edge $f_{RV1} = 0.415 (c/h_{ef}) - 0.0375$	or away from edge $f_{RV2} = 0.275 (c/h_{ef}) + 0.312$	⊥ toward edge $f_{RV1} = 0.554 (c/h_{ef}) - 0.107$	or away from edge $f_{RV2} = 0.366 (c/h_{ef}) + 0.267$
⊥ toward edge $f_{RV1} = 0.415 (c/h_{ef}) - 0.0375$	or away from edge $f_{RV2} = 0.275 (c/h_{ef}) + 0.312$				
⊥ toward edge $f_{RV1} = 0.554 (c/h_{ef}) - 0.107$	or away from edge $f_{RV2} = 0.366 (c/h_{ef}) + 0.267$				

1 d = nominal bolt diameter

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-HY 150 MAX

Load Adjustment Factors for 1" and 1-1/4" Diameter Anchors																										
Anchor Diameter	1" diameter												1-1/4" diameter													
Adjustment Factor	Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}				
Embedment Depth, in	4-1/2	9	12	4-1/2	9	12	4-1/2	9	12	4-1/2	9	12	5-5/8	11-1/4	15	5-5/8	11-1/4	15	5-5/8	11-1/4	15	5-5/8	11-1/4	15		
Spacing (s)/Edge Distance (c), in.	2-1/4	0.75			0.60			0.17			0.45															
	2-1/2	0.76			0.62			0.19			0.46															
	2-13/16	0.77			0.65			0.22			0.48			0.75			0.60			0.17			0.45			
	3	0.78			0.67			0.24			0.50			0.76			0.61			0.18			0.46			
	3-1/2	0.80			0.71			0.29			0.53			0.78			0.65			0.22			0.48			
	4	0.82			0.76			0.33			0.56			0.79			0.68			0.26			0.51			
	4-1/2	0.84	0.75		0.80	0.60		0.38	0.17		0.59	0.45		0.81			0.72			0.29			0.53			
	5	0.85	0.76		0.84	0.62		0.42	0.20		0.62	0.47		0.82			0.76			0.33			0.56			
	5-5/8	0.88	0.77		0.90	0.65		0.48	0.24		0.66	0.50		0.84	0.75		0.80	0.60		0.38	0.17		0.59	0.45		
	6	0.89	0.78	0.75	0.93	0.67	0.60	0.52	0.26	0.17	0.68	0.51	0.45	0.85	0.76		0.83	0.61		0.41	0.19		0.61	0.46		
	6-3/4	0.92	0.79	0.76	1.00	0.70	0.63	0.59	0.31	0.20	0.72	0.54	0.47	0.87	0.77		0.88	0.64		0.46	0.23		0.64	0.49		
	7-1/2	0.95	0.81	0.77		0.73	0.65	0.65	0.35	0.24	0.77	0.57	0.50	0.90	0.78	0.75	0.93	0.67	0.60	0.52	0.26	0.17	0.68	0.51	0.45	
	8	0.96	0.82	0.78		0.76	0.67	0.70	0.39	0.26	0.80	0.59	0.51	0.91	0.79	0.76	0.97	0.68	0.61	0.55	0.29	0.19	0.70	0.53	0.46	
	8-7/16	0.98	0.82	0.79		0.78	0.68	0.74	0.41	0.28	0.83	0.61	0.52	0.92	0.79	0.76	1.00	0.70	0.63	0.59	0.31	0.20	0.72	0.54	0.47	
	9	1.00	0.84	0.79		0.80	0.70	0.79	0.45	0.31	0.86	0.63	0.54	0.94	0.80	0.77		0.72	0.64	0.63	0.34	0.23	0.75	0.56	0.49	
	10		0.85	0.81		0.84	0.73	0.88	0.51	0.35	0.92	0.67	0.57	0.97	0.82	0.78		0.76	0.67	0.70	0.39	0.26	0.80	0.59	0.51	
	11-1/4		0.88	0.82		0.90	0.78	1.00	0.59	0.41	1.00	0.72	0.61	1.00	0.84	0.79		0.80	0.70	0.79	0.45	0.31	0.86	0.63	0.54	
	12		0.89	0.84		0.93	0.80		0.63	0.45		0.76	0.63		0.85	0.80		0.83	0.72	0.85	0.48	0.34	0.90	0.66	0.56	
	13		0.91	0.85		0.98	0.83		0.69	0.49		0.80	0.66		0.86	0.81		0.86	0.75	0.92	0.53	0.37	0.95	0.69	0.58	
	13-1/2		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68		0.87	0.82		0.88	0.76	0.96	0.56	0.39	0.97	0.71	0.60	
	14-1/16		0.93	0.86			0.87		0.76	0.54		0.84	0.70		0.88	0.82		0.90	0.78	1.00	0.59	0.41	1.00	0.72	0.61	
	16		0.96	0.89			0.93		0.88	0.63		0.92	0.76		0.90	0.85		0.97	0.83		0.68	0.48		0.79	0.66	
	16-7/8		0.98	0.90			0.96		0.93	0.67		0.95	0.78		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68	
	18		1.00	0.92			1.00		1.00	0.72		1.00	0.82		0.93	0.87			0.88		0.78	0.56		0.85	0.71	
	20			0.95						0.82			0.88			0.96	0.89			0.93		0.88	0.63		0.92	0.76
	22			0.97						0.91			0.94			0.99	0.91			0.99		0.98	0.71		0.98	0.80
	22-1/2			0.98						0.93			0.95		1.00	0.92			1.00		1.00	0.72		1.00	0.82	
	24			1.00						1.00			1.00			0.93							0.78		0.85	
26															0.96							0.85		0.90		
28															0.98							0.93		0.95		
30															1.00							1.00		1.00		

Note:

Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing for $s_{cr} > s > s_{min}$	Edge Distance for $c_{cr} > c > c_{min}$
Tension and Shear $s_{min} = 0.5 h_{ef}$, $s_{cr} = 2.0 h_{ef}$ $f_A = 0.165 (s/h_{ef}) + 0.67$	Tension $c_{min} = 0.5 h_{ef}$, $c_{cr} = 1.5 h_{ef}$ $f_{RN} = 0.40 (c/h_{ef}) + 0.4$
	Shear, where $h_{ef} < 9.0 \times d^1$ $c_{min} = 0.5 h_{ef}$, $c_{cr} = 2.5 h_{ef}$
	<div> <div>⊥ toward edge $f_{RV1} = 0.415 (c/h_{ef}) - 0.0375$</div> <div> or away from edge $f_{RV2} = 0.275 (c/h_{ef}) + 0.312$</div> </div>
	Shear, where $h_{ef} \geq 9.0 \times d^1$ $c_{min} = 0.5 h_{ef}$, $c_{cr} = 2.0 h_{ef}$
	<div> <div>⊥ toward edge $f_{RV1} = 0.554 (c/h_{ef}) - 0.107$</div> <div> or away from edge $f_{RV2} = 0.366 (c/h_{ef}) + 0.267$</div> </div>

¹ d = nominal bolt diameter

HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-TZ and HIT-RTZ Threaded Rods

Load Adjustment Factors for 3/8" and 1/2" Diameter Anchors								
Anchor Diameter	3/8" diameter				1/2" diameter			
Adjustment Factor	Spacing Tension/Shear f_A	Edge Distance Tension f_{RN}	Edge Distance Shear (⊥ toward edge) f_{RV1}	Edge Distance Shear (to or away from edge) f_{RV2}	Spacing Tension/Shear f_A	Edge Distance Tension f_{RN}	Edge Distance Shear (⊥ toward edge) f_{RV1}	Edge Distance Shear (to or away from edge) f_{RV2}
Embedment Depth, in	2-7/8	2-7/8	2-7/8	2-7/8	3-1/2	3-1/2	3-1/2	3-1/2
Spacing (s)/Edge Distance (c), in.	2	0.77	0.63	0.25	0.53			
	2-7/16	0.79	0.68	0.35	0.59	0.77	0.63	0.25
	3	0.81	0.74	0.46	0.67	0.79	0.68	0.35
	3-3/8	0.83	0.78	0.55	0.72	0.80	0.71	0.42
	4	0.86	0.84	0.68	0.80	0.83	0.77	0.53
	4-3/8	0.87	0.88	0.76	0.85	0.84	0.80	0.59
	5	0.90	0.95	0.90	0.94	0.86	0.85	0.71
	5-1/4	0.91	0.98	0.95	0.97	0.87	0.88	0.75
	5-7/16	0.92	1.00	1.00	1.00	0.88	0.89	0.79
	6	0.95				0.90	0.94	0.88
	6-11/16	0.98				0.92	1.00	1.00
	7	0.99				0.94		
	7-3/16	1.00				0.94		

Note:

Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing for $s_{cr} > s > s_{min}$
Tension and Shear $s_{min} = 0.7 h_{ef}$, $s_{cr} = 2.5 h_{ef}$ $f_A = 0.128 (s/h_{ef}) + 0.68$

Edge Distance for $c_{cr} > c > c_{min}$
Tension $c_{min} = 0.7 h_{ef}$, $c_{cr} = 1.9 h_{ef}$ $f_{RN} = 0.308 (c/h_{ef}) + 0.414$
Shear $c_{min} = 0.7 h_{ef}$, $c_{cr} = 1.9 h_{ef}$
<div> <div>⊥ toward edge $f_{RV1} = 0.625 (c/h_{ef}) - 0.1875$ </div> <div> or away from edge $f_{RV2} = 0.392 (c/h_{ef}) + 0.256$ </div> </div>

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-TZ and HIT-RTZ Threaded Rods

Load Adjustment Factors for 5/8" and 3/4" Diameter Anchors								
Anchor Diameter	5/8" diameter				3/4" diameter			
Adjustment Factor	Spacing Tension/Shear f_A	Edge Distance Tension f_{RN}	Edge Distance Shear (⊥ toward edge) f_{RV1}	Edge Distance Shear (to or away from edge) f_{RV2}	Spacing Tension/Shear f_A	Edge Distance Tension f_{RN}	Edge Distance Shear (⊥ toward edge) f_{RV1}	Edge Distance Shear (to or away from edge) f_{RV2}
Embedment Depth, in	4	4	4	4	5-1/4	5-1/4	5-1/4	5-1/4
Spacing (s)/Edge Distance (c), in.	2-13/16	0.77	0.63	0.25	0.53			
	3	0.78	0.65	0.28	0.55			
	3-11/16	0.80	0.70	0.39	0.62	0.77	0.63	0.25
	4-5/16	0.82	0.75	0.49	0.68	0.79	0.67	0.33
	4-1/2	0.82	0.76	0.52	0.70	0.79	0.68	0.35
	4-3/4	0.83	0.78	0.55	0.72	0.80	0.69	0.38
	5	0.84	0.80	0.60	0.75	0.80	0.71	0.42
	5-3/4	0.86	0.86	0.71	0.82	0.82	0.75	0.50
	6-3/4	0.90	0.93	0.87	0.92	0.84	0.81	0.62
	7-3/16	0.91	0.97	0.94	0.96	0.86	0.84	0.67
	7-5/8	0.92	1.00	1.00	1.00	0.87	0.86	0.72
	8	0.94				0.88	0.88	0.76
	8-7/16	0.95				0.89	0.91	0.82
	9	0.97				0.90	0.94	0.88
	10	1.00				0.92	1.00	1.00

Note:

Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing for $s_{cr} > s > s_{min}$
Tension and Shear $s_{min} = 0.7 h_{ef}$, $s_{cr} = 2.5 h_{ef}$ $f_A = 0.128 (s/h_{ef}) + 0.68$

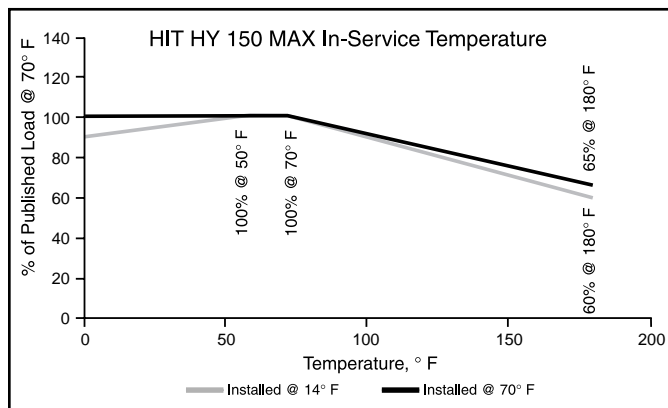
Edge Distance for $c_{cr} > c > c_{min}$	
Tension $c_{min} = 0.7 h_{ef}$, $c_{cr} = 1.9 h_{ef}$ $f_{RN} = 0.308 (c/h_{ef}) + 0.414$	
Shear $c_{min} = 0.7 h_{ef}$, $c_{cr} = 1.9 h_{ef}$	
⊥ toward edge $f_{RV1} = 0.625 (c/h_{ef}) - 0.1875$	or away from edge $f_{RV2} = 0.392 (c/h_{ef}) + 0.256$

HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

Resistance of HIT-HY 150 MAX to Chemicals

Chemical		Behavior
Sulphuric acid	conc.	–
	30%	•
	10%	+
Hydrochloric acid	conc.	•
	10%	+
Nitric acid	conc.	–
	10%	•
Phosphoric acid	conc.	+
	10%	+
Acetic acid	conc.	•
	10%	+
Formic acid	conc.	–
	10%	•
Lactic acid	conc.	+
	10%	+
Citric acid	10%	+
	10%	+
Sodium Hydroxide (Caustic soda)	40%	•
	20%	+
	5%	+
Ammonia	conc.	•
	5%	+
Soda solution	10%	+
Common salt solution	10%	+
Chlorinated lime solution	10%	+
Sodium hypochlorite	2%	+
Hydrogen peroxide	10%	+
Carbolic acid solution	10%	–
Ethanol		–
Sea water		+
Glycol		+
Acetone		–
Carbon tetrachloride		–
Toluene		+
Petrol/Gasoline		•
Machine oil		•
Diesel oil		•

Key: – non-resistant + resistant • limited resistance



Samples of the HIT-HY 150 MAX resin were immersed in the various chemical compounds for up to one year. At the time 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 **“Partially Resistant.”** Samples that were heavily damaged or destroyed were classified as **“Not Resistant.”**

Note: In actual use, the majority of the resin is encased in the base material, leaving very little surface area exposed. In some cases, this would allow the HIT-HY 150 MAX to be used where it would be exposed to the **“Partially Resistant”** chemical compounds.

Open Gel Time (Approximate)^{1,2}

Base Material Temperature		Approximate Gel Time
°F	°C	
14	–10	100 min
23	–5	40 min
32	0	20 min
50	10	8 min
68	20	6 min
86	30	3 min
104	40	2 min

Final Cure Time (Approximate)^{1,2}

Base Material Temperature		Approximate Cure Time
°F	°C	
14	–10	12 hrs
23	–5	4 hrs
32	0	2hrs
50	10	1hrs
68	20	30 min
86	30	30 min
104	40	30 min

1 The Temperature of the HIT-HY 150 MAX adhesive must be between 32°F (0°C) and 104°F (40°C) at the time of installation.

2 Use of HIT-HY 150 MAX with HIT-TZ rods must be installed in base material temperatures ≥ 40°F (5°C).

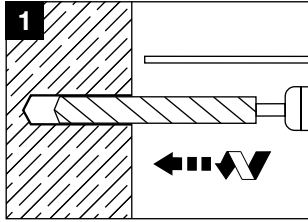
Note: Test procedure involves the concrete being held at the elevated temperature for 24 hours, then removing it from the controlled environment and testing to failure.

Long term creep test in accordance with AC58 and AC308 is available; please contact Hilti Technical Services.

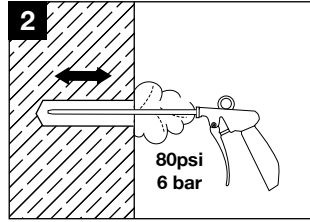
3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

3.2.6.5 Installation Instructions

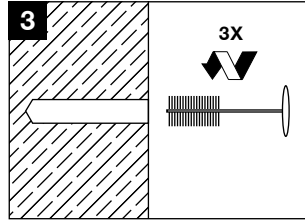
HAS Rod, Rebar and Insert Installation Instructions



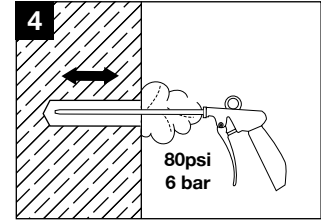
1. Drill anchor hole with a carbide bit.



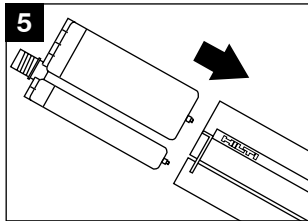
2. Insert air nozzle to bottom of hole and blow out all dust and debris from the hole using compressed air.*



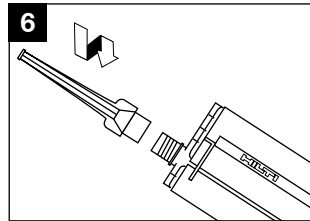
3. Clean hole with wire brush. Proper hole cleaning is essential.



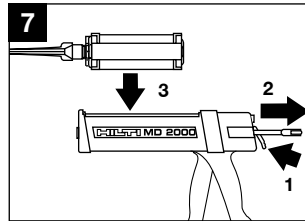
4. Insert air nozzle to bottom of hole and blow out all dust and debris from the hole using compressed air.



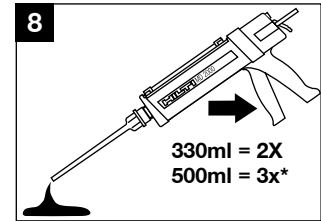
5. Put foil pack into foil pack holder. Remove cap covering threaded projection.



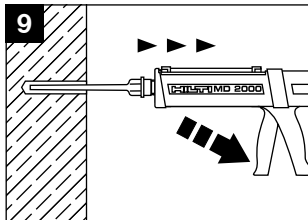
6. Screw on static mixer.



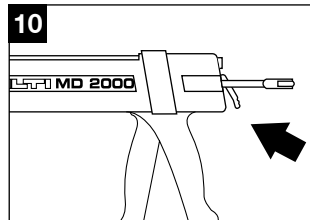
7. Put holder/foil pack into appropriate dispenser.



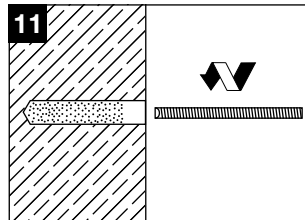
8. Discard first trigger pulls of adhesive from each foil pack. *Below 41°F (5°C) discard four trigger pulls.



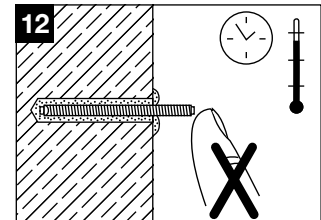
9. Inject adhesive into hole without forming air pockets starting at the bottom until 1/2 to 2/3 full. Use mixer filler tube extensions when needed to reach the hole bottom.



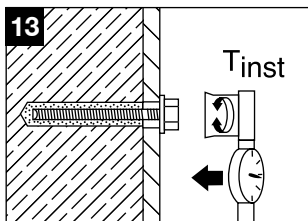
10. After injecting adhesive depressurize the dispenser by pressing the release button.



11. Insert rod, insert or rebar. Twist during installation. Fastener may be adjusted during specified gel time.



12. Do not disturb anchor between specified gel time and cure time.

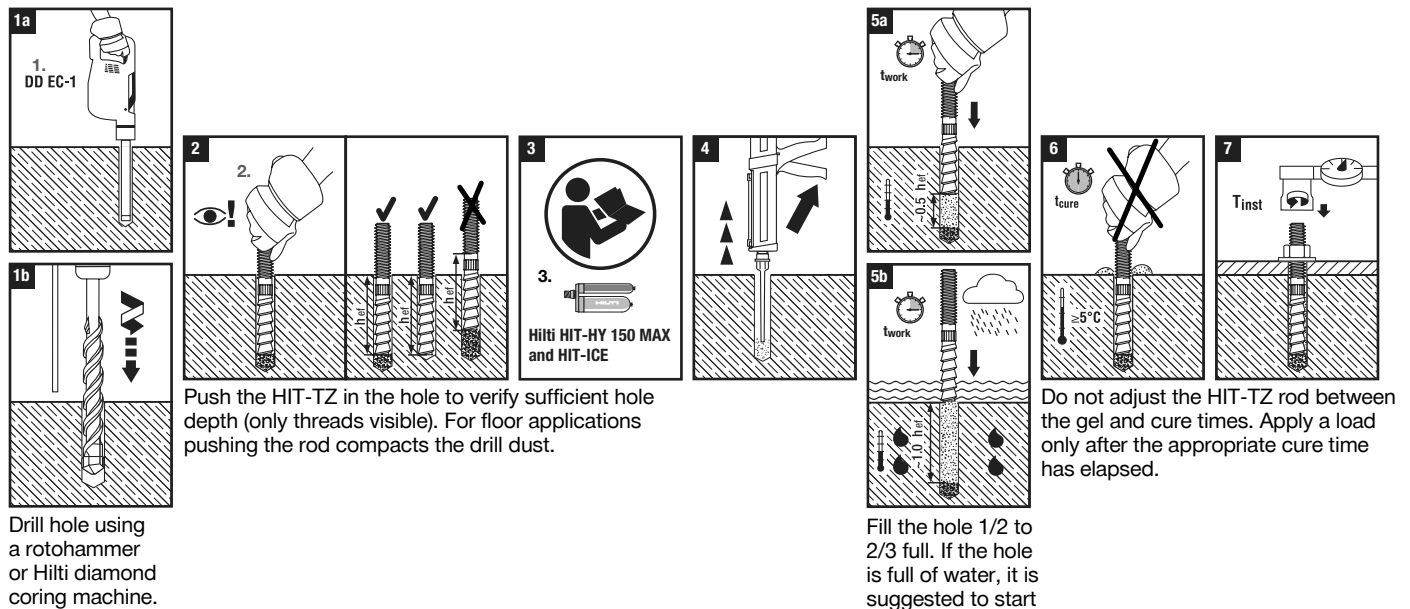


13. After cure time has elapsed, apply specified torque.

* For holes with standing water, holes must be flushed clean with water, brushed with a wire brush and again flushed clean with water or other means removing any debris or slurry in the hole. Standing water must be removed prior to performing the remainder of anchor installation.

HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

HIT-TZ and HIT-RTZ Installation Instructions



HIT-HY 150 MAX Volume Charts (Approximate)

Threaded Rod and HIT-TZ Rod Installation

Rod Diameter (in.)	Drill Bit Diameter (in.)	Adhesive Volume Required per Inch of embedment (in ³)
1/4	5/16	0.055
3/8	7/16	0.095
1/2	9/16	0.133
5/8	3/4	0.261
3/4	7/8	0.326
7/8	1	0.391
1	1-1/8	0.478
1-1/4	1-3/8	0.626

Rebar Installation

Rebar Diameter (in.)	Drill Bit ¹ Diameter (in.)	Adhesive Volume Required per Inch of embedment (in ³)
#3 or 3/8	1/2	0.110
#4 or 1/2	5/8	0.146
#5 or 5/8	3/4	0.176
#6 or 3/4	7/8	0.218
#7 or 7/8	1	0.252
#8 or 1	1-1/8	0.299
#9 or 1 1/8	1-3/8	0.601
#10 or 1 1/4	1-1/2	0.659

Metric Rebar Installation (Canada Only)

Rebar Diameter	Drill Bit ¹ Diameter (in.)	Adhesive Volume Required per Inch of embedment (in ³)
10M	5/8	0.186
15M	3/4	0.170
20M	1	0.388
25M	1-1/8	0.289
30M	1-3/8	0.481

¹ Rebar diameter may vary. Use smallest drill bit which will accommodate rebar.

Example: Determine approximate fastenings for 5/8" rod embedded 10" deep. (Assumes no waste)

$$10 \times 0.261 = 2.61 \text{ in}^3 \text{ of adhesive per anchor}$$

HIT-HY 150 MAX 11.1 oz:
 $16.5 \div 2.61 = 6 \text{ fastenings}$

HIT-HY 150 MAX 16.9 oz:
 $26.9 \div 2.61 = 10 \text{ fastenings}$

HIT-HY 150 MAX Jumbo:
 $81.8 \div 2.61 = 31 \text{ fastenings}$

Note: Estimated useable volume of:

HIT-HY 150 MAX 11.1 oz cartridge is
 16.5 in³ (270 ml)

HIT-HY 150 MAX 16.9 oz cartridge is
 26.9 in³ (440 ml)

HIT-HY 150 MAX Jumbo cartridges are
 81.8 in³

3.2.6 HIT-HY 150 MAX Adhesive Anchoring System

3.2.6.6 Ordering Information



HIT-HY 150 MAX
Foil Pack

HIT Adhesives

Description	Contents
HIT-HY 150 MAX 11.1 fl oz (330 ml)	1 Foil Pack, 1 Mixer with Filler Tube
HIT-HY 150 MAX 11.1 fl oz (330 ml) MC	25 Foil Packs, 25 Mixers, 25 Filler Tubes
HIT-HY 150 MAX 16.9 fl oz (500 ml) MC	20 Foil Packs, 20 Mixers, 20 Filler Tubes
HIT-HY 150 MAX Jumbo 47.3 fl oz (1400 ml) MC	4 Foil Packs, 4 Mixers

HIT Dispensers

Battery Powered Dispenser



ED 3500
Battery Dispenser

Description

ED 3500 2.0 Ah Kit

Manual Dispensers



MD 2000
Dispenser

MD 2500
Dispenser

Description

MD 2000 Manual Dispenser + 1 foil pack holder for HIT-HY foil packs

MD 2500 Manual Dispenser + 1 foil pack holder for HIT-HY foil packs

Foil Pack Holder Replacement for MD 2000 or BD 2000 dispensers

Foil Pack Holder for 16.9 fl oz (500 ml) (MD 2500, P 3500)

Pneumatic Dispensers



P 3500
Dispenser

P 8000
Dispenser

Description

HIT P 3500 Pneumatic Dispenser + 1 foil pack holder for HIT-HY foil packs

HIT P 8000-D Pneumatic Dispenser (for Jumbo cartridges)

Jumbo Foil Pack Holder Replacement for HIT P 8000 dispenser

Mixers and Filler Tubes



HIT-RE-M

HIT Filler Tube

Description	Qty/Pkg	Notes
HIT-RE Mixer	1	For use with any cartridge size

HIT-HY 150 MAX Adhesive Anchoring System 3.2.6

HAS-E, HAS-R and HAS Super Rods, HIS Inserts and HIT-TZ and HIT-RTZ Rods

Threaded Anchors for Hilti Chemical Anchor Systems

HAS-E Rods 5.8 Steel			HAS Super A 193, B7 High Strength Steel		HAS-R 304 Stainless Steel		HAS-R 316 Stainless Steel	
Description	Qty	Master Carton Qty	Description	Qty	Description	Qty	Description	Qty
3/8" x 3"	10	360	-	-	-	-	-	-
3/8" x 4-3/8"	10	240	-	-	-	-	-	-
3/8" x 5-1/8"	20	200	3/8" x 5-1/8"	10	3/8" x 5-1/8"	20	3/8" x 5-1/8"	10
3/8" x 8"	10	160	-	-	3/8" x 8"	10	-	-
3/8" x 12"	10	90	-	-	-	-	3/8" x 8"	10
1/2" x 3-1/8"	10	240	-	-	-	-	-	-
1/2" x 4-1/2"	10	160	-	-	-	-	-	-
1/2" x 6-1/2"	20	160	1/2" x 6-1/2"	10	1/2" x 6-1/2"	20	1/2" x 6-1/2"	10
1/2" x 8"	10	120	-	-	1/2" x 8"	10	1/2" x 8"	10
1/2" x 10"	10	120	-	-	1/2" x 10"	10	-	-
-	-	-	-	-	-	-	1/2" x 11" *	10
1/2" x 12"	10	80	-	-	-	-	1/2" x 12"	10
5/8" x 8"	20	80	5/8" x 7-5/8"	10	5/8" x 7-5/8"	20	5/8" x 7-5/8"	10
-	-	-	-	-	5/8" x 10"	10	-	-
5/8" x 9"	10	60	-	-	-	-	5/8" x 9"	10
5/8" x 12"	10	60	-	-	-	-	5/8" x 12"	10
5/8" x 17"	10	40	-	-	-	-	-	-
3/4" x 10"	10	40	3/4" x 9-5/8"	5	3/4" x 9-5/8"	10	3/4" x 9-5/8" *	5
3/4" x 11"	10	30	-	-	-	-	3/4" x 10"	5
3/4" x 12"	10	30	-	-	3/4" x 12"	10	-	-
3/4" x 14"	10	30	3/4" x 14" *	5	3/4" x 14"	10	3/4" x 16"	5
-	-	-	-	-	3/4" x 16"	10	-	-
3/4" x 17"	10	20	-	-	-	-	7/8" x 10"	5
3/4" x 19"	10	20	-	-	-	-	-	-
3/4" x 21"	10	20	-	-	-	-	-	-
3/4" x 25"	10	20	-	-	-	-	7/8" x 16"	5
7/8" x 10"	10	20	7/8" x 10" (HDG)	5	7/8" x 10"	10	-	-
-	-	-	7/8" x 12" (HDG) *	5	-	-	-	-
7/8" x 13"	10	20	7/8" x 16" (HDG)	5	-	-	-	-
1" x 12"	4	16	1" x 12"	5	1" x 12"	4	1" x 12" *	4
1" x 14"	2	16	1" x 14" *	5	-	-	-	-
1" x 16"	2	12	1" x 16" *	5	-	-	1" x 16" *	4
1" x 20"	2	12	1" x 21" *	5	-	-	1" x 20" *	4
1-1/4" x 16"	4	8	1-1/4" x 16"	4	-	-	-	-
1-1/4" x 22"	4	8	-	-	-	-	-	-
-	-	-	1-1/4" x 23" *	4	-	-	-	-

*Item not returnable

HIS Carbon Steel and HIS-R 316 Stainless Steel Internally Threaded Inserts

Description	Useable Thread Length (in)	Qty	Qty
3/8" x 4-1/4"	1"	10	10
1/2" x 5"	1-3/16"	5	5
5/8" x 6-5/8"	1-1/2"	5	5
3/4" x 8-1/4"	2"	5	5

Hilti Rods are now stamped on the end to show grade of steel and overall anchor length!

E = ISO 898 Class 5.8 Steel

B = ASTM A 193, Grade B7 Steel

R1 = AISI 304 Stainless Steel

R2 = AISI 316 Stainless Steel

Hilti HIT-TZ Threaded Rod

Description	Threaded Rod Diameter (in)	Bit Diameter (in)	Embed (in)	Maximum Fastening Thickness (in)	Overall Length (in)	Qty	Qty
HIT-TZ 3/8" x 2-7/8"	3/8"	7/16"	2-7/8"	1"	4-1/2"	40	40
HIT-TZ 1/2" x 3-1/2"	1/2"	9/16"	3-1/2"	1-1/2"	5-11/16"	24	24
HIT-TZ 5/8" x 4-1/2"	5/8"	11/16"	4"	2-1/4"	7-1/16"	16	16
HIT-TZ 3/4" x 5-1/4"	3/4"	13/16"	5-1/4"	4-1/16"	10-1/2"	8	8

3.2.7 HIT-RE 500 Epoxy Adhesive Anchoring System

3.2.7.1 Product Description

3.2.7.2 Material Specifications

3.2.7.3 Technical Data

3.2.7.4 Installation Instructions

3.2.7.5 Ordering Information

Listings/Approvals

NSF/ANSI Std 61

certification for use in potable water

European Technical Approval

ETA-04/0027

ETA-08/0105



Independent Code Evaluation

LEED®: Credit 4.1-Low Emitting Materials



The Leadership in Energy and Environmental Design (LEED®) Green Building Rating system™ is the nationally accepted benchmark for the design, construction and operation of high performance green buildings.

3.2.7.1 Product Description

The Hilti HIT-RE 500 System is a high strength, two part epoxy adhesive. The system consists of a side-by-side adhesive refill pack, a mixing nozzle, a HIT dispenser with refill pack holder, and either a threaded rod, rebar, HIS internally threaded insert or smooth epoxy coated bar. HIT-RE 500 is specifically designed for fastening into solid base materials such as concrete, grout, stone or solid masonry. HIT-RE 500 may be used in underwater fastenings and for oversized holes up to 2 times the rod diameter (2-1/2" rod and 3" max. hole diameter) and for diamond-cored holes.

Product Features

- Superior bond performance
- Use in diamond cored or pneumatic drilled holes.
- Under water up to 165 feet (50 m)
- Meets DOT requirements for most states; contact the Hilti Technical Staff
- Meets requirements of ASTM C 881-90, Type IV, Grade 2 and 3, Class A, B, C except gel times
- Meets requirements of AASHTO specification M235, Type IV, Grade 3, Class A, B, C except gel times
- Mixing tube provides proper mixing, eliminates measuring errors and minimizes waste
- Contains no styrene; virtually odorless
- Extended temperature range from 23°F to 104°F (-5°C to 40°C)
- Excellent weathering resistance; Resistance against elevated temperatures
- Suitable for oversized holes

Fastener Components



HAS Threaded Rods



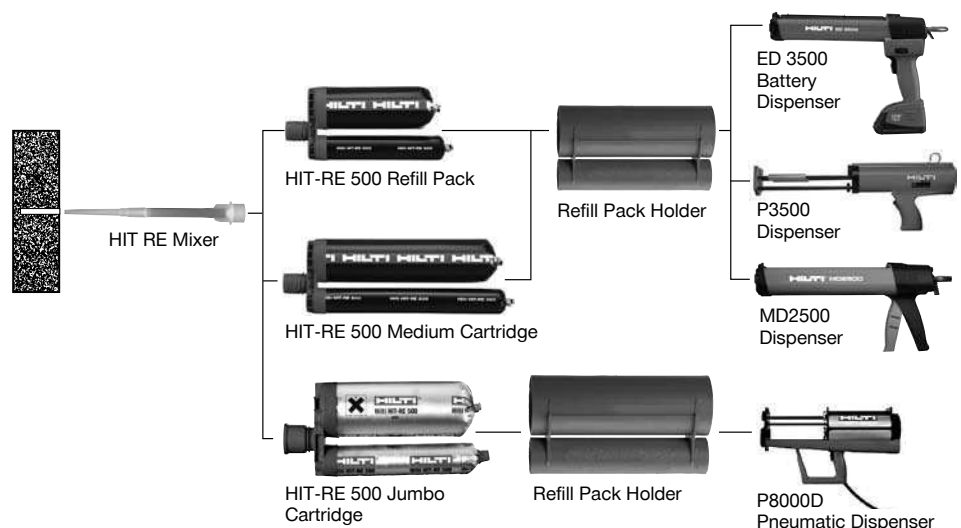
HIS Internally Threaded Inserts



Rebar (supplied by contractor)



Smooth, epoxy coated bar (supplied by contractor)



HIT-RE 500 Epoxy Adhesive Anchoring System 3.2.7

Guide Specifications

Master Format Section:

Previous 2004 Format

03250 03 16 00 (Concrete Anchors)

Related Sections:

03200 03 20 00 (Concrete Reinforcing)

05050 05 50 00 (Metal Fabrications)

05120 05 10 00 (Structural Metal Framing)

Injectable adhesive shall be used for installation of all reinforcing steel dowels or threaded anchor rods and inserts into existing concrete. Adhesive shall be furnished in side-by-side refill packs which keep component A and component B separate. Side-by-side packs shall be designed to compress during use to minimize waste volume. Side-by-side packs shall also be designed to accept static mixing nozzle which thoroughly blends component A and component B and allows injection directly into drilled hole. Only injection tools and static mixing nozzles as supplied by manufacturer shall be used. Manufacturer's instructions shall be followed. Injection adhesive shall be formulated to include resin and hardener to provide optimal curing speed as well as high strength and stiffness. Typical curing time at 68°F (20°C) shall be approximately 12 hours.

Injection adhesive shall be HIT-RE 500, as furnished by Hilti.

Anchor Rods Shall be furnished with chamfered ends so that either end will accept a nut and washer. Alternatively, anchor rods shall be furnished with a 45 degree chisel point on one end to allow for easy insertion into the adhesive-filled hole. Anchor rods shall be manufactured to meet the following requirements:

1. ISO 898 Class 5.8
2. ASTM A 193, Grade B7 (high strength carbon steel anchor);
3. AISI 304 or AISI 316 stainless steel, meeting the requirements of ASTM F 593 (condition CW).

Special order length HAS Rods may vary from standard product.

Nuts and Washers Shall be furnished to meet the requirements of the above anchor rod specifications.

3.2.7 HIT-RE 500 Epoxy Adhesive Anchoring System

3.2.7.2 Material Specifications

Material Properties for HIT-RE 500 – Cured Adhesive

Bond Strength ASTM C882-91 ¹ 2 day cure 7 day cure	12.4 MPa 12.4 MPa	1800 psi 1800 psi
Compressive Strength ASTM D-695-96 ¹	82.7 MPa	12,000 psi
Compressive Modulus ASTM D-695-96 ¹	1493 MPa	0.22 x 10 ⁶ psi
Tensile Strength 7 day ASTM D-638-97	43.5 MPa	6310 psi
Elongation at break ASTM D-638-97	2.0%	2.0%
Heat Deflection Temperature ASTM D-648-95	63°C	146°F
Absorption ASTM D-570-95	0.06%	0.06%
Linear Coefficient of Shrinkage on Cure ASTM D-2566-86	0.004	0.004
Electrical resistance DIN IEC 93 (12.93)	6.6 x 10 ¹³ Ω/m	1.7 x 10 ¹² Ω/in.

¹ Minimum values obtained as the result of tests at three cure temperatures (23, 40, 60°F).

Material Specifications

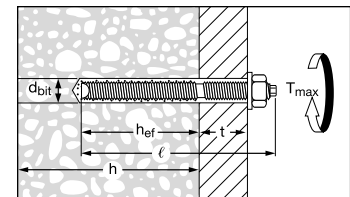
	Mechanical Properties			
	f_y ksi (MPa)		min. f_u ksi (MPa)	
Standard HAS-E rod material meets the requirements of ISO 898 Class 5.8	58	(400)	72.5	(500)
High Strength or 'Super HAS' rod material meets the requirements of ASTM A 193, Grade B7	105	(724)	125	(862)
Stainless HAS rod material meets the requirements of ASTM F 593 (AISI 304/316) Condition CW 3/8" to 5/8"	65	(448)	100	(689)
Stainless HAS rod material meets the requirements of ASTM F 593 (AISI 304/316) Condition CW 3/4" to 1-1/4"	45	(310)	85	(586)
HIS Insert 11MnPb30+C Carbon Steel conforming to DIN 10277-3	54.4	(375)	66.7	(460)
HIS-R Insert X5CrNiMo17122 K700 Stainless Steel conforming to DIN EN 10088-3	50.8	(350)	101.5	(700)
HAS Super & HAS-E Standard Nut Material meets the requirements of SAE J995 Grade 5				
HAS Stainless Steel Nut material meets the requirements of ASTM F 594				
HAS-E Carbon Steel and Stainless Steel Washers meet dimensional requirements of ANSI B18.22.1 Type A Plain				
HAS Super & HAS-E Standard Washers meet the requirements of ASTM F 884, HV				
All HAS-E & HAS Super Rods (except 7/8") & HAS-E Standard, HIS inserts, nuts & washers are zinc plated to ASTM B 633 SC 1				
7/8" Standard HAS-E & HAS Super rods hot-dip galvanized in accordance with ASTM A 153				

Note: Special Order steel rod material may vary from standard materials.

3.2.7.3 Technical Data

HIT-RE 500 Installation Specification Table for HAS Threaded Rods

HAS Rod Size			in.	3/8	1/2	5/8	3/4	7/8	1	1-1/4
Details			(mm)	(9.5)	(12.7)	(15.9)	(19.1)	(22.2)	(25.4)	(31.8)
d _{bit} bit diameter ¹			in.	7/16	9/16	3/4	7/8	1	1-1/8	1-3/8
h _{nom} std. depth of embed.			in.	3-3/8	4-1/2	5-5/8	6-3/4	7-7/8	9	11-1/4
			(mm)	(90)	(110)	(143)	(171)	(200)	(229)	(286)
T _{max} max. tightening torque	HAS-E Rods HAS SS HAS-Super	Embed ≥ h _{nom}	ft lb (Nm)	18 (24)	30 (41)	75 (102)	150 (203)	175 (237)	235 (319)	400 (540)
		Embed < h _{nom}	ft lb (Nm)	15 (20)	20 (27)	50 (68)	105 (142)	125 (169)	165 (224)	280 (375)
h min. base material thickness			-	1.5 hef						
Approximate number of fastenings per cartridge at standard embedment ²										
Small Cartridge				52	28	11	7	5	4	2
Medium Cartridge				84	45	18	11	8	6	3
Jumbo Cartridge				255	137	56	37	27	19	12



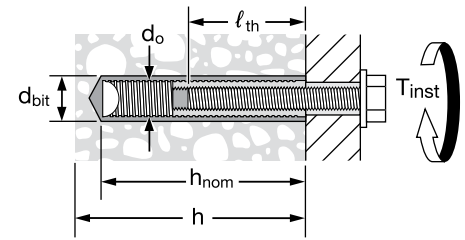
1 Use matched tolerance carbide tipped bits or Hilti matched tolerance DD-B or DD-C diamond core bits.

2 Assumes no waste.

HIT-RE 500 Epoxy Adhesive Anchoring System 3.2.7

HIT-RE 500 Installation Specification Table for HIS Inserts

HIS Insert	in.	3/8	1/2	5/8	3/4
Details	(mm)	(9.5)	(12.7)	(15.9)	(19.1)
d_{bit} bit diameter ¹	in.	11/16	7/8	1-1/8	1-1/4
d_o outside diameter	in.	0.65	0.81	1	1.09
h_{nom} std. embed. depth	in.	4-3/8	5	6-5/8	8-1/4
	(mm)	(110)	(125)	(170)	(210)
ℓ_{th} useable thread length	in.	1	1-3/16	1-1/2	2
	(mm)	(25)	(30)	(40)	(50)
T_{max} Max. tightening torque	ft-lb	18	35	80	160
	(Nm)	(24)	(47)	(108)	(217)
h min. base material thickness	in.	6-3/8	7-1/2	10	12-3/8
	(mm)	(162)	(191)	(254)	(314)
Approx. number of fastenings per cartridge at standard embedment ²					
Small Cartridge		27	16	6	4
Medium Cartridge		49	30	11	8
Jumbo Cartridge		168	105	38	27



1 Use matched tolerance carbide tipped bits or Hilti matched tolerance DD-B or DD-C diamond core bits.

2 Assumes no waste.

HIT-RE 500 Installation Specification Table for Rebar in Concrete

Rebar Size	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11
Details									
Bit diameter ^{1,2}	in.	1/2	5/8	3/4	7/8	1	1-1/8	1-3/8	1-1/2
h_{nom} std. embed. depth	in.	3-3/8	4-1/2	5-5/8	6-3/4	7-7/8	9	10-1/8	11-1/4
	(mm)	(86)	(114)	(143)	(171)	(200)	(229)	(257)	(286)
Approx. number of fastenings per cartridge at standard embedment ³									
Small Cartridge		44	25	16	11	8	6	3	2
Medium Cartridge		72	41	27	18	13	10	5	3
Jumbo Cartridge		221	125	83	56	41	31	14	11

1 Rebar diameters may vary. Use smallest drill bit which will accommodate rebar.

2 Use matched tolerance carbide tipped bits or Hilti matched tolerance DD-B or DD-C diamond core bits.

3 Assumes no waste.

HIT-RE 500 Installation Specification Table for Metric Rebar in Concrete (Canada Only)



Rebar Size	10M	15M	20M	25M	30M	35M
Details						
Bit diameter ¹	in.	5/8	3/4	1	1-1/8	1-3/8
h_{nom} std. embed. depth	(mm)	115	145	200	230	260
Approx. number of fastenings per cartridge at standard embedment ³						
Small Cartridge		20	17	5	6	3
Medium Cartridge		32	28	9	10	5
Jumbo Cartridge		98	84	27	31	16

1 Rebar diameters may vary. Use smallest bit which will accommodate rebar.

2 Assumes no waste.

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right)^{5/3} + \left(\frac{V_d}{V_{rec}} \right)^{5/3} \leq 1.0 \text{ (Ref. Section 3.1.8.3)}$$

3.2.7 HIT-RE 500 Epoxy Adhesive Anchoring System

HIT-RE 500 Allowable and Ultimate Bond/Concrete Capacity for HAS Rods in Normal Weight Concrete^{1,2,3,4}

Anchor Diameter in (mm)	Embedment Depth in (mm)	HIT-RE 500 Allowable Bond/Concrete Capacity				HIT-RE 500 Ultimate Bond/Concrete Capacity			
		Tensile		Shear		Tensile		Shear	
		$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)
3/8 (9.5)	1-3/4 (44)	645 (2.9)	1095 (4.9)	1510 (6.7)	2135 (9.5)	2580 (11.5)	4370 (19.4)	4530 (20.2)	6405 (28.4)
	3-3/8 (86)	2190 (9.7)	2585 (11.5)	3155 (14.0)	4460 (19.8)	8760 (39.0)	10345 (46.0)	9460 (42.1)	13380 (59.5)
	4-1/2 (114)	2420 (10.8)	2585 (11.5)	4855 (21.6)	6860 (30.5)	9685 (43.1)	10335 (46.0)	14560 (64.8)	20580 (91.5)
1/2 (12.7)	2-1/4 (57)	1130 (5.0)	1965 (8.7)	2510 (11.2)	3550 (15.8)	4530 (20.2)	7860 (35.0)	7525 (33.5)	10640 (47.3)
	4-1/2 (114)	4045 (18.0)	5275 (23.5)	5610 (25.0)	7935 (35.3)	16185 (72.0)	21095 (93.8)	16820 (74.8)	23800 (105.9)
	6 (152)	4775 (21.2)	5380 (23.9)	8635 (38.4)	12210 (54.3)	19095 (84.9)	21520 (95.7)	25900 (115.2)	36620 (162.9)
5/8 (15.9)	2-7/8 (73)	1690 (7.5)	3045 (13.5)	5245 (23.3)	7420 (33.0)	6770 (30.1)	12175 (54.2)	15735 (70.0)	22250 (99.0)
	5-5/8 (143)	6560 (29.2)	7355 (32.7)	8760 (39.0)	12395 (55.1)	26240 (116.7)	29420 (130.9)	26280 (116.9)	37180 (165.4)
	7-1/2 (190)	7320 (32.6)	7515 (33.4)	13615 (60.6)	19080 (84.9)	29290 (130.3)	30060 (133.7)	40480 (180.1)	57240 (254.6)
3/4 (19.1)	3-3/8 (86)	2310 (10.3)	4515 (20.1)	7335 (32.6)	10370 (46.1)	9250 (41.1)	18065 (80.4)	22000 (97.9)	31108 (138.4)
	6-3/4 (172)	8670 (38.6)	10755 (47.8)	12615 (56.1)	17840 (79.4)	34685 (154.3)	43020 (191.4)	37840 (168.3)	53520 (238.1)
	9 (229)	10385 (46.2)	12995 (57.8)	19430 (86.4)	27470 (122.2)	41535 (184.8)	51985 (231.2)	58280 (259.2)	82400 (366.5)
7/8 (22.2)	4 (101)	3005 (13.4)	5665 (25.2)	7795 (34.7)	11020 (49.0)	12030 (53.5)	22670 (100.8)	23375 (104.0)	33050 (147.0)
	7-7/8 (200)	12495 (55.6)	15875 (70.6)	17175 (76.4)	24290 (108.0)	49975 (222.3)	63495 (282.4)	51520 (229.2)	72860 (324.1)
	10-1/2 (267)	14705 (65.4)	16185 (72.0)	26440 (117.6)	37390 (166.3)	58820 (261.6)	64730 (287.9)	79320 (352.8)	112160 (498.9)
1 (25.4)	4-1/2 (114)	3945 (17.5)	8440 (37.5)	10035 (44.6)	14190 (63.1)	15790 (70.2)	33765 (150.2)	30104 (133.9)	42565 (189.3)
	9 (229)	13845 (61.6)	17365 (77.2)	22435 (99.8)	31720 (141.1)	55380 (246.3)	69465 (309.0)	67300 (299.4)	95160 (423.3)
	12 (305)	17935 (79.8)	17935 (79.8)	34535 (153.6)	48830 (217.2)	71740 (319.1)	71740 (319.1)	103600 (460.8)	146480 (651.6)
1-1/4 (31.8)	5-5/8 (143)	5760 (25.6)	12815 (57.0)	14760 (65.7)	20870 (92.8)	23045 (102.5)	51270 (228.1)	44280 (197.0)	62610 (278.5)
	11-1/4 (286)	24610 (109.5)	31620 (140.7)	35050 (155.9)	49570 (220.5)	98430 (437.8)	126480 (562.6)	105140 (467.7)	148710 (661.5)
	15 (381)	34130 (151.8)	35270 (156.9)	53960 (240.0)	76300 (339.4)	136525 (607.3)	141090 (627.6)	161880 (720.1)	228900 (1018.2)

1 Influence factors for spacing and/or edge distance are applied to allowable concrete/bond values above, and then compared to the steel value. The lesser of the values is to be used for the design.

2 Average ultimate concrete shear capacity based on Strength Design method for standard and deep embedment and based on testing for shallow embedment.

3 All values based on holes drilled with carbide bit and installed per manufacturer's instructions. Ultimate tensile concrete/bond loads represent the average values obtained in testing.

4 For all underwater applications up to 165 feet/50m depth reduce the tabulated concrete/bond values 30% to account for reduced mechanical properties of saturated concrete.

HIT-RE 500 Epoxy Adhesive Anchoring System 3.2.7

Allowable Steel Strength for Carbon Steel and Stainless Steel HAS Rods¹

Rod Diameter in (mm)	HAS-E Standard ISO 898 Class 5.8		HAS Super ASTM A 193 B7		HAS SS AISI 304/316 SS	
	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	2640 (11.7)	1360 (6.0)	4555 (20.3)	2345 (10.4)	3645 (16.2)	1875 (8.3)
1/2 (12.7)	4700 (20.9)	2420 (10.8)	8100 (36.0)	4170 (18.5)	6480 (28.8)	3335 (14.8)
5/8 (15.9)	7340 (32.7)	3780 (16.8)	12655 (56.3)	6520 (29.0)	10125 (45.0)	5215 (23.2)
3/4 (19.1)	10570 (47.0)	5445 (24.2)	18225 (81.1)	9390 (41.8)	12390 (55.1)	6385 (28.4)
7/8 (22.2)	14385 (64.0)	7410 (33.0)	24805 (110.3)	12780 (56.9)	16865 (75.0)	8690 (38.6)
1 (25.4)	18790 (83.6)	9680 (43.0)	32400 (144.1)	16690 (74.2)	22030 (98.0)	11350 (50.5)
1-1/4 (31.8)	29360 (130.6)	15125 (67.3)	50620 (225.2)	26080 (116.0)	34425 (153.1)	17735 (78.9)

¹ Steel strength as defined in AISC Manual of Steel Construction (ASD):

Tensile = $0.33 \times F_u \times \text{Nominal Area}$

Shear = $0.17 \times F_u \times \text{Nominal Area}$

Ultimate Steel Strength for Carbon Steel and Stainless Steel HAS Rods¹

Rod Diameter in (mm)	HAS-E Standard ISO 898 Class 5.8			HAS Super ASTM A 193 B7			HAS SS AISI 304/316 SS		
	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	4495 (20.0)	6005 (26.7)	3605 (16.0)	8135 (36.2)	10350 (43.4)	6210 (27.6)	5035 (22.4)	8280 (36.8)	4970 (22.1)
1/2 (12.7)	8230 (36.6)	10675 (47.5)	6405 (28.5)	14900 (66.3)	18405 (79.0)	11040 (49.1)	9225 (41.0)	14720 (65.5)	8835 (39.3)
5/8 (15.9)	13110 (58.3)	16680 (74.2)	10010 (44.5)	23730 (105.6)	28760 (125.7)	17260 (76.8)	14690 (65.3)	23010 (102.4)	13805 (61.4)
3/4 (19.1)	19400 (86.3)	24020 (106.9)	14415 (64.1)	35120 (156.2)	41420 (185.7)	24850 (110.5)	15050 (66.9)	28165 (125.3)	16800 (75.2)
7/8 (22.2)	26780 (119.1)	32695 (145.4)	19620 (87.3)	48480 (215.7)	56370 (256.9)	33825 (150.5)	20775 (92.4)	38335 (170.5)	23000 (102.3)
1 (25.4)	35130 (156.3)	42705 (190.0)	25625 (114.0)	63600 (282.9)	73630 (337.0)	44180 (196.5)	27255 (121.2)	50070 (222.7)	30040 (133.6)
1-1/4 (31.8)	56210 (250.0)	66730 (296.8)	40035 (178.1)	101755 (452.6)	115050 (511.8)	69030 (307.1)	43610 (194.0)	78235 (348.0)	46940 (208.8)

¹ Steel strength as defined in AISC Manual of Steel Construction 2nd Ed. (LRFD):

Yield = $F_y \times \text{Tensile Stress Area}$

Tensile = $0.75 \times F_u \times \text{Nominal Area}$

Shear = $0.45 \times F_u \times \text{Nominal Area}$

3.2.7 HIT-RE 500 Epoxy Adhesive Anchoring System

HIT-RE 500 Allowable Bond/Concrete Capacity and Steel Strength for HIS Carbon Steel and HIS-R Stainless Steel Internally Threaded Inserts

Anchor Diameter in (mm)	Embedment Depth in (mm)	HIT-RE 500 Allowable Bond/Concrete Capacity ²		Steel Bolt Strength ^{1,2}			
		Tensile $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	Shear $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	ASTM A 325 Carbon Steel		ASTM F 593 Stainless Steel	
				Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	4-3/8 (110)	2870 (12.8)	1565 (7.0)	4370 (19.4)	2250 (10.0)	3645 (16.2)	1875 (8.3)
1/2 (12.7)	5 (127)	4530 (20.1)	2890 (12.9)	7775 (34.6)	4005 (17.8)	6480 (28.8)	3335 (14.8)
5/8 (15.9)	6-5/8 (168)	8255 (36.7)	4635 (20.6)	12150 (54.0)	6260 (27.8)	10125 (45.0)	5215 (23.2)
3/4 (19.1)	8-1/4 (210)	9030 (40.1)	6695 (29.8)	17945 (77.8)	9010 (40.1)	12395 (55.1)	6385 (28.4)

HIT-RE 500 Ultimate Bond/Concrete Capacity and Steel Strength for HIS Carbon Steel and HIS-R Stainless Steel Internally Threaded Inserts

Anchor Diameter in (mm)	Embedment Depth in (mm)	HIT-RE 500 Ultimate Bond/Concrete Capacity		Ultimate Bolt Strength ¹			
		Tensile $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	Shear $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	ASTM A 325 Carbon Steel		ASTM F 593 Stainless Steel	
				Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	4-3/8 (110)	11480 (51.0)	6260 (27.8)	9935 (44.2)	5960 (26.5)	8280 (36.8)	4970 (22.1)
1/2 (12.7)	5 (127)	18115 (80.5)	11565 (51.4)	17665 (78.6)	10600 (47.2)	14720 (65.5)	8835 (39.3)
5/8 (15.9)	6-5/8 (168)	33025 (146.9)	18550 (82.5)	27610 (122.8)	16565 (73.7)	23010 (102.4)	13805 (61.4)
3/4 (19.1)	8-1/4 (210)	36125 (160.6)	26775 (119.1)	39760 (176.9)	23855 (106.1)	28165 (125.3)	16900 (75.1)

1 Steel values in accordance with AISC

ASTM A 325 bolts: $F_y = 92$ ksi, $F_u = 120$ ksi
 ASTM F 593 (AISI 304/316): $F_y = 65$ ksi, $F_u = 100$ ksi for 3/8" thru 5/8"
 $F_y = 45$ ksi, $F_u = 85$ ksi for 3/4"

Allowable Load Values Ultimate Load Values

Tension = $0.33 \times F_u \times A_{nom}$ Tension = $0.75 \times F_u \times A_{nom}$

Shear = $0.17 \times F_u \times A_{nom}$ Shear = $0.45 \times F_u \times A_{nom}$

2 Use lower value of either allowable bond/concrete capacity or steel strength.

HIT-RE 500 Epoxy Adhesive Anchoring System 3.2.7

HIT-RE 500 Ultimate Bond Capacity and Steel Strength for Rebar in Concrete

Nominal Rebar Size	Embedment Depth in. (mm)	Concrete Compressive Strength						Grade 60 Rebar	
		f'_c = 2000 psi (13.8 MPa)			f'_c = 4000 psi (27.6 MPa)				
		Ultimate Bond Strength lb (kN)	Embed. to Develop Yield Strength ¹ in. (mm)	Embed. to Develop Tensile Strength ¹ in. (mm)	Ultimate Bond Strength lb (kN)	Embed. to Develop Yield Strength ¹ in. (mm)	Embed. to Develop Tensile Strength ¹ in. (mm)	Yield Strength lb (kN)	Tensile Strength lb (kN)
#3	3-3/8 (86)	10105 (45.0)	2-1/4 (57)	3-3/8 (86)	10810 (48.1)	2-1/8 (54)	3-1/4 (84)	6600 (29.4)	9900 (44.0)
	4-1/2 (114)	10920 (48.6)			10810 (48.1)				
#4	4-1/2 (114)	15980 (71.1)	3-3/8 (86)	5-5/8 (143)	18540 (82.5)	3 (76)	4-3/8 (111)	12000 (53.4)	18000 (80.1)
	6 (152)	18830 (83.8)			18655 (83.0)				
#5	5-5/8 (143)	20630 (91.8)	5-1/8 (130)	8-7/8 (225)	27790 (123.6)	3-7/8 (98)	5-3/4 (146)	18600 (82.7)	27900 (124.1)
	7-1/2 (191)	24870 (110.6)			27790 (128.6)				
#6	6-3/4 (171)	33695 (149.9)	5-3/8 (136)	9-3/8 (238)	44675 (198.7)	4 (102)	6 (152)	26400 (117.4)	39600 (176.2)
	9 (229)	38960 (173.3)			44870 (200.0)				
#7	7-7/8 (200)	40525 (180.3)	7 (178)	12-3/8 (314)	59340 (264.0)	4-7/8 (124)	7-1/4 (184)	36000 (160.1)	54000 (240.2)
	10-1/2 (267)	48460 (215.6)			61720 (274.6)				
#8	9 (229)	63940 (284.4)	8-1/4 (210)	12-7/8 (327)	72820 (323.9)	5-7/8 (149)	8-7/8 (225)	47400 (210.9)	71100 (316.3)
	12 (305)	69610 (309.7)			72950 (324.5)				
#9	10-1/8 (257)	72245 (321.4)	8-1/2 (216)	13 (330)	81235 (361.4)	7-1/2 (191)	12 (305)	60000 (266.9)	90000 (400.4)
	13-1/2 (343)	94205 (419.1)			84015 (373.7)				
#10	11-1/4 (286)	92000 (409.3)	9-3/8 (238)	17-7/8 (454)	96725 (430.3)	8-7/8 (225)	14 (356)	76200 (339.0)	114300 (508.5)
	15 (381)	95850 (426.4)			97070 (431.8)				
#11	12-3/8 (314)	118615 (527.6)	9-7/8 (251)	18-3/4 (476)	123120 (547.7)	9-1/2 (241)	16-1/2 (419)	93600 (416.4)	140400 (624.6)
	16-1/2 (419)	123570 (549.7)			123790 (550.7)				

1 Based on comparison of average ultimate adhesive bond test values versus minimum yield and ultimate tensile strength of rebar. For more information, contact Hilti.

3.2.7 HIT-RE 500 Epoxy Adhesive Anchoring System

HIT-RE 500 Bond Capacity and Steel Strength for Metric Rebar in Concrete (Canada Only)^{1, 2, 3, 4, 5, 6, 7}



Rebar Size	HIT-RE 500 Tensile Bond Strength					Strength Properties of Metric Rebar	
	Embedment Depth mm (in.)	$f'_c = 14 \text{ MPa}$		$f'_c = 28 \text{ MPa}$		$f_y = 400 \text{ MPa}$	$f_u = 600 \text{ MPa}$
		Ultimate Bond kN (lb)	Allowable Bond kN (lb)	Ultimate Bond kN (lb)	Allowable Bond kN (lb)	Yield Strength kN (lb)	Tensile Strength kN (lb)
10M	115 (4-1/2)	71.1 (15980)	17.8 (3995)	82.5 (18540)	20.6 (4635)	40 (8990)	60 (13490)
	150 (6)	83.8 (18830)	20.9 (4705)	83.0 (18655)	20.7 (4665)		
15M	145 (5-5/8)	91.8 (20630)	22.9 (5155)	123.7 (27810)	30.9 (6945)	80 (17985)	120 (26975)
	190 (7-1/2)	110.6 (24870)	27.6 (6215)	123.6 (27790)	30.9 (6945)		
20M	200 (7-7/8)	180.3 (40525)	45.1 (10130)	264 (59340)	66 (14835)	120 (26975)	180 (40465)
	265 (10-1/2)	215.6 (48460)	53.9 (12115)	274.6 (61720)	68.6 (15430)		
25M	230 (9)	284.4 (63940)	71.0 (15985)	323.9 (72820)	81.0 (18205)	200 (44960)	300 (67440)
	305 (12)	309.7 (69610)	77.4 (17400)	324.5 (72950)	81.1 (18235)		
30M	260 (10-1/8)	321.4 (72245)	80.3 (18060)	361.4 (81235)	90.3 (20305)	280 (62945)	420 (94415)
	345 (13-1/2)	419.1 (94205)	104.8 (23550)	373.7 (84015)	93.4 (21000)		
35M	315 (12-3/8)	527.6 (118615)	131.9 (29650)	547.7 (123120)	136.9 (30780)	400 (89920)	600 (134880)
	420 (16-1/2)	549.7 (123570)	137.4 (30890)	550.7 (123790)	137.6 (30945)		

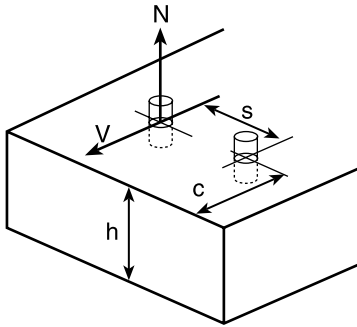
- 1 Based on minimum steel strength and nominal cross-sectional area of rebar.
- 2 Use lesser value of allowable bond strength or steel strength.
- 3 Minimum concrete thickness must be equal to 1.5 times the anchor embedment.
- 4 Bond/concrete values interpolated from testing done with imperial rebar sizes.
- 5 Allowable tension for adhesive bond based on a safety factor of 4.0.
- 6 For anchor spacing and edge distance guidelines, please refer to the following pages.
- 7 Ultimate tensile concrete/bond loads represent the average values obtained in testing.

HIT-RE 500 Ultimate Tensile Bond Strength for Smooth Epoxy Coated Dowel Bars in Concrete $\geq 2410 \text{ psi (15.9 MPa)}$

Anchor Diameter in. (mm)	Drill Bit Diameter in. (mm)	Embedment Depth in. (mm)	Ultimate Tensile Load lb (kN)
1 (25.4)	1-1/8 (29)	9 (229)	40385 (179.7)
1-1/4 (31.8)	1-3/8 (34.9)		
1-1/2 (38.1)	1-5/8 (41)		

HIT-RE 500 Epoxy Adhesive Anchoring System 3.2.7

Anchor Spacing and Edge Distance Guidelines in Concrete



Note: Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing Tension/Shear
 $s_{\min} = 0.5 h_{ef}$ $s_{cr} = 1.5 h_{ef}$
 $f_A = 0.3(s/h_{ef}) + 0.55$
for $s_{cr} > s > s_{\min}$

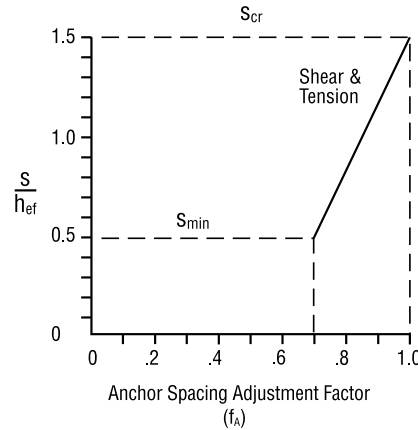
Edge Distance Tension
 $c_{\min} = 0.5 h_{ef}$ $c_{cr} = 1.5 h_{ef}$
 $f_{RN} = 0.3(c/h_{ef}) + 0.55$
for $c_{cr} > c > c_{\min}$

Edge Distance Shear
(⊥ toward edge)
 $c_{\min} = 0.5 h_{ef}$ $c_{cr} = 2.0 h_{ef}$
 $f_{RV1} = 0.54(c/h_{ef}) - 0.09$
for $c_{cr} > c > c_{\min}$

Edge Distance Shear
(∥ to or away from edge)
 $c_{\min} = 0.5 h_{ef}$ $c_{cr} = 2.0 h_{ef}$
 $f_{RV2} = 0.36(c/h_{ef}) + 0.28$
for $c_{cr} > c > c_{\min}$

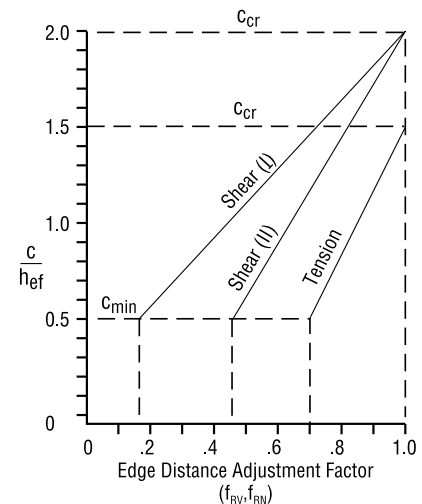
Anchor Spacing Adjustment Factors

s = Actual spacing
 h_{ef} = Actual embedment
 $s_{\min} = 0.5 h_{ef}$
 $s_{cr} = 1.5 h_{ef}$



Edge Distance Adjustment Factors

c = Actual edge distance
 h_{ef} = Actual embedment
 $c_{\min} = 0.5 h_{ef}$ Tension and shear
 $c_{cr} = 1.5 h_{ef}$ Tension
 $c_{cr} = 2.0 h_{ef}$ Shear
⊥ = Perpendicular to edge
∥ = Parallel to edge



Load Adjustment Factors for 3/8" Diameter Anchors

Load Adjustment Factors for 3/8" Diameter Anchors													
Anchor Diameter		3/8" diameter											
Adjustment Factor		Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}		
Embedment Depth, in		1-3/4	3-3/8	4-1/2	1-3/4	3-3/8	4-1/2	1-3/4	3-3/8	4-1/2	1-3/4	3-3/8	4-1/2
Spacing (s)/Edge Distance (c), in.	7/8	0.70			0.70			0.18			0.46		
	1	0.72			0.72			0.22			0.49		
	1 11/16	0.84	0.70		0.84	0.70		0.43	0.18		0.63	0.46	
	2	0.89	0.73		0.89	0.73		0.53	0.22		0.69	0.49	
	2 1/4	0.94	0.75	0.70	0.94	0.75	0.70	0.60	0.27	0.18	0.74	0.52	0.46
	2 5/8	1.00	0.78	0.73	1.00	0.78	0.73	0.72	0.33	0.23	0.82	0.56	0.49
	3		0.82	0.75		0.82	0.75	0.84	0.39	0.27	0.90	0.60	0.52
	3 1/2		0.86	0.78		0.86	0.78	1.00	0.47	0.33	1.00	0.65	0.56
	4		0.91	0.82		0.91	0.82		0.55	0.39		0.71	0.60
	5 1/16		1.00	0.89		1.00	0.89		0.72	0.52		0.82	0.69
	5 1/2			0.92			0.92		0.79	0.57		0.87	0.72
	6			0.95			0.95		0.87	0.63		0.92	0.76
	6 3/4			1.00			1.00		1.00	0.72		1.00	0.82
	8									0.87			0.92
	9									1.00			1.00

3.2.7 HIT-RE 500 Epoxy Adhesive Anchoring System

Anchor Spacing and Edge Distance Guidelines in Concrete

Note: Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Load Adjustment Factors for 1/2" Diameter Anchors												
Anchor Diameter	1/2" diameter											
Adjustment Factor	Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (L toward edge) f_{RV1}			Edge Distance Shear (ll to or away from edge) f_{RV2}		
Embedment Depth, in	2-1/4	4-1/2	6	2-1/4	4-1/2	6	2-1/4	4-1/2	6	2-1/4	4-1/2	6
1-1/8	0.70			0.70			0.18			0.46		
1-1/2	0.75			0.75			0.27			0.52		
1-3/4	0.78			0.78			0.33			0.56		
2	0.82			0.82			0.39			0.60		
2-1/4	0.85	0.70		0.85	0.70		0.45	0.18		0.64	0.46	
2-1/2	0.88	0.72		0.88	0.72		0.51	0.21		0.68	0.48	
3	0.95	0.75	0.70	0.95	0.75	0.70	0.63	0.27	0.18	0.76	0.52	0.46
3-3/8	1.00	0.78	0.72	1.00	0.78	0.72	0.72	0.32	0.21	0.82	0.55	0.48
4		0.82	0.75		0.82	0.75	0.87	0.39	0.27	0.92	0.60	0.52
4-1/2		0.85	0.78		0.85	0.78	1.00	0.45	0.32	1.00	0.64	0.55
5		0.88	0.80		0.88	0.80		0.51	0.36		0.68	0.58
6		0.95	0.85		0.95	0.85		0.63	0.45		0.76	0.64
6-3/4		1.00	0.89		1.00	0.89		0.72	0.52		0.82	0.69
7			0.90			0.90		0.75	0.54		0.84	0.70
8			0.95			0.95		0.87	0.63		0.92	0.76
9			1.00			1.00		1.00	0.72		1.00	0.82
10									0.81			0.88
11									0.90			0.94
12									1.00			1.00

Spacing Tension/Shear

$$s_{\min} = 0.5 h_{ef}, s_{cr} = 1.5 h_{ef}$$

$$f_A = 0.3(s/h_{ef}) + 0.55$$

for $s_{cr} > s > s_{\min}$

Edge Distance Tension

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 1.5 h_{ef}$$

$$f_{RN} = 0.3(c/h_{ef}) + 0.55$$

for $c_{cr} > c > c_{\min}$

Edge Distance Shear (L toward edge)

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV1} = 0.54(c/h_{ef}) - 0.09$$

for $c_{cr} > c > c_{\min}$

Edge Distance Shear (ll to or away from edge)

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV2} = 0.36(c/h_{ef}) + 0.28$$

for $c_{cr} > c > c_{\min}$

Load Adjustment Factors for 5/8" and 3/4" Diameter Anchors																												
Anchor Diameter		5/8" diameter												3/4" diameter														
Adjustment Factor		Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}					
Embedment Depth, in		2-7/8	5-5/8	7-1/2	2-7/8	5-5/8	7-1/2	2-7/8	5-5/8	7-1/2	2-7/8	5-5/8	7-1/2	2-7/8	5-5/8	7-1/2	3-3/8	6-3/4	9	3-3/8	6-3/4	9	3-3/8	6-3/4	9	3-3/8	6-3/4	9
Spacing (s)/Edge Distance (c), in.	1-7/16	0.70			0.70			0.18			0.46																	
	1-11/16	0.73			0.73			0.23			0.49			0.70			0.70			0.18			0.46					
	2	0.76			0.76			0.29			0.53			0.73			0.73			0.23			0.49					
	2-13/16	0.84	0.70		0.84	0.70		0.44	0.18		0.63	0.46		0.80			0.80			0.36			0.58					
	3-3/8	0.90	0.73		0.90	0.73		0.54	0.23		0.70	0.50		0.85	0.70		0.85	0.70		0.45	0.18		0.64	0.46				
	3-3/4	0.94	0.75	0.70	0.94	0.75	0.70	0.61	0.27	0.18	0.75	0.52	0.46	0.88	0.72		0.88	0.72		0.51	0.21		0.68	0.48				
	4-5/16	1.00	0.78	0.72	1.00	0.78	0.72	0.72	0.32	0.22	0.82	0.56	0.49	0.93	0.74		0.93	0.74		0.60	0.26		0.74	0.51				
	4-1/2		0.79	0.73		0.79	0.73	0.76	0.34	0.23	0.84	0.57	0.50	0.95	0.75	0.70	0.95	0.75	0.70	0.63	0.27	0.18	0.76	0.52	0.46			
	5-1/16		0.82	0.75		0.82	0.75	0.86	0.40	0.27	0.91	0.60	0.52	1.00	0.78	0.72	1.00	0.78	0.72	0.72	0.32	0.21	0.82	0.55	0.48			
	5-5/8		0.85	0.78		0.85	0.78	0.97	0.45	0.32	0.98	0.64	0.55		0.80	0.74		0.80	0.74	0.81	0.36	0.25	0.88	0.58	0.51			
	5-3/4		0.86	0.78		0.86	0.78	1.00	0.46	0.32	1.00	0.65	0.56		0.81	0.74		0.81	0.74	0.83	0.37	0.26	0.89	0.59	0.51			
	6-3/4		0.91	0.82		0.91	0.82		0.56	0.40		0.71	0.60		0.85	0.78		0.85	0.78	1.00	0.45	0.32	1.00	0.64	0.55			
	8-7/16		1.00	0.89		1.00	0.89		0.72	0.52		0.82	0.69		0.93	0.83		0.93	0.83		0.59	0.42		0.73	0.62			
	10-1/8			0.96			0.96		0.88	0.64		0.93	0.77		1.00	0.89		1.00	0.89		0.72	0.52		0.82	0.69			
	11-1/4			1.00			1.00		1.00	0.72		1.00	0.82			0.93			0.93		0.81	0.59		0.88	0.73			
	12									0.77			0.86			0.95			0.95		0.87	0.63		0.92	0.76			
	13-1/2									0.88			0.93			1.00			1.00		1.00	0.72		1.00	0.82			
15									1.00			1.00									0.81			0.88				
16																					0.87			0.92				
18																					1.00			1.00				

HIT-RE 500 Epoxy Adhesive Anchoring System 3.2.7

Anchor Spacing and Edge Distance Guidelines in Concrete

Note: Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Load Adjustment Factors for 7/8" Diameter Anchors												
Anchor Diameter	7/8" diameter											
Adjustment Factor	Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (L toward edge) f_{RV1}			Edge Distance Shear (ll to or away from edge) f_{RV2}		
Embedment Depth, in	4	7-7/8	10-1/2	4	7-7/8	10-1/2	4	7-7/8	10-1/2	4	7-7/8	10-1/2
Spacing (s)/Edge Distance (c), in.	2	0.70		0.70			0.18			0.46		
	2-1/2	0.74		0.74			0.25			0.51		
	3	0.78		0.78			0.32			0.55		
	3-1/2	0.81		0.81			0.38			0.60		
	3-15/16	0.85	0.70	0.85	0.70		0.44	0.18		0.63	0.46	
	4-1/2	0.89	0.72	0.89	0.72		0.52	0.22		0.69	0.49	
	5	0.93	0.74	0.93	0.74		0.59	0.25		0.73	0.51	
	5-1/4	0.94	0.75	0.94	0.75	0.70	0.62	0.27	0.18	0.75	0.52	0.46
	6	1.00	0.78	1.00	0.78	0.72	0.78	0.32	0.22	0.82	0.55	0.49
	6-1/2		0.80	0.74		0.80	0.74	0.79	0.36	0.87	0.58	0.50
	7		0.82	0.75		0.82	0.75	0.86	0.39	0.91	0.60	0.52
	8		0.85	0.78		0.85	0.78	1.00	0.46	1.00	0.65	0.55
	10		0.93	0.84		0.93	0.84		0.60	0.42	0.74	0.62
	11-13/16		1.00	0.89		1.00	0.89		0.72	0.52	0.82	0.69
	12			0.89			0.89		0.73	0.53	0.83	0.69
	14			0.95			0.95		0.87	0.63	0.92	0.76
	15-3/4			1.00			1.00		1.00	0.72	1.00	0.82
	18									0.84		0.90
	20									0.94		0.97
	21								1.00			1.00

$$s_{\min} = 0.5 h_{ef}, s_{cr} = 1.5 h_{ef}$$

$$f_A = 0.3(c/h_{ef}) + 0.55$$

for $s_{cr} > s_{\min}$

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 1.5 h_{ef}$$

$$f_{RN} = 0.3(c/h_{ef}) + 0.55$$

for $c_{cr} > c_{\min}$

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV1} = 0.54(c/h_{ef}) - 0.09$$

for $c_{cr} > c_{\min}$

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV2} = 0.36(c/h_{ef}) + 0.28$$

for $c_{cr} > c_{\min}$

Load Adjustment Factors for 1" and 1-1/4" Diameter Anchors																									
Anchor Diameter		1" diameter												1-1/4" diameter											
Adjustment Factor		Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}		
Embedment Depth, in		4-1/2	9	12	4-1/2	9	12	4-1/2	9	12	4-1/2	9	12	5-5/8	11-1/4	15	5-5/8	11-1/4	15	5-5/8	11-1/4	15	5-5/8	11-1/4	15
Spacing (s)/Edge Distance (c), in.	2-1/4	0.70			0.70			0.18			0.46														
	2-3/4	0.73			0.73			0.24			0.50			0.70			0.70			0.18			0.46		
	3	0.75			0.75			0.27			0.52			0.71			0.71			0.20			0.47		
	4	0.82			0.82			0.39			0.60			0.76			0.76			0.29			0.54		
	4-1/2	0.85	0.70		0.85	0.70		0.45	0.18		0.64	0.46		0.79			0.79			0.34			0.57		
	5	0.88	0.72		0.88	0.72		0.51	0.21		0.68	0.48		0.82			0.82			0.39			0.60		
	5-5/8	0.93	0.74		0.93	0.74		0.59	0.25		0.73	0.51		0.85	0.70		0.85	0.70		0.45	0.18		0.64	0.46	
	6	0.95	0.75	0.70	0.95	0.75	0.70	0.63	0.27	0.18	0.76	0.52	0.46	0.87	0.71		0.87	0.71		0.49	0.20		0.66	0.47	
	6-3/4	1.00	0.78	0.72	1.00	0.78	0.72	0.72	0.32	0.21	0.82	0.55	0.48	0.91	0.73		0.91	0.73		0.56	0.23		0.71	0.50	
	7-1/2		0.80	0.74		0.80	0.74	0.81	0.36	0.25	0.88	0.58	0.51	0.95	0.75	0.70	0.95	0.75	0.70	0.63	0.27	0.18	0.76	0.52	0.46
	8-1/4		0.83	0.76		0.83	0.76	0.90	0.41	0.28	0.94	0.61	0.53	0.99	0.77	0.72	0.99	0.77	0.72	0.70	0.31	0.21	0.81	0.54	0.48
	9		0.85	0.78		0.85	0.78	1.00	0.45	0.32	1.00	0.64	0.55	1.00	0.79	0.73	1.00	0.79	0.73	0.77	0.34	0.23	0.86	0.57	0.50
	10		0.88	0.80		0.88	0.80		0.51	0.36		0.68	0.58		0.82	0.75		0.82	0.75	0.87	0.39	0.27	0.92	0.60	0.52
	11		0.92	0.83		0.92	0.83		0.57	0.41		0.72	0.61		0.84	0.77		0.84	0.77	1.00	0.44	0.31	0.98	0.63	0.54
	12		0.95	0.85		0.95	0.85		0.63	0.45		0.76	0.64		0.87	0.79		0.87	0.79		0.49	0.34	1.00	0.66	0.57
	13-1/2		1.00	0.89		1.00	0.89		0.72	0.52		0.82	0.69		0.91	0.82		0.91	0.82		0.56	0.40		0.71	0.60
	14			0.90			0.90		0.75	0.54		0.84	0.70		0.92	0.83		0.92	0.83		0.58	0.41		0.73	0.62
	16-7/8			0.97			0.97		0.92	0.67		0.96	0.79		1.00	0.89		1.00	0.89		0.72	0.52		0.82	0.69
	18			1.00			1.00		1.00	0.72		1.00	0.82			0.91			0.91		0.77	0.56		0.86	0.71
	20									0.81			0.88			0.95			0.95		0.87	0.63		0.92	0.76
	22-1/2									0.92			0.96			1.00			1.00		1.00	0.72		1.00	0.82
	24									1.00			1.00									0.77			0.86
	27																						0.88		0.93
	30																						1.00		1.00

3.2.7 HIT-RE 500 Epoxy Adhesive Anchoring System

Resistance of HIT-RE 500 to Chemicals

Chemical	Chemicals Tested	Resistant	Not Resistant
Alkaline (Base material concrete)	Concrete drilling mud (10%) pH=12.6	+	
	Concrete drilling mud (10%) pH=13.2	+	
	Concrete potash solution (10%) pH=14.0	+	
Acids	Acetic acid (10%)*		-
	Nitric acid (10%)*		-
	Hydrochloric acid (10%) 3 month -		-
	Sulfuric acid (10%)		-
Solvents	Benzyl alcohol		-
	Ethanol		-
	Ethyl acetate		-
	Methyl ethyl ketone (MEK)		-
	Trichlorethylene		-
	Xylene (mixture)	+	
Chemicals used on job sites	Concrete plasticizer	+	
	Diesel oil	+	
	Oil	+	
	Petrol	+	
	Oil for form work (forming oil)	+	
Environmental Chemicals	Salt water	+	
	de-mineralized water	+	
	salt spraying test	+	
	SO ₂	+	
	Environment/Weather	+	

*Concrete was dissolved by acid.

Samples of the HIT-RE 500 resin 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 were heavily damaged or destroyed were classified as **“Not Resistant.”**

Note: In actual use, the majority of the resin is encased in the base material, leaving very little surface area exposed.

Full Cure Time Table¹ (100% of working load)

Base Material Temperature		Approximate Full Curing Time
°F	°C	
23	-5	72 hours
32	0	50 hours
50	10	24 hours
68	20	12 hours
86	30	8 hours
104	40	4 hours

Initial Cure Time Table¹ (25% of working load)

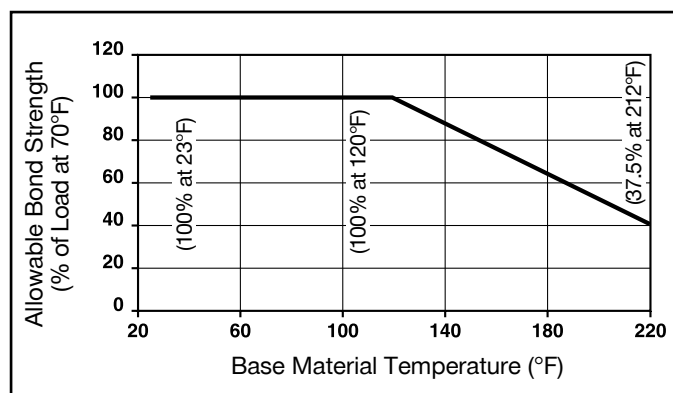
Base Material Temperature		Approximate Initial Cure Time
°F	°C	
23	-5	36 hours
32	0	25 hours
50	10	12 hours
68	20	6 hours
86	30	4 hours
104	40	2 hours

Gel Time Table¹ (Approximate)

Base Material Temperature		Approximate Gel Time
°F	°C	
23	-5	4 hours
32	0	3 hours
50	10	2 hours
68	20	30 minutes
86	30	20 minutes
104	40	12 minutes

¹ Minimum product temperature must be maintained above 41°F (5°C) prior/during installation.

Influence of Temperature on Bond Strength



Note: 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.

Long term creep test in accordance with AC58 is available; please contact Hilti Technical Services.

HIT-RE 500 Epoxy Adhesive Anchoring System 3.2.7

3.2.7.4 Installation Instructions

Please refer to installation instructions provided within packaging of adhesive anchoring product.

3.2.7 HIT-RE 500 Epoxy Adhesive Anchoring System

HIT HIT-RE 500 Volume Charts

Threaded Rod Installation

Rod Diameter (in.)	Drill Bit Diameter (in.)	Adhesive Volume Required per Inch of embedment (in ³)
1/4	5/16	0.055
3/8	7/16	0.095
1/2	9/16	0.133
5/8	3/4	0.261
3/4	7/8	0.326
7/8	1	0.391
1	1-1/8	0.478
1-1/4	1-3/8	0.626

EXAMPLE:

Determine approximate fastenings for 5/8" rod embedded 10" deep.

$10 \times 0.261 = 2.61 \text{ in}^3$ of adhesive per anchor

$16.5 \div 2.61 \approx 6$ fastenings per small cartridge

$81.8 \div 2.61 \approx 31$ fastenings per jumbo cartridge

Rebar Installation

Rod Diameter (in.)	Drill Bit ¹ Diameter (in.)	Adhesive Volume Required per Inch of embedment (in ³)
#3 or 3/8	1/2	0.110
#4 or 1/2	5/8	0.146
#5 or 5/8	3/4	0.176
#6 or 3/4	7/8	0.218
#7 or 7/8	1	0.252
#8 or 1	1-1/8	0.299
#9 or 1-1/8	1-3/8	0.601
#10 or 1-1/4	1-1/2	0.659
#11 or 1-3/8	1-3/4	1.037

NOTE:

Useable volume of HIT-RE 500 refill cartridge is 16.5 in³ (270 ml).

Useable volume of HIT-RE 500 medium refill cartridge is 26.9 in³ (440 ml).

Useable volume of HIT-RE 500 jumbo refill cartridge is 81.8 in³ (1340 ml).

¹ Rebar diameter may vary. Use smallest drill bit which will accommodate rebar.

Metric Rebar Installation (Canada Only)



Bar Diameter	Drill Bit ¹ Diameter (in.)	Adhesive Volume Required per Inch of embedment (in ³)
10M	5/8	0.186
15M	3/4	0.170
20M	1	0.388
25M	1-1/8	0.289
30M	1-3/8	0.481
35M	1-3/4	0.996

3.2.7.5 Ordering Information

HIT RE Mixer			
	HIT-RE 500 Refill Pack	HIT-RE 500 Medium Cartridge	HIT-RE 500 Jumbo Cartridge

Hit Adhesives

Description	Contents
HIT-RE 500 11.1 oz (330 ml)	Includes (1) Refill Pack and (1) Mixer with filler tube
HIT-RE 500 MC 11.1 oz (330 ml)	Includes (25) Refill Packs and (25) Mixers with filler tube
HIT-RE 500 Medium 16.9 oz (500 ml)	Includes (20) Refill Packs and (20) Mixers with filler tube
HIT-RE 500 Jumbo 47.3 oz (1400 ml)	Includes (4) Jumbo Refill Packs and (4) Mixers

HIT-RE 500 Epoxy Adhesive Anchoring System 3.2.7

Dispensers

Battery Powered

Ordering designation	Contents	
ED3500 2.0 Ah kit	①	①

Manual

Ordering designation	Contents		
MD 2000 dispenser — includes foil pack holder	②	②	
MD 2500 Manual Dispenser	③		
Refill Holder Replacement for MD2000, ED 3500 or P-3000HY dispensers	④		④

Pneumatic Dispenser with 1/4" internally threaded compressed air coupling

Ordering designation	Contents	
P-3500 dispenser (for foil packs)	⑤	③
HIT-P8000D pneumatic dispenser (for jumbo cartridges)	⑥	
Jumbo pack holder replacement for P8000D		⑤

Mixers & Filler Tubes

Ordering designation	Qty/Pkg	
HIT-RE-M static mixer (suitable for foil pack and jumbo cartridges)	1	⑥

HIT-RE-M Mixer

Refer to Section 3.2.6.5 for ordering information of HAS threaded rods and HIS inserts.

HIT-ICE Adhesive Anchoring System 3.2.8

3.2.8.1 Product Description

HIT-ICE consists of an epoxy acrylate and hardener. It is formulated for fast curing and installation in a wide range of solid base material temperatures. Designed for colder environmental installations, HIT-ICE adhesive is a winter formulation for base material temperatures down to -10°F (-23°C).

The systems consist of adhesive refill packs, a mixing nozzle, a HIT dispenser and either a threaded rod, rebar, HIS internally threaded insert or eyebolts. HIT-ICE is specifically designed for fastening into solid base materials such as concrete, grout, stone or grout filled block.

The Hilti HIT-TZ is an innovative threaded rod installed with HIT-ICE. Please refer to section 3.2.5 for details on HIT-TZ. With the combination of HIT-ICE and the innovative design of the HIT-TZ rod, anchoring into uncleaned holes, wet holes (including standing water) and/or Hilti matched tolerance diamond-cored holes does not adversely affect tensile capacity.

Product Features of HIT-ICE

- Small edge distance and anchor spacing allowance
- Mixing tube provides proper mixing and accurate dispensing of mixed resin
- Contains no styrene; virtually odorless
- Cures quickly over a large range of base material temperatures
- Excellent weathering resistance; high temperature resistance
- High load capacities

3.2.8.1 Product Description

3.2.8.2 Material Specifications

3.2.8.3 Technical Data

3.2.8.4 Installation Instructions

3.2.8.5 Ordering Information

HIT-ICE Cartridge

Independent Code Evaluation

LEED®: Credit 4.1-Low Emitting Materials

The Leadership in Energy and Environmental Design (LEED®) Green Building Rating system™ is the nationally accepted benchmark for the design, construction and operation of high performance green buildings.

3.2.8 HIT-ICE Adhesive Anchoring System

Guide Specifications

Master Format Section:

Previous 2004 Format

03250 03 16 00 (Concrete Anchors)

Related Sections:

03200 03 20 00 (Concrete Reinforcing)

05050 05 50 00 (Metal Fabrications)

05120 05 10 00 (Structural Metal Framing)

Injectable adhesive shall be used for installation of all reinforcing steel dowels or threaded anchor rods and inserts into new or existing concrete. Adhesive shall be furnished in containers which keep component A and component B

separate. Containers shall be designed to accept static mixing nozzle which thoroughly blends component A and component B and allows injection directly into drilled hole. Only injection tools and static mixing nozzles as recommended by manufacturer shall be used. Manufacturer's instructions shall be followed. Injection adhesive shall be formulated to include resin and hardener to provide optimal curing speed as well as high strength and stiffness. Typical curing time at 68°F shall be 1 hour for HIT-ICE. Injection adhesive shall be HIT-ICE, as furnished by Hilti.

Anchor Rods shall be furnished with chamfered ends so that either end will accept a nut and washer. Alternatively, anchor rods shall be furnished with a 45 degree chisel point on one end to allow for easy insertion into the adhesive-filled hole. Anchor rods shall be manufactured to meet the following requirements: 1. ISO 898 Class 5.8; 2. ASTM A 193, Grade B7 (high strength carbon steel anchor); 3. AISI 304 or AISI 316 stainless steel, meeting the requirements of ASTM F 593 (condition CW).

Special order length HAS Rods may vary from standard product.

Nuts and Washers shall be furnished to meet the requirements of the above anchor rod specifications.

Fastener Components

HIT-ICE Mixer

HIT-ICE Cartridge

HIT-ICE Dispenser

HIT-ICE Adhesive Anchoring System 3.2.8

3.2.8.2 Material Specifications

Material Properties for Cured Adhesive	HIT-ICE	
Compressive Strength	72 MPa	10,440 psi
Tensile Strength	12 MPa	1740 psi
Water Absorption DIN 53495	2.4%	2.4%
Electrical Resistance DIN/VDE 0303T3	2x10 ¹¹ OHM/in.	5.1x10 ¹¹ OHM/in.

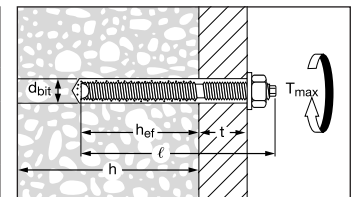
Material

	Mechanical Properties			
	f _y ksi (MPa)		min. f _u ksi (MPa)	
Standard HAS-E rod material meets the requirements of ISO 898 Class 5.8	58	(400)	72.5	(500)
High Strength or 'Super HAS' rod material meets the requirements of ASTM A 193, Grade B7	105	(724)	125	(862)
Stainless HAS rod material meets the requirements of ASTM F 593 (AISI 304/316) Condition CW 3/8" to 5/8"	65	(448)	100	(689)
Stainless HAS rod material meets the requirements of ASTM F 593 (AISI 304/316) Condition CW 3/4" to 1-1/4"	45	(310)	85	(586)
HIS Insert 11MnPb30+C Carbon Steel conforming to DIN 10277-3	54.4	(375)	66.7	(460)
HIS-R Insert X5CrNiMo17122 K700 Stainless Steel conforming to DIN EN 10088-3	50.8	(350)	101.5	(700)
HAS Super & HAS-E Standard Nut Material meets the requirements of SAE J995 Grade 5				
HAS Stainless Steel Nut material meets the requirements of ASTM F 594				
HAS Standard and Stainless Steel Washers meet dimensional requirements of ANSI B18.22.1 Type A Plain				
HAS Stainless Steel Washers meet the requirements of AISI 304 or AISI 316 conforming to ASTM A 240				
HAS Super & HAS-E Standard Washers meet the requirements of ASTM F 884, HV				
All HAS Super Rods (except 7/8") & HAS-E Standard, HIS inserts, nuts & washers are zinc plated to ASTM B 633 SC 1				
7/8" HAS Super rods hot-dip galvanized in accordance with ASTM A 153				
Note: Special Order threaded rods may vary from standard materials.				

3.2.8.3 Technical Data

HIT-ICE Installation Specification Table for HAS Rods

HAS Rod Size			in.	3/8	1/2	5/8	3/4	7/8	1	1-1/4
Details			(mm)	(9.5)	(12.7)	(15.9)	(19.1)	(22.2)	(25.4)	(31.8)
d _{bit} bit diameter ¹			in.	7/16	9/16	11/16	13/16	1	1-1/16	1-1/2
h _{ef} = h _{nom} standard depth of embedment ²			in.	3-1/2	4-1/4	5	6-5/8	7-1/2	8-1/4	12
			(mm)	(90)	(110)	(125)	(170)	(190)	(210)	(305)
T _{max} max. tightening torque	All HILTI Threaded Rods	h _{ef} ≥ h _{nom}	ft-lb (Nm)	18 (24)	30 (41)	75 (102)	150 (203)	175 (237)	235 (319)	400 (540)
		h _{ef} < h _{nom}	ft-lb (Nm)	15 (20)	20 (27)	50 (68)	105 (142)	125 (169)	165 (224)	280 (375)
h minimum base material thickness ³		h _{ef} = h _{nom}	in. (mm)	5-1/2 (140)	6-1/4 (160)	7 (180)	8-5/8 (220)	9-1/2 (240)	10-1/2 (270)	15 (380)
		h _{ef} ≠ h _{nom}	in. (mm)	1.0 h _{ef} + 2 (51)	1.0 h _{ef} + 2 (51)	1.0 h _{ef} + 2 (51)	1.0 h _{ef} + 2 (51)	1.0 h _{ef} + 2 (51)	1.0 h _{ef} + 2-1/4 (57)	1.0 h _{ef} + 3 (76)
Approximate number of fastenings at standard embedment										
HIT-ICE Small Refill Pack				45	28	16	9	7	5	2

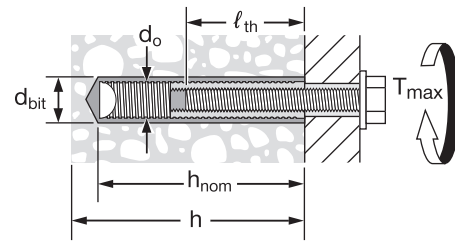


- 1 Use Hilti matched tolerance carbide tipped bits.
- 2 Data available for varying embedments; see Load Tables.
- 3 Minimum base material thickness given to minimize backside blowout during drilling process. Ability of base material to withstand loads applied (e.g. bending of concrete slab) should be determined by design engineer.

3.2.8 HIT-ICE Adhesive Anchoring System

HIT-ICE Installation Specification Table for HIS Inserts

Details \ HIS Insert	in.	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)
d_{bit} bit diameter ¹	in.	11/16	7/8	1-1/8	1-1/4
d_o outside diameter	in.	0.65	0.81	1	1.09
h_{nom} std. depth of embed.	in. (mm)	4-3/8 (110)	5 (125)	6-5/8 (170)	8-1/4 (170)
ℓ_{th} useable thread length	in. (mm)	1 (25)	1-3/16 (30)	1-1/2 (40)	2 (50)
T_{max} max. tightening torque	ft-lb (Nm)	18 (24)	35 (47)	80 (108)	160 (217)
h min. base material thickness	in. (mm)	6-3/8 (162)	7-1/2 (191)	10 (254)	12-3/8 (314)
Recommended Hilti Rotary Hammer Drill		TE 6, 16, 25, 35	TE 16, 25, 35, 46	TE 46, 56, 76	



1 Hilti matched tolerance carbide tipped drill bits

HIT-ICE Installation Specification Table for Rebar in Concrete

Details \ Rebar Size	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11
d_{bit} bit diameter ^{1,2} in.	1/2	5/8	3/4	7/8	1	1-1/8	1-3/8	1-1/2	1-9/16

1 Rebar diameters may vary. Use smallest drill bit which will accommodate rebar.

2 Hilti matched tolerance carbide tipped drill bits

**HIT-ICE Installation Specification Table for Metric Rebar in Concrete
(Canada Only)**



Details \ Rebar Number	10M	15M	20M	25M	30M	35M
d_{bit} bit diameter ^{1,2}	14 mm	3/4"	24mm	1-1/8"	37mm	1-9/16"

1 Rebar diameters may vary. Use smallest drill bit which will accommodate rebar.

2 Hilti matched tolerance carbide tipped drill bits

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right)^{5/3} + \left(\frac{V_d}{V_{rec}} \right)^{5/3} \leq 1.0 \text{ (Ref. Section 3.1.8.3)}$$

HIT-ICE Adhesive Anchoring System 3.2.8

HIT-ICE Allowable and Ultimate Bond/Concrete Capacity for HAS Rods in Normal-Weight Concrete^{1,2,3}

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	HIT-ICE Allowable Bond/Concrete Capacity				HIT-ICE Ultimate Bond/Concrete Capacity			
		Tensile		Shear		Tensile		Shear	
		$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)
3/8 (9.5)	1-3/4 (44)	720 (3.2)	1265 (5.6)	1395 (6.2)	1970 (8.8)	2710 (12.1)	4750 (21.1)	4175 (18.6)	5900 (26.2)
	3-1/2 (89)	1895 (8.4)	2705 (12.0)	3335 (14.8)	4715 (21.0)	7120 (31.7)	10160 (45.2)	10000 (44.5)	14140 (62.9)
	5-1/4 (133)	2635 (11.7)	2800 (12.5)	6120 (27.2)	8655 (38.5)	9880 (44.0)	10510 (46.8)	18360 (81.7)	25960 (115.5)
1/2 (12.7)	2-1/8 (54)	1220 (5.4)	1575 (7.0)	1980 (8.8)	2800 (12.5)	4580 (20.4)	5910 (26.3)	5940 (26.4)	8400 (37.4)
	4-1/4 (108)	2725 (12.1)	3935 (17.5)	5150 (22.9)	7280 (32.4)	10220 (44.5)	14760 (65.7)	15440 (68.7)	21840 (97.1)
	6-3/8 (162)	4300 (19.1)	5295 (23.6)	9455 (42.1)	13375 (59.5)	16140 (71.8)	19860 (88.3)	28360 (126.2)	40120 (178.5)
5/8 (15.9)	2-1/2 (64)	1620 (7.2)	1985 (8.8)	2460 (10.9)	3480 (15.5)	6090 (27.1)	7460 (33.2)	7380 (32.8)	10440 (46.4)
	5 (127)	4395 (19.5)	5250 (23.4)	7350 (32.7)	10390 (46.2)	16480 (73.3)	19690 (87.6)	22040 (98.0)	31160 (138.6)
	7-1/2 (191)	6025 (26.8)	8225 (36.6)	13495 (60.0)	19080 (84.9)	22595 (100.5)	30850 (137.2)	40480 (180.0)	57240 (254.6)
3/4 (19.1)	3-3/8 (86)	2365 (10.5)	3925 (17.5)	5435 (24.2)	7680 (34.2)	8870 (39.5)	14720 (65.5)	16295 (72.5)	23040 (102.5)
	6-5/8 (168)	4655 (20.7)	8885 (39.5)	12270 (54.6)	17355 (77.2)	17460 (77.7)	33330 (148.3)	36800 (163.7)	52060 (231.6)
	10 (254)	9515 (42.3)	12140 (54.0)	22755 (101.2)	32180 (143.1)	35695 (158.8)	45530 (202.5)	68260 (303.6)	96540 (429.4)
7/8 (22.2)	3-3/4 (95)	3080 (13.7)	4800 (21.4)	6705 (29.8)	9480 (42.4)	11555 (51.4)	18000 (80.1)	20105 (89.4)	28430 (126.5)
	7-1/2 (191)	7845 (34.9)	11020 (49.0)	15960 (71.0)	22575 (100.4)	29430 (130.9)	41000 (182.3)	47880 (213.0)	67720 (301.2)
	11-1/4 (286)	13330 (59.3)	16645 (74.0)	29330 (130.5)	41475 (184.5)	49990 (222.4)	62425 (277.7)	87980 (391.4)	124420 (553.4)
1 (25.4)	4-1/8 (105)	3445 (15.3)	4865 (21.6)	8265 (36.8)	11685 (52.0)	12920 (57.5)	18250 (81.2)	24790 (110.3)	35050 (155.9)
	8-1/4 (210)	8330 (37.1)	11635 (51.8)	19690 (87.6)	27840 (123.8)	31250 (139.0)	43640 (194.1)	59060 (262.7)	83520 (371.5)
	12-3/8 (314)	15540 (69.1)	19525 (86.8)	36170 (160.9)	51150 (227.5)	58280 (259.3)	73220 (325.7)	108500 (482.6)	153440 (682.5)
1-1/4 (31.8)	6 (152)	4645 (20.7)	7000 (31.1)	14760 (65.7)	20870 (92.8)	17430 (77.5)	26265 (116.8)	44280 (197.0)	62610 (278.5)
	12 (305)	15490 (68.9)	20770 (92.4)	38615 (171.8)	54610 (242.9)	58085 (258.4)	77900 (346.5)	115840 (515.3)	163820 (728.7)
	15 (381)	19210 (85.5)	26815 (119.3)	53960 (240.0)	76315 (339.5)	72040 (320.5)	100560 (447.3)	161880 (720.1)	228940 (1018.4)

1 Influence factors for spacing and/or edge distance are applied to concrete/bond values above, and then compared to the steel value. The lesser of the values is to be used for the design.

2 For $h_{ef} \geq h_{nom}$ average ultimate concrete shear capacity based on Strength Design method. For $h_{ef} < h_{nom}$ average ultimate concrete shear values based on testing.

3 All values based on holes drilled with carbide bit and cleaned with compressed air and a wire brush per manufacturer's instructions.

3.2.8 HIT-ICE Adhesive Anchoring System

Allowable Steel Strength for Carbon Steel and Stainless Steel HAS Rods¹

Rod Diameter in. (mm)	HAS-E Standard ISO 898 Class 5.8		HAS Super ASTM A 193 B7		HAS SS AISI 304/316 SS	
	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	2640 (11.7)	1360 (6.0)	4555 (20.3)	2345 (10.4)	3645 (16.2)	1875 (8.3)
1/2 (12.7)	4700 (20.9)	2420 (10.8)	8100 (36.0)	4170 (18.5)	6480 (28.8)	3335 (14.8)
5/8 (15.9)	7340 (32.7)	3780 (16.8)	12655 (56.3)	6520 (29.0)	10125 (45.0)	5215 (23.2)
3/4 (19.1)	10570 (47.0)	5445 (24.2)	18225 (81.1)	9390 (41.8)	12390 (55.1)	6385 (28.4)
7/8 (22.2)	14385 (64.0)	7410 (33.0)	24805 (110.3)	12780 (56.9)	16865 (75.0)	8690 (38.6)
1 (25.4)	18790 (83.6)	9680 (43.0)	32400 (144.1)	16690 (74.2)	22030 (98.0)	11350 (50.5)
1-1/4 (31.8)	29360 (130.6)	15125 (67.3)	50620 (225.2)	26080 (116.0)	34425 (153.1)	17735 (78.9)

¹ Steel strength as defined in AISC Manual of Steel Construction (ASD):

Tensile = $0.33 \times F_u \times \text{Nominal Area}$

Shear = $0.17 \times F_u \times \text{Nominal Area}$

Ultimate Steel Strength for Carbon Steel and Stainless Steel HAS Rods¹

Rod Diameter in. (mm)	HAS-E Standard ISO 898 Class 5.8			HAS Super ASTM A 193 B7			HAS SS AISI 304/316 SS		
	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	4495 (20.0)	6005 (26.7)	3605 (16.0)	8135 (36.2)	10350 (43.4)	6210 (27.6)	5035 (22.4)	8280 (36.8)	4970 (22.1)
1/2 (12.7)	8230 (36.6)	10675 (47.5)	6405 (28.5)	14900 (66.3)	18405 (79.0)	11040 (49.1)	9225 (41.0)	14720 (65.5)	8835 (39.3)
5/8 (15.9)	13110 (58.3)	16680 (74.2)	10010 (44.5)	23730 (105.6)	28760 (125.7)	17260 (76.8)	14690 (65.3)	23010 (102.4)	13805 (61.4)
3/4 (19.1)	19400 (86.3)	24020 (106.9)	14415 (64.1)	35120 (156.2)	41420 (185.7)	24850 (110.5)	15050 (66.9)	28165 (125.3)	16800 (75.2)
7/8 (22.2)	26780 (119.1)	32695 (145.4)	19620 (87.3)	48480 (215.7)	56370 (256.9)	33825 (150.5)	20775 (92.4)	38335 (170.5)	23000 (102.3)
1 (25.4)	35130 (156.3)	42705 (190.0)	25625 (114.0)	63600 (282.9)	73630 (337.0)	44180 (196.5)	27255 (121.2)	50070 (222.7)	30040 (133.6)
1-1/4 (31.8)	56210 (250.0)	66730 (296.8)	40035 (178.1)	101755 (452.6)	115050 (511.8)	69030 (307.1)	43610 (194.0)	78235 (348.0)	46940 (208.8)

¹ Steel strength as defined in AISC Manual of Steel Construction 2nd Ed. (LRFD):

Yield = $F_y \times \text{Tensile Stress Area}$

Tensile = $0.75 \times F_u \times \text{Nominal Area}$

Shear = $0.45 \times F_u \times \text{Nominal Area}$

HIT-ICE Adhesive Anchoring System 3.2.8

HIT-ICE Allowable Bond/Concrete Capacity and Steel Strength for HIS Carbon Steel and HIS-R Stainless Steel Internally Threaded Inserts

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	HIT-ICE Allowable Bond/Concrete Capacity		Allowable Bolt Strength ^{1,2}			
		Tensile $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	Shear $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	ASTM A 325 Carbon Steel		ASTM F 593 Stainless Steel	
				Tensile ¹ lb (kN)	Shear ¹ lb (kN)	Tensile ¹ lb (kN)	Shear ¹ lb (kN)
3/8 (9.5)	4-3/8 (110)	2750 (12.2)	1605 (7.1)	4370 (19.4)	2250 (10.0)	3645 (16.2)	1875 (8.3)
1/2 (12.7)	5 (127)	4195 (18.7)	3040 (13.5)	7775 (34.6)	4005 (17.8)	6480 (28.8)	3335 (14.8)
5/8 (15.9)	6-5/8 (168)	6700 (29.8)	4575 (20.4)	12150 (54.0)	6260 (27.8)	10125 (45.0)	5215 (23.2)
3/4 (19.1)	8-1/4 (210)	7855 (34.9)	6305 (28.0)	17495 (77.8)	9010 (40.1)	12395 (55.1)	6385 (28.4)

HIT-ICE Ultimate Bond/Concrete Capacity and Steel Strength for HIS Carbon Steel and HIS-R Stainless Steel Internally Threaded Inserts

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	HIT-ICE Ultimate Bond/Concrete Capacity ²		Ultimate Bolt Strength ^{1,2}			
		Tensile $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	Shear $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	ASTM A 325 Carbon Steel		ASTM F 593 Stainless Steel	
				Tensile ¹ lb (kN)	Shear ¹ lb (kN)	Tensile ¹ lb (kN)	Shear ¹ lb (kN)
3/8 (9.5)	4-3/8 (110)	11000 (48.9)	6425 (28.6)	9935 (44.2)	5960 (26.5)	8280 (36.8)	4970 (22.1)
1/2 (12.7)	5 (127)	16790 (74.7)	12170 (54.1)	17665 (78.6)	10600 (47.2)	14720 (65.5)	8835 (39.3)
5/8 (15.9)	6-5/8 (168)	26795 (119.2)	18310 (81.5)	27610 (122.8)	16565 (73.7)	23010 (102.4)	13805 (61.4)
3/4 (19.1)	8-1/4 (210)	31430 (139.8)	25215 (112.2)	39760 (176.9)	23855 (106.1)	28165 (125.3)	16900 (75.1)

1 Steel values in accordance with AISC

ASTM A 325 bolts: $F_y = 92$ ksi, $F_u = 120$ ksi

ASTM F 593 (AISI 304/316): $F_y = 65$ ksi, $F_u = 100$ ksi for 3/8" thru 5/8"

$F_y = 45$ ksi, $F_u = 85$ ksi for 3/4"

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 = $0.45 \times F_u \times A_{nom}$

2 Use lower value of either bond/concrete capacity or steel strength.

3.2.8 HIT-ICE Adhesive Anchoring System

HIT-ICE Allowable and Ultimate Bond/Concrete Capacity for HAS Rods Installed in Lightweight Concrete 3000 psi (20.7 MPa)²

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Allowable Bond/Concrete Capacity ¹ lb (kN)		Ultimate Bond/Concrete Capacity lb (kN)	
		Tensile	Shear	Tensile	Shear
3/8 (9.5)	1-3/4 (44)	745 (3.3)	1285 (5.7)	2980 (13.3)	5150 (22.9)
	3-1/2 (89)	1220 (5.4)	1580 (7.0)	4920 (21.9)	6320 (28.1)
1/2 (12.7)	2-1/8 (54)	975 (4.3)	2130 (9.5)	3900 (17.3)	8520 (37.9)
	4-1/4 (108)	1210 (5.4)	2910 (12.9)	4840 (21.5)	11640 (51.8)
5/8 (15.9)	2-1/2 (63)	1200 (5.3)	2480 (11.0)	4800 (21.4)	9920 (44.1)
3/4 (19.1)	3-3/8 (86)	1760 (7.8)	4000 (17.8)	7040 (31.3)	15985 (71.1)

1 Influence factors for spacing and/or edge distance are applied to allowable concrete/bond values above, and then compared to the allowable steel value. The lesser of these values is to be used for design.

2 All values based on holes drilled with matched tolerance carbide tipped bit and cleaned with a wire brush per manufacturer's instructions.

HIT-ICE Allowable Bond/Concrete Capacity for Sill Plate Applications

Allowable Loads for Attachment of Sill Plates to $f'_c = 2000$ PSI Normal Weight Concrete with HIT-ICE¹

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Edge Distance in. (mm)	Tension lb (kN)	Shear lb (kN)	
				Load to Edge	Load \perp to Edge
1/2 (12.7)	4-1/4 (108.0)	1-3/4 (44.5)	1280 (5.3)	1445 (6.4)	400 (1.8)
		2-3/4 (69.9)	1800 (8.1)	2100 (9.5)	845 (3.8)
5/8 (15.9)	5 (127.0)	1-3/4 (44.5)	1700 (7.6)	1445 (6.4)	400 (1.8)
		2-3/4 (69.9)	2725 (12.1)	2455 (10.9)	960 (4.3)

1 Loads are based on concrete failure. Steel strength must be checked separately. Values are based on safety factor of 4.

Allowable Loads for Attachment of Sill Plates to top of grout filled block wall with HIT-ICE¹

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Edge Distance in. (mm)	Tension lb (kN)	Shear lb (kN)	
				Load to Edge	Load \perp to Edge
1/2 (12.7)	4-1/4 (108.0)	1-3/4 (44.5)	1120 (5.0)	1425 (6.3)	560 (2.5)
		2-3/4 (69.9)	1440 (6.4)	2085 (9.3)	1110 (4.9)
5/8 (15.9)	5 (127.0)	1-3/4 (44.5)	1475 (6.5)	1800 (8.0)	680 (3.0)
		2-3/4 (69.9)	1630 (7.2)	3070 (13.7)	1110 (4.9)

1 Loads are based on masonry failure. Steel strength must be checked separately. Values are based on safety factor of 5.

HIT-ICE Adhesive Anchoring System 3.2.8

HIT-ICE Allowable Loads for Threaded Rods in Grout-Filled Concrete Masonry Units (ASTM C 90 Block)^{1, 2, 3, 4}

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Distance from Edge in. (mm)	Tension ^{5,6} lb (kN)	Shear lb (kN) ^{5,6}					
				HAS-E		HAS Super		HAS SS	
3/8 (9.5)	3-1/2 (88.9)	4 (101.6)	1550 (6.9)	1360	(6.0)	2020	(9.0)	1875	(8.3)
		≥12 (304.8)							
1/2 (12.7)	4-1/4 (108)	4 (101.6)	1785 (7.9)	2020	(9.0)	2020	(9.0)	2020	(9.0)
		≥12 (304.8)		2420	(10.8)	4170	(18.5)	3335	(14.8)
5/8 (15.9)	5 (127)	4 (101.6)	2265 (10.1)	2020	(9.0)	2020	(9.0)	2020	(9.0)
		≥12 (304.8)		3780	(16.8)	5625	(25.0)	5215	(23.2)
3/4 (19.1)	6-5/8 (168.3)	4 (101.6)	3740 (16.6)	2020	(9.0)	2020	(9.0)	2020	(9.0)
		≥12 (304.8)		5445	(24.2)	5625	(25.0)	5625	(25.0)

HIT-ICE Ultimate Loads for Threaded Rods in Grout-Filled Concrete Masonry Units (ASTM C 90 Block)^{1, 2, 3, 4}

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Distance from Edge in. (mm)	Tension lb (kN) ^{5,6}			Shear lb (kN) ^{5,6}		
			HAS-E	HAS Super	HAS SS (304SS)	HAS-E	HAS Super	HAS SS (304SS)
3/8 (9.5)	3-1/2 (88.9)	4 (101.6)	6005 (26.7)	6200 (27.6)	6200 (27.6)	3605 (16.0)	6210 (27.6)	4970 (22.1)
		≥12 (304.8)						
1/2 (12.7)	4-1/4 (108)	4 (101.6)	7140 (31.8)	7140 (31.8)	7140 (31.8)	6405 (28.5)	8075 (35.9)	8075 (35.9)
		≥12 (304.8)					11040 (49.1)	8835 (39.3)
5/8 (15.9)	5 (127)	4 (101.6)	9060 (40.3)	9060 (40.3)	9060 (40.3)	8075 (35.9)	8075 (35.9)	8075 (35.9)
		≥12 (304.8)				10010 (44.2)	17260 (76.8)	13805 (61.4)
3/4 (19.1)	6-5/8 (168.3)	4 (101.6)	14970 (66.6)	14970 (66.6)	14970 (66.6)	8075 (35.9)	8075 (35.9)	8075 (35.9)
		≥12 (304.8)				14415 (64.1)	22500 (100.1)	16800 (75.2)

- Values are for lightweight, medium weight or normal weight concrete masonry units conforming to ASTM C 90 with 2000 psi grout conforming to ASTM C 476.
- Embedment depth is measured from the outside face of the concrete masonry unit.
- Values are for anchors located in the grouted cell, head joint, bed joint, "T" joint, cross web or any combination of the above.
- Values for edge distances between 4 inches and 12 inches can be calculated by linear interpolation.
- Loads are based on the lesser of bond strength, steel strength or base material strength.
- Steel values in accordance with AISC

Allowable Load Values

$$\text{Tension} = 0.33 \times F_u \times A_{\text{nom}}$$

$$\text{Shear} = 0.17 \times F_u \times A_{\text{nom}}$$

Ultimate Load Values

$$\text{Tension} = 0.75 \times F_u \times A_{\text{nom}}$$

$$\text{Shear} = 0.45 \times F_u \times A_{\text{nom}}$$

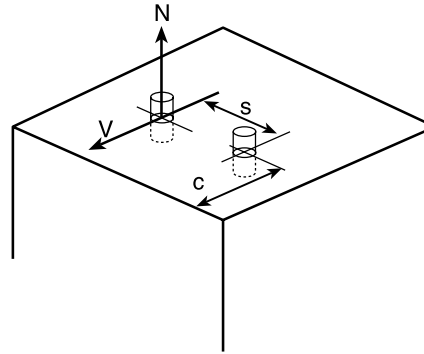
3.2.8 HIT-ICE Adhesive Anchoring System

Anchor Spacing and Edge Distance Guidelines for Grout-Filled Block

Influence of Anchor Spacing and Edge Distance

Anchor Size	in.	3/8	1/2	5/8	3/4
	(mm)	(9.5)	(12.7)	(15.8)	(19.1)
h_{nom}	in.	3-1/2	4-1/4	5	6-5/8
	(mm)	(90)	(110)	(125)	(170)

h_{nom} = standard embedment depth



Edge Distance for Shear and Tension:

Grout Filled, Normal Weight and Lightweight Block

c_{cr} = 12 in. (305 mm) minimum from free edge

c_{min} = 4 in. (102 mm) minimum from free edge

Anchor Spacing for Shear and Tension:

Grout Filled, Normal Weight and Lightweight Block

$s_{cr} = s_{min}$ = One (1) anchor per cell (max), and 8 in. (203mm) (min)

HIT-ICE Adhesive Anchoring System 3.2.8

HIT-ICE Ultimate Bond Capacity and Steel Strength for Rebar in Concrete

Nominal Rebar Size	Embedment Depth in. (mm)	Concrete Compressive Strength						Grade 60 Rebar	
		$f'_c = 2000$ psi (13.8 MPa)			$f'_c = 4000$ psi (27.6 MPa)				
		Ultimate Bond Strength lb (kN)	Embed. to Develop Yield Strength ¹ in. (mm)	Embed. to Develop Tensile Strength ¹ in. (mm)	Ultimate Bond Strength lb (kN)	Embed. to Develop Yield Strength ¹ in. (mm)	Embed. to Develop Tensile Strength ¹ in. (mm)	Yield Strength lb (kN)	Tensile Strength lb (kN)
#3	1-1/2 (38)	2500 (11.1)	3-3/4 (95.3)	5-1/2 (139.7)	3800 (16.9)	2-3/4 (69.9)	4-1/4 (108.0)	6600 (29.4)	9900 (44.0)
	3-1/2 (89)	6300 (28.0)			8200 (36.5)				
	7 (178)	12600 (56.0)			16500 (73.4)				
#4	2 (51)	4200 (18.7)	5-1/2 (139.7)	8 (203.2)	6000 (26.7)	4-1/4 (108.0)	6-1/4 (158.8)	12000 (53.4)	18000 (80.1)
	4 (102)	9000 (40.0)			11800 (52.5)				
	8 (203)	18000 (80.1)			23600 (105.0)				
#5	2-1/2 (64)	5600 (24.9)	7 (177.8)	10-1/4 (260.4)	6900 (30.7)	5-1/4 (133.4)	8 (203.2)	18600 (82.7)	27900 (124.1)
	5 (127)	13500 (60.1)			17700 (78.7)				
	10 (254)	27000 (120.1)			35300 (157.0)				
#6	3-1/2 (90)	10200 (45.4)	8-1/2 (215.9)	12-3/4 (323.9)	12800 (56.9)	6-1/2 (165.1)	9-3/4 (247.7)	26400 (117.4)	39600 (176.2)
	7 (178)	22100 (98.3)			28900 (128.6)				
	14 (356)	44200 (196.6)			57700 (256.7)				
#7	3-3/4 (95)	10700 (47.6)	10 (254.0)	15 (381)	15800 (70.3)	7-3/4 (196.9)	11-1/2 (292.1)	36000 (160.1)	54000 (240.2)
	7-1/2 (190)	27100 (120.6)			35300 (157.0)				
	15 (380)	54200 (241.1)			70700 (314.5)				
#8	4 (102)	14100 (62.7)	11-3/4 (298.5)	17-1/2 (444.5)	18100 (80.5)	9 (228.6)	13-1/2 (342.9)	47450 (211.1)	71100 (316.3)
	8 (204)	32500 (144.6)			42400 (188.6)				
	16 (408)	65000 (289.1)			84800 (377.2)				
#9	5 (127)	16700 (74.3)	12-3/4 (323.9)	19 (482.6)	21800 (97.0)	10 (254.0)	15-3/4 (400.1)	60000 (266.9)	90000 (400.4)
	10 (254)	47400 (210.9)			61800 (274.9)				
	18 (457)	85300 (379.4)			111300 (495.1)				
#10	6 (152)	23300 (103.6)	15-1/2 (393.7)	23 (584.2)	32400 (144.1)	12 (304.8)	17-3/4 (450.9)	76200 (339.0)	114300 (508.5)
	12 (304)	59600 (265.1)			77700 (345.6)				
	20 (508)	99300 (441.7)			129600 (576.5)				
#11	7 (178)	32000 (142.3)	17-1/4 (438.2)	26 (660.4)	41300 (183.7)	13-1/2 (342.9)	20 (508.0)	93600 (416.4)	140400 (624.6)
	14 (356)	75800 (337.2)			99000 (440.4)				
	20 (508)	108400 (482.2)			141400 (629.0)				

1 Based on comparison of average ultimate adhesive bond test values versus minimum yield and ultimate tensile strength of rebar; for more information, contact Hilti.

3.2.8 HIT-ICE Adhesive Anchoring System

HIT-ICE Bond Capacity and Steel Strength for Metric Rebar in Concrete (Canada Only)^{1,2,3}



Rebar Size	HIT-ICE Tensile Bond Strength ^{2,3,4}					Strength Properties of Metric Rebar ^{2,3}	
	Embedment Depth (mm)	$f'_c = 14 \text{ MPa}$		$f'_c = 28 \text{ MPa}$		$f_y = 400 \text{ MPa}$	
		Ultimate Bond (kN)	Allowable Bond (kN)	Ultimate Bond (kN)	Allowable Bond (kN)	Yield Strength (kN)	Tensile Strength (kN)
10M (#3)	40	11.1	2.8	16.9	4.2	40	60
	90	28.0	7.0	36.5	9.1		
	180	56.0	14.0	73.4	18.3		
15M (#5)	65	24.9	6.2	30.7	7.7	80	120
	130	60.1	15.0	78.7	19.7		
	250	120	30.0	157	39.2		
20M (#6)	90	45.4	11.3	56.9	14.2	120	180
	180	98.3	24.6	129	32.2		
	355	197	49.2	257	64.2		
25M (#8)	100	62.7	15.7	80.5	20.1	200	300
	200	145	36.2	189	47.2		
	405	289	72.2	377	94.2		
30M (#9)	125	74.3	18.6	97.0	24.2	280	420
	250	211	52.8	275	68.8		
	455	379	94.8	495	124		
35M (#11)	180	142	35.5	184	46.0	400	600
	355	337	84.2	440	110		
	510	482	120	629	157		

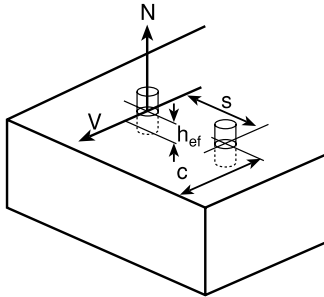
1 Use lesser value of bond strength or rebar's steel strength for tensile capacity.

2 Test data developed for hammer-drilled holes. For diamond cored holes, contact Hilti Engineering.

3 For anchoring spacing and edge distance guidelines, please refer to the following pages of this HIT-ICE Injection Adhesive Anchor section.

HIT-ICE Adhesive Anchoring System 3.2.8

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-ICE



Note: Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing Tension/Shear

$$s_{\min} = 0.5 h_{ef}, s_{cr} = 1.5 h_{ef}$$

$$f_A = 0.3(s/h_{ef}) + 0.55$$

for $s_{cr} > s > s_{\min}$

Edge Distance Tension

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 1.5 h_{ef}$$

$$f_{RN} = 0.4(c/h_{ef}) + 0.40$$

for $c_{cr} > c > c_{\min}$

Edge Distance Shear (⊥ toward edge)

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV1} = 0.54(c/h_{ef}) - 0.09$$

for $c_{cr} > c > c_{\min}$

Edge Distance Shear (|| to or away from edge)

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV2} = 0.36(c/h_{ef}) + 0.28$$

for $c_{cr} > c > c_{\min}$

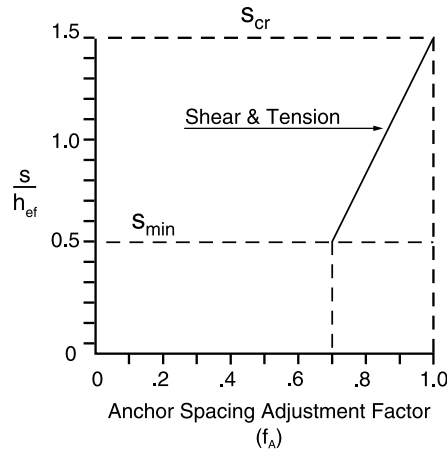
Anchor Spacing Adjustment Factors

$$s = \text{Actual spacing}$$

$$s_{\min} = 0.5 h_{ef}$$

$$s_{cr} = 1.5 h_{ef}$$

$$h_{ef} = \text{Actual embedment}$$



Edge Distance Adjustment Factors

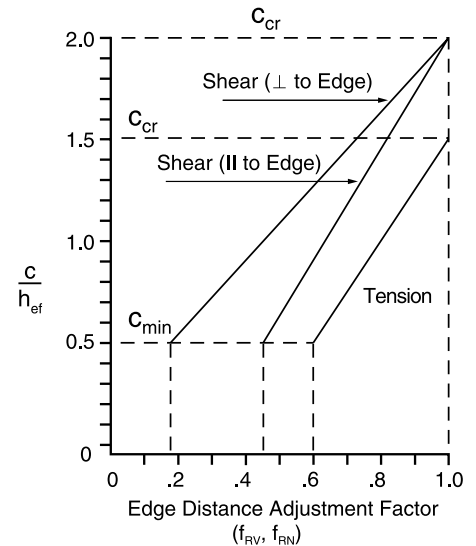
$$c = \text{Actual edge distance}$$

$$c_{\min} = 0.5 h_{ef}$$

$$c_{cr} = 1.5 h_{ef} \text{ Tension}$$

$$c_{cr} = 2.0 h_{ef} \text{ for Shear}$$

$$h_{ef} = \text{Actual embedment}$$



Load Adjustment Factors for 3/8" Diameter Anchors

Anchor Diameter	3/8" diameter											
	Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}		
Adjustment Factor	1-3/4	3-1/2	5-1/4	1-3/4	3-1/2	5-1/4	1-3/4	3-1/2	5-1/4	1-3/4	3-1/2	5-1/4
Embedment Depth, in.												
7/8	0.70			0.60			0.18			0.46		
1-1/4	0.76			0.69			0.30			0.54		
1-3/4	0.85	0.70		0.80	0.60		0.45	0.18		0.64	0.46	
2	0.89	0.72		0.86	0.63		0.53	0.22		0.69	0.49	
2-5/8	1.00	0.78	0.70	1.00	0.70	0.60	0.72	0.32	0.18	0.82	0.55	0.46
3		0.81	0.72		0.74	0.63	0.84	0.37	0.22	0.90	0.59	0.49
3-1/2		0.85	0.75		0.80	0.67	1.00	0.45	0.27	1.00	0.64	0.52
4		0.89	0.78		0.86	0.70		0.53	0.32		0.69	0.55
4-1/2		0.94	0.81		0.91	0.74		0.60	0.37		0.74	0.59
5-1/4		1.00	0.85		1.00	0.80		0.72	0.45		0.82	0.64
6-1/2			0.92			0.90		0.91	0.58		0.95	0.73
7			0.95			0.93		1.00	0.63		1.00	0.76
7-7/8			1.00			1.00			0.72			0.82
9									0.84			0.90
10-1/2									1.00			1.00

3.2.8 HIT-ICE Adhesive Anchoring System

Load Adjustment Factors for 1/2" Diameter Anchors												
Anchor Diameter	1/2" diameter											
Adjustment Factor	Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (L toward edge) f_{RV1}			Edge Distance Shear (ll to or away from edge) f_{RV2}		
Embedment Depth, in	2-1/8	4-1/4	6-3/8	2-1/8	4-1/4	6-3/8	2-1/8	4-1/4	6-3/8	2-1/8	4-1/4	6-3/8
Spacing (s)/Edge Distance (c), in.	1-1/16	0.70		0.60			0.18			0.46		
	1-1/2	0.76		0.68			0.29			0.53		
	2	0.83		0.78			0.42			0.62		
	2-1/8	0.85	0.70	0.80	0.60		0.45	0.18		0.64	0.46	
	2-3/4	0.94	0.74	0.92	0.66		0.61	0.26		0.75	0.51	
	3	0.97	0.76	0.96	0.68		0.67	0.29		0.79	0.53	
	3-3/16	1.00	0.78	0.70	1.00	0.70	0.72	0.32	0.18	0.82	0.55	0.46
	4		0.83	0.74		0.78	0.65	0.93	0.42	0.25	0.96	0.62
	4-1/4		0.85	0.75		0.80	0.67	1.00	0.45	0.27	1.00	0.64
	5		0.90	0.79		0.87	0.71		0.55	0.33	0.70	0.56
	6		0.97	0.83		0.96	0.78		0.67	0.42	0.79	0.62
	6-3/8		1.00	0.85		1.00	0.80		0.72	0.45	0.82	0.64
	7			0.88			0.84		0.80	0.50	0.87	0.68
	7-1/2			0.90			0.87		0.86	0.55	0.92	0.70
	8-1/2			0.95			0.93		1.00	0.63	1.00	0.76
	9			0.97			0.96			0.67		0.79
	9-9/16			1.00			1.00			0.72		0.82
	10									0.76		0.84
	11									0.84		0.90
	12-3/4								1.00			1.00

Note: Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing Tension/Shear

$$s_{\min} = 0.5 h_{ef}, s_{cr} = 1.5 h_{ef}$$

$$f_A = 0.3(s/h_{ef}) + 0.55$$

for $s_{cr} > s > s_{\min}$

Edge Distance Tension

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 1.5 h_{ef}$$

$$f_{RN} = 0.4(c/h_{ef}) + 0.40$$

for $c_{cr} > c > c_{\min}$

Edge Distance Shear (L toward edge)

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV1} = 0.54(c/h_{ef}) - 0.09$$

for $c_{cr} > c > c_{\min}$

Edge Distance Shear (ll to or away from edge)

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV2} = 0.36(c/h_{ef}) + 0.28$$

for $c_{cr} > c > c_{\min}$

Load Adjustment Factors for 5/8" and 3/4" Diameter Anchors																									
Anchor Diameter		5/8" diameter												3/4" diameter											
Adjustment Factor		Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}		
Embedment Depth, in		2-1/2	5	7-1/2	2-1/2	5	7-1/2	2-1/2	5	7-1/2	2-1/2	5	7-1/2	3-3/8	6-5/8	10	3-3/8	6-5/8	10	3-3/8	6-5/8	10	3-3/8	6-5/8	10
Spacing (s)/Edge Distance (c), in.	1-1/4	0.70			0.60			0.18			0.46														
	1-11/16	0.75			0.67			0.27			0.52			0.70			0.60			0.18			0.46		
	2	0.79			0.72			0.34			0.57			0.73			0.64			0.23			0.49		
	2-1/2	0.85	0.70		0.80	0.60		0.45	0.18		0.64	0.46		0.77			0.70			0.31			0.55		
	3	0.91	0.73		0.88	0.64		0.56	0.23		0.71	0.50		0.82			0.76			0.39			0.60		
	3-5/16	0.95	0.75		0.93	0.67		0.63	0.27		0.76	0.52		0.84	0.70		0.79	0.60		0.44	0.18		0.63	0.46	
	3-3/4	1.00	0.78	0.70	1.00	0.70	0.60	0.72	0.32	0.18	0.82	0.55	0.46	0.88	0.72		0.84	0.63		0.51	0.22		0.68	0.48	
	4		0.79	0.71		0.72	0.61	0.77	0.34	0.20	0.86	0.57	0.47	0.91	0.73		0.87	0.64		0.55	0.24		0.71	0.50	
	4-1/2		0.82	0.73		0.76	0.64	0.88	0.40	0.23	0.93	0.60	0.50	0.95	0.75		0.93	0.67		0.63	0.28		0.76	0.52	
	5		0.85	0.75		0.80	0.67	1.00	0.45	0.27	1.00	0.64	0.52	0.99	0.78	0.70	0.99	0.70	0.60	0.71	0.32	0.18	0.81	0.55	0.46
	5-1/16		0.85	0.75		0.81	0.67		0.46	0.27		0.64	0.52	1.00	0.78	0.70	1.00	0.71	0.60	0.72	0.32	0.18	0.82	0.56	0.46
	5-1/2		0.88	0.77		0.84	0.69		0.50	0.31		0.68	0.54		0.80	0.72		0.73	0.62	0.79	0.36	0.21	0.87	0.58	0.48
	6		0.91	0.79		0.88	0.72		0.56	0.34		0.71	0.57		0.82	0.73		0.76	0.64	0.87	0.40	0.23	0.92	0.61	0.50
	6-3/4		0.96	0.82		0.94	0.76		0.64	0.40		0.77	0.60		0.86	0.75		0.81	0.67	1.00	0.46	0.27	1.00	0.65	0.52
	7-1/2		1.00	0.85		1.00	0.80		0.72	0.45		0.82	0.64		0.89	0.78		0.85	0.70		0.52	0.32		0.69	0.55
	8			0.87			0.83		0.77	0.49		0.86	0.66		0.91	0.79		0.88	0.72		0.56	0.34		0.71	0.57
	8-1/2			0.89			0.85		0.83	0.52		0.89	0.69		0.93	0.81		0.91	0.74		0.60	0.37		0.74	0.59
	9			0.91			0.88		0.88	0.56		0.93	0.71		0.96	0.82		0.94	0.76		0.64	0.40		0.77	0.60
	9-15/16			0.95			0.93		0.98	0.63		1.00	0.76		1.00	0.85		1.00	0.80		0.72	0.45		0.82	0.64
	10			0.95			0.93		1.00	0.63			0.76			0.85			0.80		0.73	0.45		0.82	0.64
	11-1/4			1.00			1.00			0.72			0.82			0.89			0.85		0.83	0.52		0.89	0.69
	12									0.77			0.86			0.91			0.88		0.89	0.56		0.93	0.71
	13-1/4									0.86			0.92			0.95			0.93		1.00	0.63		1.00	0.76
	14									0.92			0.95			0.97			0.96			0.67			0.78
15									1.00			1.00			1.00			1.00			0.72			0.82	
16																					0.77			0.86	
18																					0.88			0.93	
20																					1.00			1.00	

HIT-ICE Adhesive Anchoring System 3.2.8

Load Adjustment Factors for 7/8" Diameter Anchors												
Anchor Diameter	7/8" diameter											
Adjustment Factor	Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (L toward edge) f_{RV1}			Edge Distance Shear (ll to or away from edge) f_{RV2}		
Embedment Depth, in	3-3/4	7-1/2	11-1/4	3-3/4	7-1/2	11-1/4	3-3/4	7-1/2	11-1/4	3-3/4	7-1/2	11-1/4
Spacing (s)/Edge Distance (c), in.	1-7/8	0.70		0.60			0.18			0.46		
	2-1/2	0.75		0.67			0.27			0.52		
	3	0.79		0.72			0.34			0.57		
	3-3/4	0.85	0.70	0.80	0.60		0.45	0.18		0.64	0.46	
	4	0.87	0.71	0.83	0.61		0.49	0.20		0.66	0.47	
	4-1/2	0.91	0.73	0.88	0.64		0.56	0.23		0.71	0.50	
	5	0.95	0.75	0.93	0.67		0.63	0.27		0.76	0.52	
	5-5/8	1.00	0.78	0.70	1.00	0.70	0.72	0.32	0.18	0.82	0.55	0.46
	6		0.79	0.71		0.72	0.61	0.77	0.34	0.86	0.57	0.47
	6-1/2		0.81	0.72		0.75	0.63	0.85	0.38	0.90	0.59	0.49
	7		0.83	0.74		0.77	0.65	0.92	0.41	0.95	0.62	0.50
	7-1/2		0.85	0.75		0.80	0.67	1.00	0.45	1.00	0.64	0.52
	8		0.87	0.76		0.83	0.68		0.49	0.29	0.66	0.54
	8-1/2		0.89	0.78		0.85	0.70		0.52	0.32	0.69	0.55
	9		0.91	0.79		0.88	0.72		0.56	0.34	0.71	0.57
	9-15/16		0.95	0.82		0.93	0.75		0.63	0.39	0.76	0.60
	10		0.95	0.82		0.93	0.76		0.63	0.39	0.76	0.60
	11-1/4		1.00	0.85		1.00	0.80		0.72	0.45	0.82	0.64
	12			0.87			0.83		0.77	0.49	0.86	0.66
	14			0.92			0.90		0.92	0.58	0.95	0.73
	15			0.95			0.93		1.00	0.63	1.00	0.76
	16-7/8			1.00			1.00			0.72		0.82
	18									0.77		0.86
	20									0.87		0.92
	22-1/2									1.00		1.00

Note: Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

$$s_{\min} = 0.5 h_{ef}, s_{cr} = 1.5 h_{ef}$$

$$f_A = 0.3(s/h_{ef}) + 0.55$$

for $s_{cr} > s_{\min}$

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 1.5 h_{ef}$$

$$f_{RN} = 0.4(c/h_{ef}) + 0.40$$

for $c_{cr} > c_{\min}$

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV1} = 0.54(c/h_{ef}) - 0.09$$

for $c_{cr} > c_{\min}$

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV2} = 0.36(c/h_{ef}) + 0.28$$

for $c_{cr} > c_{\min}$

Load Adjustment Factors for 1" and 1 1/4" Diameter Anchors																									
Anchor Diameter	1" diameter												1 1/4" diameter												
Adjustment Factor	Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}			
Embedment Depth, in	4-1/8	8-1/4	12-3/8	4-1/8	8-1/4	12-3/8	4-1/8	8-1/4	12-3/8	4-1/8	8-1/4	12-3/8	6	12	15	6	12	15	6	12	15	6	12	15	
Spacing (s)/Edge Distance (c), in.	2-1/16	0.70			0.60			0.18			0.46														
	3	0.77			0.69			0.30			0.54			0.70			0.60			0.18			0.46		
	3-1/2	0.80			0.74			0.37			0.59			0.73			0.63			0.23			0.49		
	4-1/8	0.85	0.70		0.80	0.60		0.45	0.18		0.64	0.46		0.76			0.68			0.28			0.53		
	5	0.91	0.73		0.88	0.64		0.56	0.24		0.72	0.50		0.80			0.73			0.36			0.58		
	5-1/2	0.95	0.75		0.93	0.67		0.63	0.27		0.76	0.52		0.83			0.77			0.41			0.61		
	6	0.99	0.77		0.98	0.69		0.70	0.30		0.80	0.54		0.85	0.70		0.80	0.60		0.45	0.18		0.64	0.46	
	6-3/16	1.00	0.78	0.70	1.00	0.70	0.60	0.72	0.32	0.18	0.82	0.55	0.46	0.86	0.70		0.81	0.61		0.47	0.19		0.65	0.47	
	7-1/2		0.82	0.73		0.76	0.64	0.89	0.40	0.24	0.93	0.61	0.50	0.93	0.74	0.70	0.90	0.65	0.60	0.59	0.25	0.18	0.73	0.51	0.46
	8-1/4		0.85	0.75		0.80	0.67	1.00	0.45	0.27	1.00	0.64	0.52	0.96	0.76	0.72	0.95	0.68	0.62	0.65	0.28	0.21	0.78	0.53	0.48
	9		0.88	0.77		0.84	0.69		0.50	0.30		0.67	0.54	1.00	0.78	0.73	1.00	0.70	0.64	0.72	0.32	0.23	0.82	0.55	0.50
	9-1/2		0.90	0.78		0.86	0.71		0.53	0.32		0.69	0.56		0.79	0.74		0.72	0.65	0.77	0.34	0.25	0.85	0.57	0.51
	10		0.91	0.79		0.88	0.72		0.56	0.35		0.72	0.57		0.80	0.75		0.73	0.67	0.81	0.36	0.27	0.88	0.58	0.52
	10-1/2		0.93	0.80		0.91	0.74		0.60	0.37		0.74	0.59		0.81	0.76		0.75	0.68	0.86	0.38	0.29	0.91	0.60	0.53
	12		0.99	0.84		0.98	0.79		0.70	0.43		0.80	0.63		0.85	0.79		0.80	0.72	1.00	0.45	0.34	1.00	0.64	0.57
	12-3/8		1.00	0.85		1.00	0.80		0.72	0.45		0.82	0.64		0.86	0.80		0.81	0.73		0.47	0.36		0.65	0.58
	14			0.89			0.85		0.83	0.52		0.89	0.69		0.90	0.83		0.87	0.77		0.54	0.41		0.70	0.62
	16-1/2			0.95			0.93		1.00	0.63		1.00	0.76		0.96	0.88		0.95	0.84		0.65	0.50		0.78	0.68
	18			0.99			0.98			0.70			0.80		1.00	0.91		1.00	0.88		0.72	0.56		0.82	0.71
	18-9/16			1.00			1.00			0.72			0.82			0.92			0.90		0.75	0.58		0.84	0.73
	20								0.78				0.86			0.95			0.93		0.81	0.63		0.88	0.76
	22-1/2								0.89				0.93			1.00			1.00		0.92	0.72		0.96	0.82
	24								0.96				0.98								1.00	0.77		1.00	0.86
	24-3/4								1.00				1.00									0.80			0.87
	26																					0.85			0.90
	28																					0.92			0.95
	30																					1.00			1.00

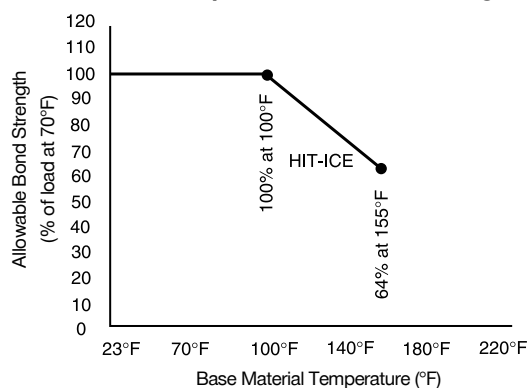
3.2.8 HIT-ICE Adhesive Anchoring System

Resistance of HIT-ICE to Chemicals

Chemical		Behavior
Sulphuric acid	conc.	–
	30%	•
	10%	+
Hydrochloric acid	conc.	•
	10%	+
Nitric acid	conc.	–
	10%	•
Phosphoric acid	conc.	+
	10%	+
Acetic acid	conc.	•
	10%	+
Formic acid	conc.	–
	10%	•
Lactic acid	conc.	+
	10%	+
Citric acid	10%	+
	10%	+
Sodium Hydroxide (Caustic soda)	40%	•
	20%	+
	5%	+
Ammonia	conc.	•
	5%	+
Soda solution	10%	+
Common salt solution	10%	+
Chlorinated lime solution	10%	+
Sodium hypochlorite	2%	+
Hydrogen peroxide	10%	+
Carbolic acid solution	10%	–
Ethanol		–
Sea water		+
Glycol		+
Acetone		–
Carbon tetrachloride		–
Toluene		+
Petrol/Gasoline		•
Machine oil		•
Diesel oil		•

Key: – non-resistant + resistant • limited resistance

Influence of Temperature on Bond Strength



Note: 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.

Long term creep test in accordance with AC58 is available; please contact Hilti Technical Services.

Samples of the HIT-ICE resin 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 **“Partially Resistant”**. Samples that were heavily damaged or destroyed were classified as **“Not Resistant”**.

Note: In actual use, the majority of the resin is encased in the base material, leaving very little surface area exposed. In some cases, this would allow the HIT-ICE to be used where it would be exposed to the **“Partially Resistant”** chemical compounds.

Open Gel Time Table (Approximate)¹

Base Material Temperature		HIT-ICE
°F	°C	
–10	–23	1.5 hrs
0	–18	1.5 hrs
23	–5	40 min
32	0	26 min
41	5	11 min
68	20	4 min
86	30	1.5 min

Final Cure Time Table (Approximate)¹

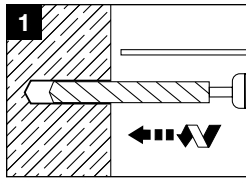
Base Material Temperature		HIT-ICE
°F	°C	
–10	–23	36 hrs
0	–18	24 hrs
23	–5	6 hrs
32	0	4 hrs
41	5	2 hrs
68	20	1 hrs
86	30	30 min

¹ Product temperatures must be maintained above 0°F (–18°C) prior to installation.

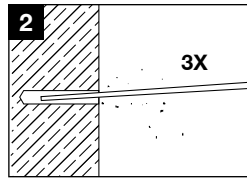
HIT-ICE Adhesive Anchoring System 3.2.8

3.2.8.4 Installation Instructions

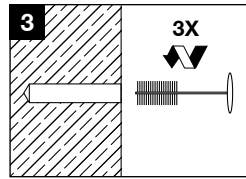
HAS, Rebar and Insert Installation Instructions



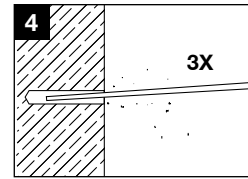
1. Drill anchor hole with a carbide bit. Contact Hilti for use of Diamond Core bits.



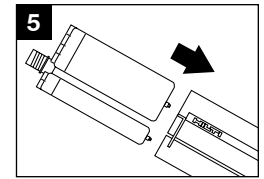
2. Insert air nozzle to bottom of hole and blow out hole using a pump, or compressed air.



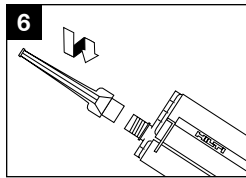
3. Clean hole with wire brush. Proper hole cleaning is essential.



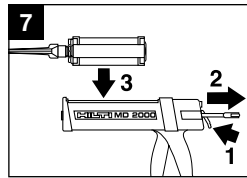
4. Insert air nozzle to bottom of hole and blow out hole using a pump, or compressed air.



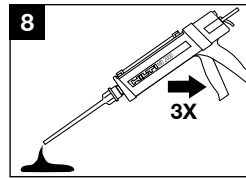
5. HIT-HY 150 only: Put refill pack into holder. Remove cap covering threaded projection.



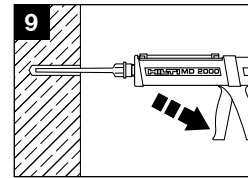
6. Screw on static mixer.



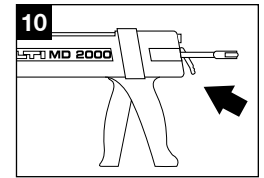
7. Put holder/cartridge into appropriate dispenser.



8. Discard first three trigger pulls of adhesive from each refill pack or cartridge.

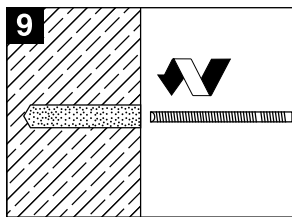


9. Inject adhesive into hole starting at the bottom until 1/2 to 2/3 full. Use mixer filler tube extensions when needed to reach the hole bottom.

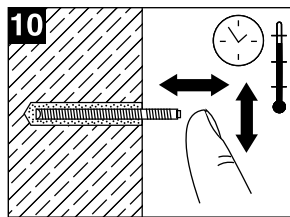


10. Unlock dispenser.

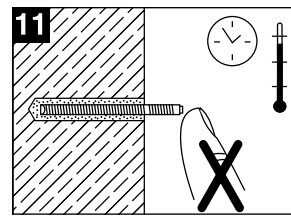
Rod



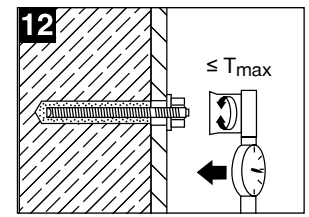
9. Insert rod. Twist during installation.



10. Fastener may be adjusted during specified gel time.

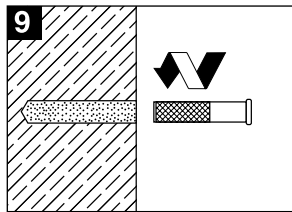


11. Do not disturb anchor between specified gel time and cure time.

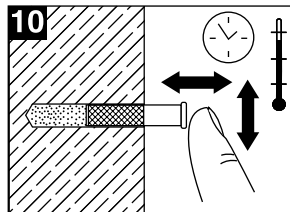


12. Apply specified torque as required to secure items to be fastened. Do not exceed maximum torque specified.

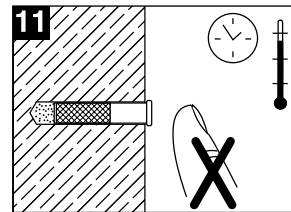
Insert



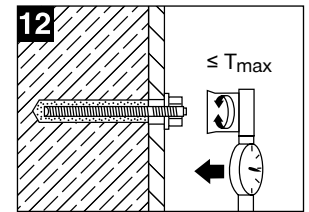
9. Insert threaded insert. Twist during installation.



10. Fastener may be adjusted during specified gel time.

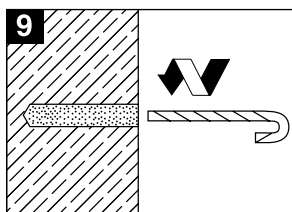


11. Do not disturb anchor between specified gel time and cure time.

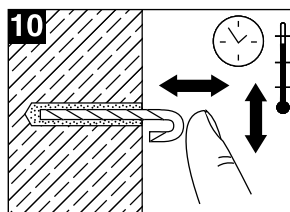


12. Apply specified torque as required to secure items to be fastened. Do not exceed maximum torque specified.

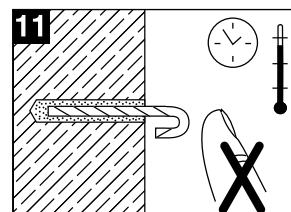
Rebar



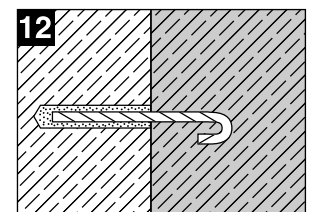
9. Insert rebar. Twist during installation.



10. Fastener may be adjusted during specified gel time.



11. Do not disturb anchor between specified gel time and cure time.



12. Apply specified torque as required to secure items to be fastened. Do not exceed maximum torque specified.

3.2.8 HIT-ICE Adhesive Anchoring System

HIT HIT-ICE Volume Charts

Threaded Rod and HIT-TZ Rod Installation

Rod Diameter (in.)	Drill Bit Diameter (in.)	Adhesive Volume Required per Inch of embedment (in. ³)
1/4	5/16	0.055
3/8	7/16	0.095
1/2	9/16	0.133
5/8	11/16	0.184
3/4	13/16	0.232
7/8	24mm	0.272
1	1-1/16	0.366
1-1/4	1-1/2	0.918

Example: Determine approximate fastenings for 5/8" rod embedded 10" deep.

$10 \times 0.184 = 1.84 \text{ in}^3$ of adhesive per anchor

- HIT-ICE cartridge:
 $18.0 \div 1.84 \approx 10$ fastenings

Rebar Installation

Rod Diameter (in.)	Drill Bit ¹ Diameter (in.)	Adhesive Volume Required per Inch of embedment (in. ³)
#3 or 3/8	1/2	0.110
#4 or 1/2	5/8	0.146
#5 or 5/8	3/4	0.176
#6 or 3/4	7/8	0.218
#7 or 7/8	1	0.252
#8 or 1	1-1/8	0.299
#9 or 1-1/8	1-3/8	0.601
#10 or 1-1/4	1-1/2	0.659
#11 or 1-3/8	1-9/16	0.547

Note: Useable volume of

- HIT-ICE is 18 in^3 (297 ml)

Metric Rebar Installation (Canada Only)



Bar Diameter	Drill Bit ¹ Diameter	Adhesive Volume Required per Inch of embedment (in. ³)
10M	14 mm	0.101
15M	3/4"	0.176
20M	24 mm	0.268
25M	1-1/8"	0.309
30M	37 mm	0.644
35M	1-9/16"	0.480

¹ Rebar diameter may vary. Use smallest drill bit which will accommodate rebar. Use Hilti matched tolerance carbide tipped drill bits.

3.2.8.5 Ordering Information

HIT Adhesives

Description	Contents
HIT-ICE (10 oz) 297 ml	24 Cartridges, 24 Mixers

HIT-ICE Cartridge

HIT Dispensers

Description	Qty/Pkg	Notes
MD 1000	1	For use with HIT-ICE cartridges

MD 1000
Dispenser

Mixers & Filler Tubes

Description	Qty/Pkg	Notes
HIT-M2 for HIT-ICE	1	For use with HIT-ICE cartridges

HIT-ICE Mixer

HIT Filler Tube

Refer to Section 3.2.6.5 for ordering information of HAS and HIT-TZ threaded rods and HIS inserts.

3.2.9 HIT-HY 20 for Masonry Construction

3.2.9.1 Product Description

3.2.9.2 Material Specifications

3.2.9.3 Technical Data

3.2.9.4 Installation Instructions

3.2.9.5 Ordering Information

Listings/Approvals

ICC-ES (International Code Council)
ESR-2659 (URM only)

City of Los Angeles
Research Report No. 24564 (URM only)

Independent Code Evaluation

IBC® / IRC® / IEBC® 2009

IBC® / IRC® / IEBC® 2006

UBC® / UCBC® 1997 (ICC-ES AC60)

LEED®: Credit 4.1-Low Emitting Materials

3.2.9.1 Product Description

The Hilti HIT-HY 20 System is based on a hybrid adhesive. The system consists of a dual cylinder adhesive refill pack, a mixing nozzle, a screen tube, a HIT dispenser with refill pack holder, and either a threaded rod, rebar or HIT internally threaded insert. HIT-HY 20 is specifically designed for fastening into material containing voids and holes such as hollow block, lightweight hollow block, brick with holes, multi-wythe brick walls and clay tile.

Product Features

- Accurate dispensing of resin and hardener into the wire mesh screen tube
- Mixing tube ensures proper mixing and eliminates measuring errors
- Contains no styrene; virtually odorless
- For use in hollow or multi-wythe base materials
- Excellent weathering resistance
- Enhanced load values in a variety of base materials
- Suitable for seismic retrofitting in unreinforced masonry. Please refer to ESR-2659 (ICC-ES AC60)

The Leadership in Energy and Environmental Design (LEED®) Green Building Rating system™ is the nationally accepted benchmark for the design, construction and operation of high performance green buildings.

Fastener Components

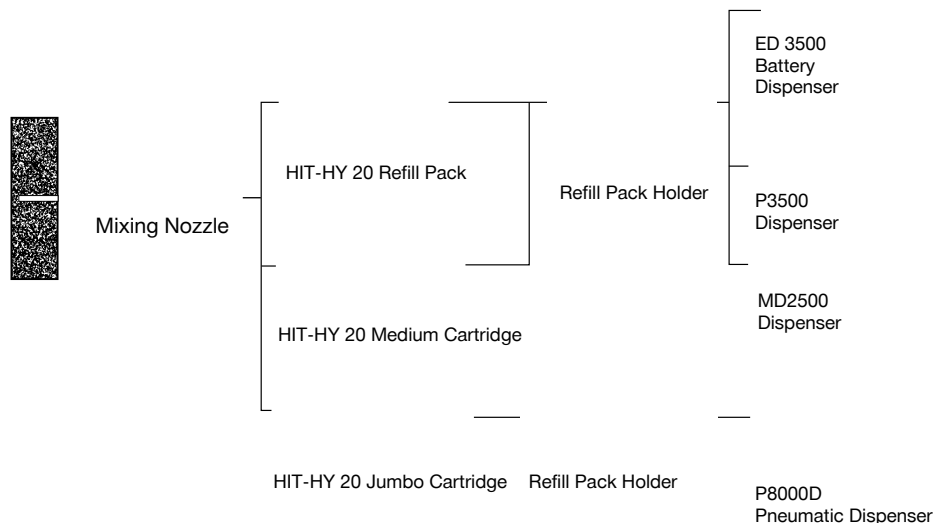
Std. HIT-A Anchor Rod with Nut & Washer

Std. HIT-I Internally Threaded Insert

Anchor Rod with Nut and Washer (URM)
or HAS-E Rod with 22.5° beveled square washer

HAS-E with Nut and Washer

Rebar for URM (supplied by contractor)



HIT-HY 20 for Masonry Construction 3.2.9

Guide Specifications

Master Format Section:

Previous 2004 Format

03250 03 16 00 (Concrete Anchors)

Related Sections:

03200 03 20 00 (Concrete Reinforcing)

05050 05 50 00 (Metal Fabrications)

05120 05 10 00 (Structural Metal Framing)

Adhesive anchors shall consist of a threaded anchor rod, nut, and washer; a cylindrical mesh screen tube, and an injectable adhesive material.

Injection adhesive shall be packaged in side by side refill packs which keep separate component A and component B. Side by side packs shall be designed to compress during use to minimize waste volume. Side by side packs shall also be designed to accept static mixing nozzle

which thoroughly blends component A and component B and allows injection directly into a mesh screen tube. Only injection tools and static mixing nozzles as recommended by the manufacturer shall be used. Manufacturer's instructions shall be followed.

Injection adhesive shall be formulated to include resin, hardener, cement and water to provide optimal curing speed as well as high strength and stiffness. Typical curing time at 68°F shall be 60 minutes.

Injection adhesive shall be HIT-HY 20, as manufactured by Hilti.

Anchor Rods Furnish with chamfered ends so that either end will accept a nut and washer. Manufactured to meet the following requirements:

1. ISO 898 Class 5.8
2. AISI 304 or AISI 316 stainless steel, meeting the requirements of ASTM F 593 (condition CW).

Special order length HAS or HIT Rods may vary from standard product.

Furnish Nuts and Washers to meet the requirements of the above anchor rod specifications.

Mesh Screen Tube Shall be formed into a cylindrical shape, with one end closed to prevent extrusion of adhesive through that end. Screen tube shall be manufactured with a mesh size, length and diameter as specified by the adhesive manufacturer. Mesh shall be manufactured from: 1. Low carbon steel with zinc electro-plating or 2. AISI 304 stainless steel or 3. plastic.

Anchor rods and screens shall be the Hilti HIT system as manufactured by Hilti.

3.2.9 HIT-HY 20 for Masonry Construction

3.2.9.2 Material Specifications

Material Properties for HIT-HY 20—Cured Adhesive

Compressive Strength	ASTM D 695/DIN 53454	7410 psi	51.1 MPa
Modulus of elasticity (Compression test)	ASTM D 790/DIN 53452	0.33×10^6 psi	2300 MPa
Water absorption	ASTM D 570/DIN 53495	2.5%	2.5%
Electrical resistance	VDE/DIN 0303T3	7.9×10^{10} ohm/in.	2×10^{11} ohm/cm

Material Specifications

	Mechanical Properties			
	f_y ksi (MPa)		min. f_u ksi (MPa)	
HIT-A Rod material ASTM A 36, 9SMNPB36K &/or 9SMN36K conforming to DIN 1651. Mechanical properties meet or exceed values for ASTM A 36	36	(248)	58	(400)
HAS-E Rod material meets the requirements of ISO 898 Class 5.8.	58	(400)	72.5	(500)
Stainless HAS rod material meets the requirements of ASTM F 593 (AISI 304) Condition CW 3/8"-5/8"	65	(448)	100	(689)
Stainless HAS rod material meets the requirements of ASTM F 593 (AISI 304) Condition CW 3/4"-1"	45	(310)	85	(586)
HIT-I Insert, 11SMnPb30+C steel conforming to 10277-3	54.4	(375)	66.7	(460)
HIT and HAS-E Standard Nut material meets the requirements of SAE J995 Grade 5				
HAS Stainless Steel Nut material meets dimensional requirements of ASTM F 594				
HIT Standard and Stainless Steel Washer material meets the requirements of ANSI B18.22.1 Type A Plain				
All standard HIT and HAS-E Rods, inserts, nuts & washers are plated to ASTM B 633 SC 1				

Note: Special Order product may vary from standard materials.

3.2.9.3 Technical Data

HY 20 Installation Specification Table for HAS-E Threaded Rods in Masonry Construction

Anchor Rod Size		in.	3/8 x 8	3/8 x 12	1/2 x 8	1/2 x 12	5/8 x 8	5/8 x 12	3/4 x 10	3/4 x 17
Details		(mm)	(9.5 x 203)	(9.5 x 305)	(12.7 x 203)	(12.7 x 305)	(15.9 x 203)	(15.9 x 305)	(19.1 x 254)	(19.1 x 432)
d_{bit}	Bit diameter ¹	in.	1/2	1/2	11/16	11/16	27/32	27/32	1	1
h_{ef}	Actual depth of embedment	in.	6	10	6	10	6	10	8	13
		(mm)	(152)	(254)	(152)	(254)	(152)	(254)	(203)	(330)
	Required screen size	in.	3/8 x 6	3/8 x 10	1/2 x 6	1/2 x 10	5/8 x 6	5/8 x 10	3/4 x 8	3/4 x 13
		(mm)	(9.5 x 152)	(9.5 x 254)	(12.7 x 152)	(12.7 x 254)	(15.9 x 152)	(15.9 x 254)	(19.1 x 203)	(19.1 x 330)
T_{inst}	Recommended Installation torque	ft-lb	10	10	30	30	45	45	60	60
		(Nm)	(13)	(13)	(41)	(41)	(62)	(62)	(81)	(81)
Approximate fastenings per Cartridge	Small		15	9	7	4	4	3	3	2
	Medium		24	14	11	6	6	5	5	3
	Jumbo		70	42	33	19	19	14	14	9.5

1 Hilti matched tolerance carbide tipped drill bits

HIT-HY 20 for Masonry Construction 3.2.9

HIT-HY 20 Installation Specifications for HIT-A Rods in Hollow Block, Tile and Brick with Holes

Anchor System Application Anchor Rod Size Details		in (mm)	HIT Combi-Rod Tile	HIT-A Short Rod Hollow and Lightweight Block			HIT-A Standard Rod Brick w/Holes, Clay Tile		
			1/4 x 2-1/2 (6.4 x 64)	5/16 x 2-1/2 (7.9 x 63.5)	3/8 x 3 (9.5 x 76.2)	1/2 x 3-1/8 (12.7 x 79.4)	5/16 x 4 (7.9 x 101.6)	3/8 x 4-3/8 (9.5 x 111.1)	1/2 x 4-1/2 (12.7 x 114.3)
d _{bit}	bit diameter ¹	in.	1/2	5/8					
	minimum hole depth	in. (mm)	Through Material	Through Face of Hollow Base Material			3-1/2 (90)		
	Required screen		HIT S-12A	HIT S-16/2			HIT S-16		
t	max. thickness fastened	in. (mm)	1/2 (13)	1/2 (13)	3/4 (19)	3/4 (19)	1/2 (13)	3/4 (19)	3/4 (19)
T _{inst}	recommended install. torque	ft-lb (Nm)	Finger Tight	3.7 (5)	5.9 (8)	7.4 (10)	3.7 (5)	5.9 (8)	7.4 (10)
Approximate fastenings per Cartridge		Small	38	13			10		
		Medium	60	20			16		
		Jumbo	180	61			47		

1 Hilti matched tolerance carbide tipped drill bits

HIT-HY 20 Installation Specifications for HIT-I Inserts in Hollow Block, Tile and Brick with Holes

Anchor System Application Anchor Rod Size Details	in (mm)	HIT Combi-Insert Tile	HIT-I Short Insert Hollow and Lightweight Block			HIT-I Standard Insert Brick w/Holes, Clay Tile		
		#14 -	5/16 x 2 (7.9 x 51)	3/8 x 2 (9.5 x 51)	1/2 x 2 (12.7 x 51)	5/16 x 3-3/16 (7.9 x 30)	3/8 x 3-3/16 (9.5 x 30)	1/2 x 3-3/16 (12.7 x 114.3)
d _{bit} bit diameter ¹	in.	1/2	5/8	27/32	27/32	5/8	27/32	27/32
minimum hole depth	in. (mm)	Through Material	Through Face of Hollow Base Material				3-1/2 (90)	
Required screen		HIT S-12/I	HIT S-16/2	HIT S-22/2	HIT S-22/2	HIT S-16	HIT S-22	HIT S-22
T _{inst} recommended install. torque	ft-lb (Nm)	Finger Tight	3.7 (5)	5.9 (8)	7.4 (10)	3.7 (5)	5.9 (8)	7.4 (10)
Approximate fastenings per Cartridge	Small	38	13				10	
	Medium	60	20				16	
	Jumbo	180	61				47	

1 Hilti matched tolerance carbide tipped drill bits

HIT-HY 20 Allowable Loads for Threaded HAS-E Rods in Multi-Wythe Solid Brick Walls^{1,2}

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Allowable Tension lb (kN)	Allowable Shear lb (kN)
3/8 (9.5)	6 (152)	685 (3.1)	590 (2.6)
	10 (254)	815 (3.6)	590 (2.6)
	10 (254)	815 (3.6)	590 (2.6)
1/2 (12.7)	6 (152)	745 (3.3)	930 (4.1)
	10 (254)	1270 (5.6)	930 (4.1)
	10 (254)	1270 (5.6)	930 (4.1)
5/8 (15.9)	6 (152)	815 (3.6)	1355 (6.0)
	10 (254)	1285 (5.7)	1355 (6.0)
	10 (254)	1285 (5.7)	1355 (6.0)
3/4 (19.1)	8 (203)	1400 (6.2)	1800 (8.0)
	13 (330)	2100 (9.3)	1800 (8.0)
	13 (330)	2100 (9.3)	1800 (8.0)

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right) + \left(\frac{V_d}{V_{rec}} \right) \leq 1.0 \text{ (Ref. Section 3.1.8.3)}$$

1 Values based on mortar shear strength of 45 psi or greater.

2 Based on using a safety factor of 5.

3.2.9 HIT-HY 20 for Masonry Construction

HIT HY 20 Allowable Loads for Threaded HIT-A Rods in Hollow Concrete Block, Lightweight Concrete Block, Brick with Holes, Clay Tile^{1,2}

Anchor Type	Anchor Diameter in. (mm)	HIT-A Short 2" (51mm) Embedment		HIT-A Standard 3-3/8" (86mm) Embedment ³			
		L/W or N/W Hollow Concrete Block		Brick with Holes		Clay Tile	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
HIT-A Rod Anchor	1/4 (6.4)	255 (1.1)	340 (1.5)	365 (1.6)	305 (1.4)	130 (0.6)	100 (0.4)
	5/16 (7.9)	370 (1.6)	505 (2.2)	565 (2.5)	530 (2.4)	150 (0.7)	220 (1.0)
	3/8 (9.5)	525 (2.3)	790 (3.5)	775 (3.4)	930 (4.1)	150 (0.7)	220 (1.0)
	1/2 (12.7)	525 (2.3)	1230 (5.5)	775 (3.4)	1375 (6.1)	150 (0.7)	500 (2.2)

1 Based on using a safety factor of 6 for tension and 4 for shear.

2 Due to wide strength variations encountered in masonry, these values should be considered as guide values.

3 1/4" anchor diameter installed at 2" embedment in brick with holes and clay tile.

HIT HY 20 Allowable Loads for Threaded HIT-I Inserts in Hollow Concrete Block, Lightweight Concrete Block, Brick with Holes, Clay Tile^{1,2}

Anchor Type	Anchor Diameter in. (mm)	HIT Short 2" (51mm) Embedment		HIT Standard 3-3/8" (86mm) Embedment ³			
		L/W or N/W Hollow Concrete Block		Brick with Holes		Clay Tile	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
HIT-I Insert Anchor	No. 14 Screw (6.4)	240 (1.1)	510 (2.3)	300 (1.3)	530 (2.4)	85 (0.4)	150 (0.7)
	5/16 (7.9)	400 (1.8)	780 (3.5)	585 (2.6)	750 (3.3)	175 (0.8)	220 (1.0)
	3/8 (9.5)	400 (1.8)	1425 (6.3)	1160 (5.2)	1380 (6.1)	185 (0.8)	435 (1.9)
	1/2 (12.7)	400 (1.8)	1800 (8.0)	1160 (5.2)	1635 (7.3)	185 (0.8)	500 (2.2)

1 Based on using a safety factor of 6 for tension and 4 for shear.

2 Due to wide strength variations encountered in masonry, these values should be considered as guide values.

3 #14 screw installed at 2" embedment in brick with holes and clay tile.

Anchor Spacing and Edge Distance Guidelines

Brick with Holes & Multi-Wythe Brick Walls

Spacing:

$$s_{cr} = s_{min} = \text{Two (2) complete bricks in any direction}$$

Edge Distance:

$$c_{cr} = c_{min} = \text{Two (2) complete bricks, or 16" (406 mm) in any direction (whichever is less.)}$$

Clay Tile

Spacing:

$$s_{cr} = s_{min} = \text{One (1) anchor per tile cell}$$

Edge Distance:

$$c_{cr} = c_{min} = 12" (305 \text{ mm}) \text{ from free edge}$$

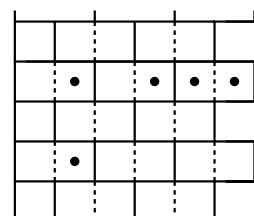
Hollow, Normal Weight & Lightweight Concrete Block

Spacing:

$$s_{cr} = s_{min} = \text{One (1) anchor per block cell}$$

Edge Distance:

$$c_{cr} = c_{min} = 12" (305 \text{ mm}) \text{ min. from free edge}$$



Wall Elevation

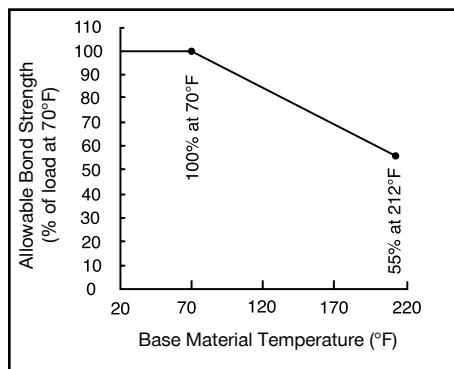
HIT-HY 20 for Masonry Construction 3.2.9

Resistance of HIT HY 20 to Chemicals

Chemical		Behavior
Sulphuric acid	conc. 30% 10%	- • +
Hydrochloric acid	conc. 10%	• +
Nitric acid	conc. 10%	- •
Phosphoric acid	conc. 10%	+ +
Acetic acid	conc. 10%	• +
Formic acid	conc. 10%	- •
Lactic acid	conc. 10%	+ +
Citric acid	10%	+
Caustic soda	40% 20% 5%	• + +
Ammonia	conc. 5%	• +
Soda solution	10%	+
Common salt solution	10%	+
Chlorinated lime solution	10%	+
Sodium hypochlorite	2%	+
Hydrogen peroxide	10%	+
Carbolic acid solution	10%	-
Ethanol		-
Sea water		+
Glycol		+
Acetone		-
Carbon tetrachloride		-
Toluene		+
Petrol/Gasoline		•
Machine oil		•
Diesel oil		•

Key: - non-resistant + resistant • partially resistant

Influence of Temperature on Bond Strength



Note: Test procedure involves the masonry being held at the elevated temperature for 24 hours then removing it from the controlled environment and testing to failure.

Long term creep test in accordance with AC58 is available; please contact Hilti Technical Services.

Samples of the HY 20 resin 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 **“Partially Resistant.”** Samples that were heavily damaged or destroyed were classified as **“Not Resistant.”**

Note: In actual use, the majority of the resin is encased in the base material, leaving very little surface area exposed. In some cases, this would allow the HY 20 to be used where it would be exposed to the **“Partially Resistant”** chemical compounds.

Curing Time Table¹ (Approximate)

Base Material Temperature		Approx. Cure Time
°F	°C	
23	-5	6 hrs
32	0	4 hrs
41	5	2 hrs
50	10	90 mins
68	20	60 mins
86	30	45 mins
104	40	30 mins

Gel Time Table¹ (Approximate)

Base Material Temperature		Approx. Gel Time
°F	°C	
23	-5	40 Minutes
32	0	30 Minutes
41	5	20 Minutes
50	10	11 Minutes
68	20	6 Minutes
86	30	3 Minutes
104	40	1 Minute

¹ Minimum product temperature must be maintained above 41°F (5°C) prior/during installation.

Influence of High Energy Radiation^{1,2}

Radiation Exposure	Detrimental Effect	Recommendation for Use
< 10 Mrad	Insignificant	Full Use
10 – 100 Mrad	Moderate	Restricted Use $F_{rec.} = 0.5 F_{perm.}$
> 100 Mrad	Medium to strong	No recommendation for use

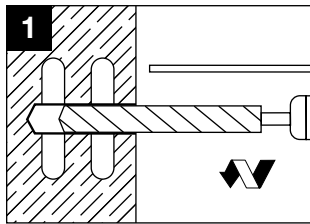
1 Mrad = Megarad

2 Dosage over life span.

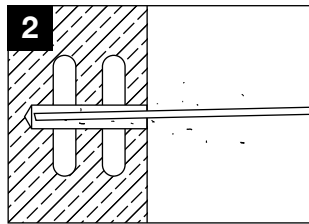
3.2.9 HIT-HY 20 for Masonry Construction

3.2.9.4 Installation Instructions

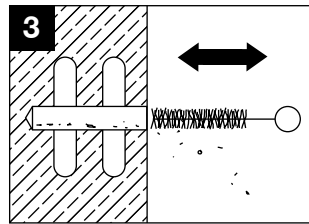
HIT-I Inserts and HIT-A Rods into Hollow Brick, Hollow Block or Tile



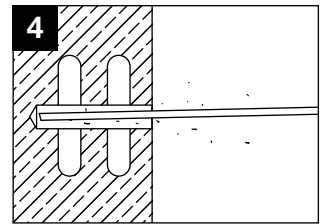
1. Select the proper bit. Set the depth gauge, drill the hole, rotation only. Hilti URM bits are recommended for drilling into masonry.



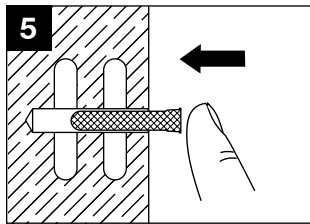
2. Use compressed air to blow out the hole from the bottom. The Hilti air nozzle is designed for hole cleaning.



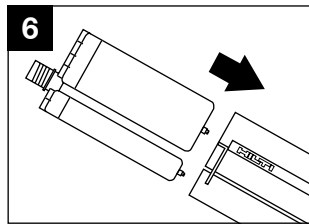
3. Proper hole cleaning is essential. Use a nylon brush to remove loose material. Do not use brushes with metal bristles.



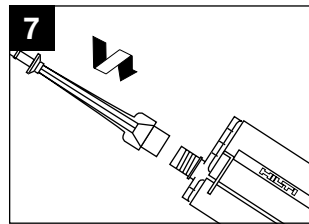
4. Use compressed air to blow out the hole from the bottom. The Hilti air nozzle is designed for hole cleaning.



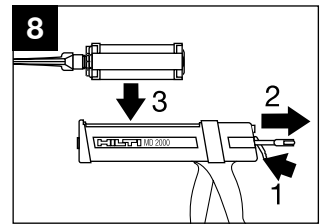
5. Insert specified HIT-S type screen tube into hole.



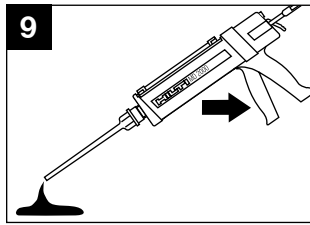
6. Insert refill pack into holder.



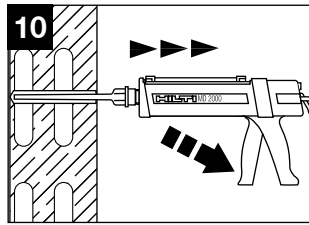
7. Screw on mixing nozzle with extension.



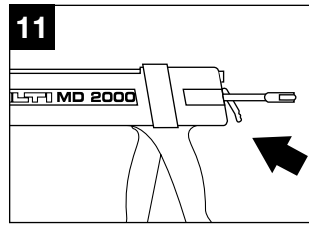
8. Put holder into dispenser.



9. **DISCARD FIRST THREE TRIGGER-PULLS OF ADHESIVE FROM EACH REFILL PACK.**



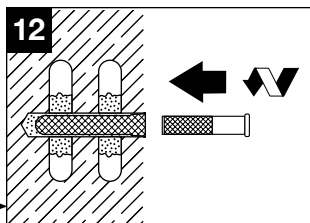
10. Fill HIT-S type screen tube completely from back to front edge of screen using the minimum number of trigger pulls listed in table.



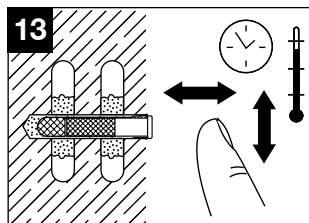
11. Unlock dispenser.

The minimum number of trigger pulls to fill each screen is as follows:

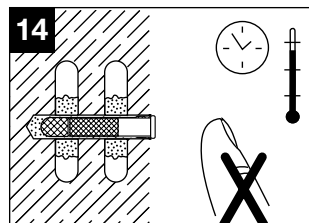
S12	1 pump
S16/2	4 pumps
S16	6 pumps
S22/2	4 pumps
S22	6 pumps



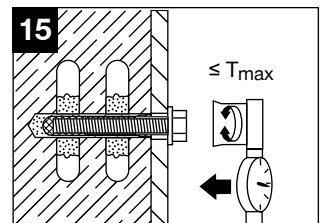
12. Insert HIT-I Insert, or HIT-A Rod into adhesive-filled screen, twisting slightly.



13. Fastener may be adjusted during specified gel time.



14. Do not disturb fastener between specified gel and cure time.

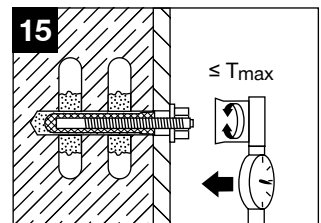
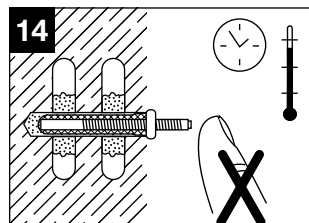
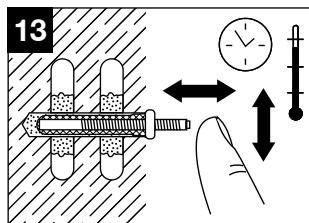
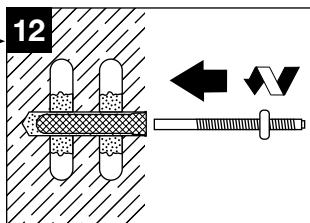


15. Apply torque to anchor. Do not exceed maximum recommended torque.

HIT-I INSERT

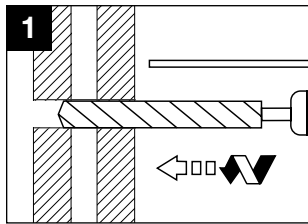
OR

HIT-A ROD

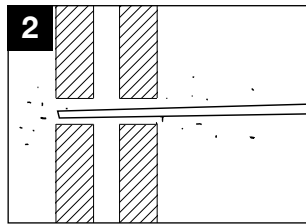


HIT-HY 20 for Masonry Construction 3.2.9

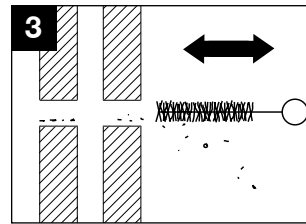
Installation of HAS-E Rods in Masonry Construction with Voids (e.g. Multi-wythe Construction)



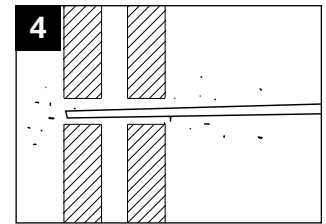
1. Select the proper bit. Set the depth gauge. Drill the hole, rotation only (unless otherwise specified).



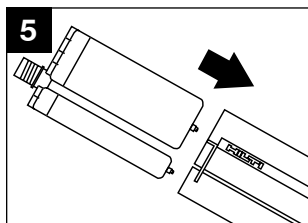
2. Use compressed air to blow out the hole from the bottom. The Hilti air nozzle is designed for hole cleaning.



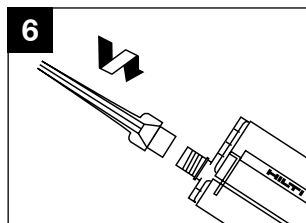
3. Proper hole cleaning is essential. Use a nylon brush to remove loose material. Do not use brushes with metal bristles.



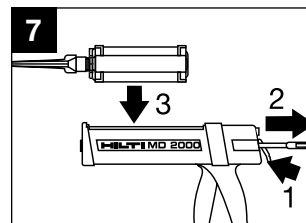
4. Use compressed air to blow out the hole from the bottom. The Hilti air nozzle is designed for hole cleaning.



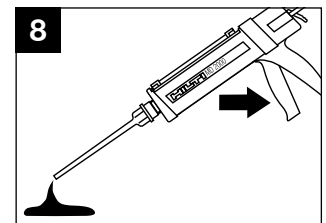
5. Insert refill pack into holder.



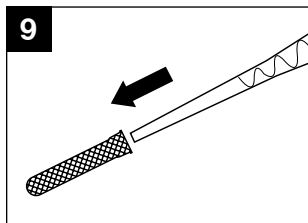
6. Screw on mixer and remove extension.



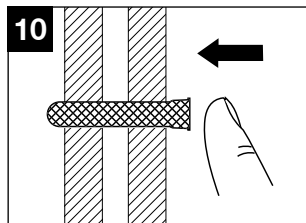
7. Put holder into dispenser.



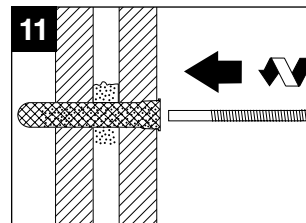
8. **DISCARD FIRST THREE TRIGGER PULLS OF ADHESIVE FROM EACH REFILL PACK.**



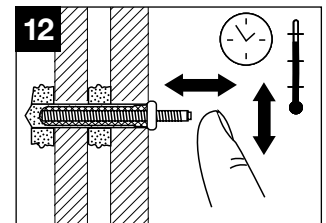
9. **Fill the screen tube completely**, beginning at the bottom. Use mixer filler extension tubes when needed to reach the screen tube bottom.



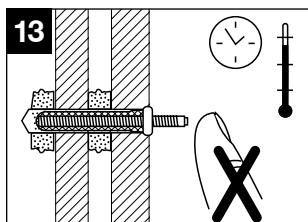
10. Insert specified screen tube into hole.



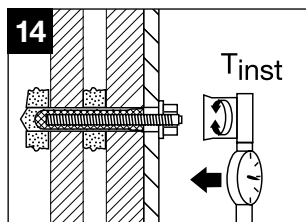
11. Insert HAS-E or HIT Rod into adhesive-filled screen, twisting slightly.



12. Fastener may be adjusted during specified gel time.



13. Do not disturb fastener between specified gel and cure time.



14. Load fastener only after cure time has elapsed.

3.2.9 HIT-HY 20 for Masonry Construction

3.2.9.5 Ordering Information

HIT-HY 20 Hybrid Adhesive

Features and Applications

- Allows for dependable fastening and a quick cure over a wide range of temperatures in hollow base materials
- HY 20 performs reliably where the quality of brick and mortar is inconsistent, even when the size and location of voids are unknown
- HY 20 is suited to solve multi wythe anchoring problems in renovation and seismic upgrades of unreinforced masonry buildings
- All seismic design categories and cracked concrete approval for maximum versatility

Gel/Full Cure Time Table (Approximate)

Base Material Temperature		t _{gel}	t _{cure}
° F	° C		
23	-5	40 min	6 hrs
32	0	30 min	4 hrs
41	5	20 min	2 hrs
68	20	6 min	60 min
86	30	3 min	45 min
104	40	1 min	30 min

Technical Data

Product

HIT-HY 20
Hybrid Urethane
Methacrylate

Base material temperature

23° F to 104° F
(-5° C to 40° C)

Diameter range

3/8" to 3/4"

Listings/Approvals

- ICC-ES (International Code Council) - ESR-2659 for URM
- COLA (City of Los Angeles) - RR-24564 for URM

Package volume

- Volume of HIT-HY 20 11.1 fl oz/330 ml foil pack is 20.1 in³
- Volume of HIT-HY 20 16.9 fl oz/500 ml oil pack is 30.5 in³
- Volume of HIT-HY 20 47.3 fl oz/1400 ml jumbo foil pack is 85.4 in³

Order Information

Description	Package Contents	Qty of Foil Packs
HIT-HY 20 (11.1 fl oz/330 ml)	Includes 1 foil pack with 1 mixer and 3/8" filler tube per pack	1
HIT-HY 20 MC (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 20 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 MD 2500 manual dispenser	25
HIT-HY 20 MC (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 20 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 the MD 2500 manual dispenser	40

HIT-A Standard and HIT-A Short Anchor Rods

①

②

Brick with Holes

HIT Rod-A		HIT-S Screen Tube (must be used with HIT Rod-A)		Hole Dia	Approximate Number Fastenings/Foil Pack ¹		
Description	Qty	Description	Qty		11.1 fl oz (330 ml)	16.9 fl oz (500 ml)	47.3 fl oz (1400 ml)
1/4" x 2-1/2"	① 20	S-12 A, 2" Long	② 20	1/2"	38	60	180
5/16" x 4"	① 10	S-16, 3-3/8" Long	② 10	5/8"	10	16	47
3/8" x 4-3/8"	① 10	S-16, 3-3/8" Long	② 10	5/8"	10	16	47
1/2" x 4-1/2"	① 10	S-16, 3-3/8" Long	② 10	5/8"	10	16	47

Hollow Concrete Block — Lightweight or Normal Weight

HIT Rod-A		HIT-S Screen Tube (must be used with HIT Rod-A)		Hole Dia	Approximate Number Fastenings/Foil Pack ¹		
Description	Qty	Description	Qty		11.1 fl oz (330 ml)	16.9 fl oz (500 ml)	47.3 fl oz (1400 ml)
1/4" x 2-1/2"	① 20	S-12 A, 2" Long	② 20	1/2"	38	61	189
5/16" x 2-1/2"	① 10	S-16/2, 2" Long	② 10	5/8"	13	20	58
3/8" x 3"	① 10	S-16/2, 2" Long	② 10	5/8"	13	20	58
1/2" x 3-1/8"	① 10	S-16/2, 2" Long	② 10	5/8"	13	20	58

Clay Tile

HIT Rod-A		HIT-S Screen Tube (must be used with HIT Rod-A)		Hole Dia	Approximate Number Fastenings/Foil Pack ¹		
Description	Qty	Description	Qty		11.1 fl oz (330 ml)	16.9 fl oz (500 ml)	47.3 fl oz (1400 ml)
1/4" x 2-1/2"	① 20	S-12 A, 2" Long	② 20	1/2"	38	60	180
5/16" x 2-1/2"	① 10	S-16/2, 2" Long	② 10	5/8"	13	20	61
3/8" x 3"	① 10	S-16/2, 2" Long	② 10	5/8"	13	20	61
1/2" x 3-1/8"	① 10	S-16/2, 2" Long	② 10	5/8"	13	20	61

¹ Assumes no waste

HIT-HY 20 for Masonry Construction 3.2.9

HIT-I Standard and HIT-I Short Internally Threaded Inserts

Brick with Holes

HIT-I Insert		HIT-S Screen Tube (10 pcs/Pkg)		Approx. Fastenings/Foil Pack ¹		
Description	Qty	Description	Hole Dia	11.1 fl oz (330 ml)	16.9 fl oz (500 ml)	47.3 fl oz (1400 ml)
Screen Tube w/ insert for #14 screw combo	20	-	1/2"	38	60	180
5/16" x 3-3/16"	10 ①	S-16, 3-3/8" Long ②	5/8"	10	16	47
3/8" x 3-3/16"	10 ①	S-22, 3-3/8" Long ②	27/32"	10	16	47
1/2" x 3-3/16"	10 ①	S-22, 3-3/8" Long ②	27/32"	10	16	47

Hollow Concrete Block — Lightweight or Normal Weight

HIT-I Insert		HIT-S Screen Tube (10 pcs/Pkg)		Approx. Fastenings/Foil Pack ¹		
Description	Qty	Description	Hole Dia	11.1 fl oz (330 ml)	16.9 fl oz (500 ml)	47.3 fl oz (1400 ml)
Screen Tube w/ insert for #14 screw combo	20	-	1/2"	38	60	180
5/16" x 2"	10 ①	S-16/2, 2" Long ②	5/8"	13	20	61
3/8" x 2"	10 ①	S-22/2, 2" Long ②	27/32"	13	20	61
1/2" x 2"	10 ①	S-22/2, 2" Long ②	27/32"	13	20	61

Clay Tile

HIT-I Insert		HIT-S Screen Tube (10 pcs/Pkg)		Approx. Fastenings/Foil Pack ¹		
Description	Qty	Description	Hole Dia	11.1 fl oz (330 ml)	16.9 fl oz (500 ml)	47.3 fl oz (1400 ml)
Screen Tube w/ insert for #14 screw combo	20	-	1/2"	38	60	180
5/16" x 3-3/16"	10 ①	S-16, 3-3/8" Long ②	5/8"	10	16	47
3/8" x 3-3/16"	10 ①	S-22, 3-3/8" Long ②	27/32"	10	16	47
1/2" x 3-3/16"	10 ①	S-22, 3-3/8" Long ②	27/32"	10	16	47

HIT-HY 20 System

Multi-Wythe Brick Walls

Threaded Rod			Screen Tube				Approx. Number Fastenings/ Foil Pack ¹		
Description	Qty	Description/Size	Qty	Hole Depth	Hole Dia	11.1 fl oz (330 ml)	16.9 fl oz (500 ml)	47.3 fl oz (1400 ml)	
HAS-E 3/8" x 8"	① 10	3/8" x 6"	② 10	6-1/4"	1/2"	15	24	70	
HAS-E 3/8" x 12"	① 10	3/8" x 10"	② 10	10-1/4"	1/2"	9	14	42	
HAS-E 1/2" x 8"	① 10	1/2" x 6"	② 10	6-1/4"	11/16"	7	11	33	
HAS-E 1/2" x 12"	① 10	1/2" x 10"	② 10	10-1/4"	11/16"	4	6	19	
HAS-E 5/8" x 8"	① 20	5/8" x 6"	② 10	6-1/4"	27/32"	4	6	19	
HAS-E 5/8" x 12"	① 10	5/8" x 10"	② 10	10-1/4"	27/32"	3	5	14	
HAS-E 5/8" x 17"	① 10	5/8" x 10"	② 10	10-1/4"	27/32"	3	5	14	
HAS-E 3/4" x 10"	① 10	3/4" x 8"	② 10	8-1/4"	1"	3	5	14	
HAS-E 3/4" x 12"	① 10	3/4" x 8"	② 10	8-1/4"	1"	3	5	14	
HAS-E 3/4" x 14"	① 10	3/4" x 8"	② 10	8-1/4"	1"	3	5	14	
HAS-E 3/4" x 17"	① 10	3/4" x 13"	② 10	13-1/4"	1"	2	3	9.5	
HAS-E 3/4" x 19"	① 10	3/4" x 17"	② 10	17-1/4"	1"	1	2	6	
HAS-E 3/4" x 21"	① 10	3/4" x 17"	② 10	17-1/4"	1"	1	2	6	
HAS-E 3/4" x 25"	① 10	3/4" x 21"	② 10	21-1/4"	1"	1	1.5	5	

1 Assumes no waste

Accessories for use with HIT-HY 20

Description	Hole Diameter	Working Length	Identifier	Quantity
Nylon Brush 5/8" x 12"	3/8" to 1/2"	10-1/2"	①	1
Nylon Brush 7/8" x 12"	1/2" to 5/8"	10-1/2"	①	1
Nylon Brush 1" x 12"	5/8" to 3/4"	10-1/2"	①	1
Nylon Brush 1-1/4" x 29"	> 3/4"	27"	①	1
HIT-M static mixer	For use with HIT-HY 20 cartridges			1
HIT-ME Static Mixer with Extension	For use with HIT-HY 20 cartridges including extension for S16, S16/2, S22, S22/2 screen tubes			1

22.5° Applications

Description	Qty/Pkg	Notes
Beveled 22.5° Square Washer	10	Use 3/4" diameter threaded HAS-E rod and screen tube in seismic upgrade of URM buildings for 22.5° shear/tension anchor
Hilti Rod 3/4 x 19 Bent	10	Seismic upgrade of URM buildings

3.2.10 HVA Capsule Adhesive Anchoring System

3.2.10.1 Product Description

3.2.10.2 Material Specifications

3.2.10.3 Technical Data

3.2.10.4 Installation Instructions

3.2.10.5 Ordering Information

3.2.10.1 Product Description

HVU Adhesive Capsule

HIS Internally Threaded Insert

HAS Anchor Rod Assembly
with nut and washer

Rebar (Not supplied by Hilti)

The Hilti HVA system is a heavy duty, two component adhesive anchor consisting of a self-contained adhesive capsule and either a threaded rod with nut and washer or an internally threaded insert.

Anchor Rod Shall be provided with 45 degree chisel or cut point to provide proper mixing of the adhesive components. Anchor rod shall be manufactured to meet the following requirements: **1.** ISO 898 Class 5.8; **2.** ASTM A 193 Grade B7; **3.** AISI 304 or AISI 316 stainless steel meeting the mechanical requirements of ASTM F 593 (Condition CW); **4.** Rebar with chisel or cut point.

Special order HAS Rod materials may vary from standard steel rod product.

Nuts and Washers Shall be furnished to meet the requirements of the above anchor rod specifications.

Adhesive Capsule Shall consist of a dual chamber foil capsule. The resin material shall be vinyl urethane methacrylate.

Steel Insert The internally threaded insert shall have a 45 degree (from central axis) chisel pointed end. The insert shall be carbon steel or stainless steel material which meets minimum ultimate tensile strengths of 66.7 and 101.5 ksi, respectively.

The adhesive anchoring system shall be the Hilti HVA anchoring system, consisting of the Hilti HVU adhesive capsule and the Hilti HAS anchor rod or HIS internally threaded insert.

Installation Adhesive anchors to be installed in holes drilled using the specified diameter of Hilti carbide tipped drill bit or matched tolerance Hilti DD-B or DD-C diamond core bit. Anchors shall be installed in strict accordance to section 3.2.10.4. Do not disturb until cure time has elapsed.

Listings/Approvals

NSF/ANSI Std 61

certification for use in potable water

European Technical approval

ETA-05/0255

ETA-05/0256

ETA-05/0257



Independent Code Evaluation

LEED®: Credit 4.1-Low Emitting Materials

The Leadership in Energy and Environmental Design (LEED®) Green Building Rating system™ is the nationally accepted benchmark for the design, construction and operation of high performance green buildings.

Product Features

- High loading capacity
- Small edge distance and anchor spacing allowance
- Excellent dynamic load resistance
- Wide range of installation temperatures
- Excellent performance in holes cored using Hilti DD-B or DD-C diamond core bits
- Excellent elevated temperature performance
- Excellent performance in freezing and thawing conditions
- No hole brushing required—just blow out hole with compressed air—makes installation fast and easy

Guide Specifications

Master Format Section:

Previous 2004 Format

03250 03 16 00 (Concrete Anchors)

Related Sections:

03200 03 20 00 (Concrete Reinforcing)

05050 05 50 00 (Metal Fabrications)

05120 05 10 00 (Structural Metal Framing)

Adhesive anchors shall consist of an all-thread anchor rod, nut, washer and adhesive capsule. Alternatively, adhesive anchors shall consist of a steel insert and an adhesive capsule.

HVA Capsule Adhesive Anchoring System 3.2.10

3.2.10.2 Material Specifications

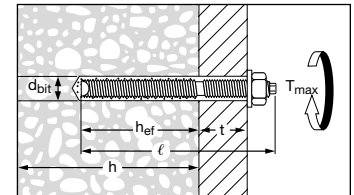
Material	Mechanical Properties			
	f_y ksi (MPa)		min. f_u ksi (MPa)	
Standard HAS-E rod material meets the requirements of ISO 898 Class 5.8	58	(400)	72.5	(500)
High Strength or 'Super HAS' rod material meets the requirements of ASTM A 193, Grade B7	105	(724)	125	(862)
Stainless HAS rod material meets the requirements of ASTM F 593 (304/316) Condition CW 3/8" to 5/8"	65	(448)	100	(689)
Stainless HAS rod material meets the requirements of ASTM F 593 (304/316) Condition CW 3/4" to 1-1/4"	45	(310)	85	(586)
HIS Insert 11SMnPb30+C Carbon Steel conforming to DIN 10277-3	54.4	(375)	66.7	(460)
HIS-R Insert X5CrNiMo17122 K700 Stainless Steel conforming to DIN EN 10088-3	50.8	(350)	101.5	(700)
HAS Super & HAS-E Standard Nut Material meets the requirements of SAE J995 Grade 5				
HAS Stainless Steel Nut material meets the requirements of ASTM F 594				
HAS Carbon Steel and Stainless Steel Washers meet dimensional requirements of ANSI B18.22.1 Type A Plain				
HAS Super & HAS-E Standard Washers meet the requirements of ASTM F 436				
All HAS-E & HAS Super Rods (except 7/8") & HAS-E Standard, HIS inserts, nuts & washers are zinc plated to ASTM B 633 SC 1				
7/8" Standard HAS-E & HAS Super rods hot-dip galvanized in accordance with ASTM A 153				
HVU Adhesive—Vinyl Urethane Methacrylate Resin with a Dibenzoyl Peroxide hardener				

Note: Special Order steel rod material may vary from standard steel rod materials.

3.2.10.3 Technical Data

HAS Rod Specification Table

HAS Rod Size		in.	3/8	1/2	5/8	3/4	7/8	1	1-1/4
Details		(mm)	(9.5)	(12.7)	(15.9)	(19.1)	(22.2)	(25.4)	(31.8)
d_{bit} : nominal bit diameter ¹		in.	7/16	9/16	11/16	7/8	1	1-1/8	1-3/8
$h_{ef} = h_{nom}$ std. depth of embed. ² = capsule length		in.	3-1/2	4-1/4	5	6-5/8	6-5/8	8-1/4	12
		(mm)	(90)	(110)	(125)	(170)	(170)	(210)	(305)
t: max. thickness fastened ³		in.	1	1-1/2	1-3/4	2	2-1/4	2-1/2	2-3/4
		(mm)	(25.4)	(38.1)	(44.5)	(50.8)	(57.2)	(63.5)	(69.9)
t_{max} : max. tightening torque	All HILTI Rods	ft-lb (Nm)	18 (24)	30 (41)	75 (102)	150 (203)	175 (237)	235 (319)	400 (540)
h: minimum base material thickness ⁴	$h_{ef} = h_{nom}$	in. (mm)	5-1/2 (140)	6-1/4 (160)	7 (180)	8-1/2 (220)	8-1/2 (220)	10-1/2 (270)	15 (380)
	$h_{ef} \neq h_{nom}$	in. (mm)	1.0 $h_{ef} + 2$ (51)	1.0 $h_{ef} + 2$ (51)	1.0 $h_{ef} + 2$ (51)	1.0 $h_{ef} + 2$ (51)	1.0 $h_{ef} + 2$ (51)	1.0 $h_{ef} + 2$ (57)	1.0 $h_{ef} + 3$ (76)
Recommended Hilti Rotary Hammer Drill			TE 1...30		TE 1...60	TE 50...60		TE 50...80	

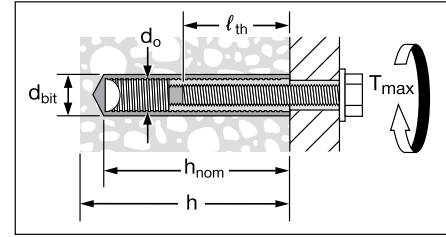


- 1 Use matched tolerance carbide tipped bits or Hilti matched tolerance DD-B or DD-C diamond core bit.
- 2 Data available for varying embedments; see Load Tables.
- 3 When using standard length rods at standard embedment (h_{nom})
- 4 Minimum base material thickness given to minimize backside blowout from drilling. Ability of base material to withstand loads applied (e.g. bending of concrete slab) should be determined by design engineer.

3.2.10 HVA Capsule Adhesive Anchoring System

HIS Insert Specification Table

HIS Insert	in. (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)
Details					
HVU capsule required		1/2 x 4-1/4	5/8 x 5	7/8 x 6-5/8	1 x 8-1/4
d _{bit} bit diameter ¹	in.	11/16	7/8	1-1/8	1-1/4
d _o outside diameter ¹	in.	0.65	0.81	1	1.09
h _{ef} = h _{nom} std. depth of embed. = capsule length	in. (mm)	4-3/8 (110)	5 (125)	6-5/8 (170)	8-1/4 (210)
ℓ _{th} useable thread length	in. (mm)	1 (25)	1-3/16 (30)	1-1/2 (40)	2 (50)
T _{max} Max. tightening torque	ft-lb (Nm)	18 (24)	30 (41)	75 (102)	150 (203)
h min. base material thickness	in. (mm)	6-3/8 (162)	7-1/2 (191)	10 (254)	12-3/8 (314)
Recommended Hilti Rotary Hammer Drill		TE 1...40	TE 1...40	TE 40...60	TE 40...80



1 Hilti matched tolerance carbide tipped drill bits

Rebar Specification Table

Rebar Size		#4	#5	#6	#7	#8
d _{bit} bit diameter ^{1,2}	in.	5/8	13/16	1	1-1/8	1-1/4
h _{ef} = h _{nom} std. depth of embed. = capsule length	in. (mm)	4-1/4 (110)	5 (125)	6-5/8 (170)	6-5/8 (170)	8-1/4 (210)

1 Rebar diameters may vary; the witnessed test was performed using the above mentioned drill bit diameters. Rebar must have a minimum length 4" greater than embedment to accommodate the setting equipment.

2 Hilti matched tolerance carbide tipped drill bits

Metric Rebar Specification Table (Canada Only)



Rebar Size		10M	15M	20M	25M
d _{bit} bit diameter ^{1,2}	in. or mm	9/16	13/16	1	32mm
h _{ef} = h _{nom} std. depth of embed. = capsule length	mm in.	90 (3-1/2)	125 (5)	170 (6-5/8)	210 (8-1/4)

1 Rebar diameters may vary; the witnessed test was performed using the above mentioned drill bit diameters. Rebar must have a minimum length 4" greater than embedment to accommodate the setting equipment.

2 Hilti matched tolerance carbide tipped drill bits

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right)^{5/3} + \left(\frac{V_d}{V_{rec}} \right)^{5/3} \leq 1.0 \text{ (Ref. Section 3.1.8.3)}$$

HVA Capsule Adhesive Anchoring System 3.2.10

HVA Allowable and Ultimate Bond/Concrete Capacity for HAS Rods in Normal Weight Concrete^{1, 2}

Rod Diameter in (mm)	Embed. Depth ³ in (mm)	Adhesive Capsule(s) Required	HVU Allowable Bond/Concrete Capacity				HVU Ultimate Bond/Concrete Capacity			
			Tensile		Shear		Tensile		Shear	
			$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)	$f'_c = 2000$ psi (13.8 MPa) lb (kN)	$f'_c = 4000$ psi (27.6 MPa) lb (kN)
3/8 (9.5)	3-1/2 (90)	(1) 3/8 x 3-1/2	2085 (9.3)	2595 (11.5)	3335 (14.8)	4710 (21.0)	8345 (37.1)	10380 (46.2)	10000 (44.5)	14120 (62.8)
	5-1/4 (133)	(2) 3/8 x 3-1/2	2325 (10.3)	4185 (18.6)	6120 (27.2)	8655 (38.5)	9295 (41.3)	16730 (74.4)	18360 (81.7)	25960 (115.5)
	7 (178)	(2) 3/8 x 3-1/2	4405 (19.6)	4895 (21.8)	9420 (41.9)	13330 (59.3)	17630 (78.4)	19590 (87.1)	28260 (125.7)	39980 (177.8)
1/2 (12.7)	4-1/4 (110)	(1) 1/2 x 4-1/4	3250 (14.5)	4735 (21.1)	5450 (24.2)	7280 (32.4)	12990 (57.8)	18940 (84.2)	15440 (68.7)	21840 (97.1)
	6-3/8 (162)	(1) 1/2 x 4-1/4 & (1) 3/8 x 3-1/2	4890 (21.8)	5455 (24.3)	9455 (42.1)	13375 (59.5)	19565 (87.0)	21815 (97.0)	28360 (126.2)	40120 (178.5)
	8-1/2 (216)	(2) 1/2 x 4-1/4	6700 (29.8)	7545 (33.6)	14560 (64.8)	20590 (91.6)	26810 (119.3)	30190 (134.3)	43680 (194.3)	61760 (274.7)
5/8 (15.9)	5 (125)	(1) 5/8 x 5	3970 (17.7)	5245 (23.3)	7350 (32.7)	10390 (46.2)	15890 (70.7)	20970 (93.3)	22040 (98.0)	31160 (138.6)
	7-1/2 (184)	(1) 5/8 x 5 & (1) 1/2 x 4-1/4	5770 (25.7)	10465 (46.6)	13495 (60.0)	19080 (84.9)	23080 (102.7)	41865 (186.2)	40480 (180.1)	57240 (254.6)
	10 (254)	(2) 5/8 x 5	11700 (52.0)	12835 (57.1)	20775 (92.4)	29375 (130.7)	46795 (208.2)	51340 (228.4)	62320 (277.2)	88120 (392.0)
3/4 (19.1)	6-5/8 (170)	(1) 3/4 x 6-5/8	6080 (27.0)	8615 (38.3)	12270 (54.6)	17355 (77.2)	24330 (108.2)	34470 (153.3)	36800 (163.7)	52060 (231.6)
	10 (254)	(1) 3/4 x 6-5/8 & (1) 1/2 x 4-1/4	9110 (40.5)	14835 (66.0)	22755 (101.2)	32180 (143.1)	36445 (162.1)	59350 (264.0)	68260 (303.6)	96540 (429.4)
	13-1/4 (337)	(2) 3/4 x 6-5/8	15220 (67.7)	15310 (68.1)	34700 (154.4)	49080 (218.3)	60875 (270.8)	61230 (272.4)	104100 (463.1)	147240 (655.0)
7/8 (22.2)	6-5/8 (170)	(1) 7/8 x 6-5/8	7145 (31.8)	9130 (40.6)	13110 (58.3)	18535 (82.4)	28580 (127.1)	36525 (162.5)	39320 (174.9)	55600 (247.3)
	10 (254)	(2) 3/4 x 6-5/8	10475 (46.6)	18970 (84.4)	24575 (109.3)	34755 (154.6)	41905 (186.4)	75870 (337.5)	73720 (327.9)	104260 (463.8)
	13-1/4 (337)	(2) 7/8 x 6-5/8	16475 (73.3)	23055 (102.6)	34780 (154.7)	53010 (235.8)	65895 (293.1)	92220 (410.2)	112440 (500.2)	159020 (707.4)
1 (25.4)	8 1/4 (210)	(1) 1 x 8-1/4	8640 (38.4)	13425 (59.7)	19690 (87.6)	27840 (123.8)	34560 (153.7)	53695 (238.8)	59060 (262.7)	83520 (371.5)
	12-3/8 (314)	(2) 7/8 x 6-5/8	14665 (65.2)	23450 (104.3)	36170 (160.9)	51150 (227.5)	58665 (261.0)	93800 (417.2)	108500 (482.6)	153440 (682.5)
	16-1/2 (419)	(2) 1 x 8-1/4	26645 (118.5)	30805 (137.0)	55690 (247.7)	78750 (350.3)	106580 (474.1)	123220 (548.1)	167060 (743.1)	236240 (1050.8)
1-1/4 (31.8)	12 (305)	(1) 1-1/4 x 12	19175 (85.3)	23920 (106.4)	38615 (171.8)	54610 (242.9)	76740 (341.4)	95680 (425.6)	115840 (515.3)	163820 (728.7)
	15 (381)	(1) 1-1/4 x 12 & (1) 1 x 8-1/4	24750 (110.1)	26855 (119.5)	53960 (240.0)	76315 (339.5)	99000 (440.4)	107420 (477.8)	161880 (720.1)	228940 (1018.4)
	18 (457)	(1) 1-1/4 x 12 & (2) 1 x 8-1/4	29535 (131.4)	37920 (168.7)	70935 (315.5)	100320 (446.2)	118140 (525.5)	151680 (674.7)	212800 (946.6)	300960 (1338.7)

1 Influence factors for spacing and/or edge distance are applied to concrete/bond values above, and then compared to the steel value. The lesser of the values is to be used for the design.

2 Average ultimate concrete shear capacity based on Strength Design method.

3 Contact Hilti for the use of alternate embedment other than those tested and listed above.

3.2.10 HVA Capsule Adhesive Anchoring System

Allowable Steel Strength for Carbon Steel and Stainless Steel HAS Rods¹

Rod Diameter in (mm)	HAS-E Standard ISO 898 Class 5.8		HAS Super ASTM A 193 B7		HAS SS AISI 304/316 SS	
	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	2640 (11.7)	1360 (6.0)	4555 (20.3)	2345 (10.4)	3645 (16.2)	1875 (8.3)
1/2 (12.7)	4700 (20.9)	2420 (10.8)	8100 (36.0)	4170 (18.5)	6480 (28.8)	3335 (14.8)
5/8 (15.9)	7340 (32.7)	3780 (16.8)	12655 (56.3)	6520 (29.0)	10125 (45.0)	5215 (23.2)
3/4 (19.1)	10570 (47.0)	5445 (24.2)	18225 (81.1)	9390 (41.8)	12390 (55.1)	6385 (28.4)
7/8 (22.2)	14385 (64.0)	7410 (33.0)	24805 (110.3)	12780 (56.9)	16865 (75.0)	8690 (38.6)
1 (25.4)	18790 (83.6)	9680 (43.0)	32400 (144.1)	16690 (74.2)	22030 (98.0)	11350 (50.5)
1-1/4 (31.8)	29360 (130.6)	15125 (67.3)	50620 (225.2)	26080 (116.0)	34425 (153.1)	17735 (78.9)

¹ Steel strength as defined in AISC Manual of Steel Construction (ASD):

Tensile = $0.33 \times F_u \times \text{Nominal Area}$

Shear = $0.17 \times F_u \times \text{Nominal Area}$

Ultimate Steel Strength for Carbon Steel and Stainless Steel HAS Rods¹

Rod Diameter in (mm)	HAS-E Standard ISO 898 Class 5.8			HAS Super ASTM A 193 B7			HAS SS AISI 304/316 SS		
	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	4495 (20.0)	6005 (26.7)	3605 (16.0)	8135 (36.2)	10350 (43.4)	6210 (27.6)	5035 (22.4)	8280 (36.8)	4970 (22.1)
1/2 (12.7)	8230 (36.6)	10675 (47.5)	6405 (28.5)	14900 (66.3)	18405 (79.0)	11040 (49.1)	9225 (41.0)	14720 (65.5)	8835 (39.3)
5/8 (15.9)	13110 (58.3)	16680 (74.2)	10010 (44.5)	23730 (105.6)	28760 (125.7)	17260 (76.8)	14690 (65.3)	23010 (102.4)	13805 (61.4)
3/4 (19.1)	19400 (86.3)	24020 (106.9)	14415 (64.1)	35120 (156.2)	41420 (185.7)	24850 (110.5)	15050 (66.9)	28165 (125.3)	16800 (75.2)
7/8 (22.2)	26780 (119.1)	32695 (145.4)	19620 (87.3)	48480 (215.7)	56370 (256.9)	33825 (150.5)	20775 (92.4)	38335 (170.5)	23000 (102.3)
1 (25.4)	35130 (156.3)	42705 (190.0)	25625 (114.0)	63600 (282.9)	73630 (337.0)	44180 (196.5)	27255 (121.2)	50070 (222.7)	30040 (133.6)
1-1/4 (31.8)	56210 (250.0)	66730 (296.8)	40035 (178.1)	101755 (452.6)	115050 (511.8)	69030 (307.1)	43610 (194.0)	78235 (348.0)	46940 (208.8)

¹ Steel strength as defined in AISC Manual of Steel Construction 2nd Ed. (LRFD):

Yield = $F_y \times \text{Tensile Stress Area}$

Tensile = $0.75 \times F_u \times \text{Nominal Area}$

Shear = $0.45 \times F_u \times \text{Nominal Area}$

HVA Capsule Adhesive Anchoring System 3.2.10

HVA Allowable Bond/Concrete Capacity and Steel Strength for HIS Carbon Steel and HIS-R Stainless Steel Internally Threaded Inserts

Anchor Dia. in (mm)	Embed. Depth in (mm)	Adhesive Capsule(s) Required	HVU Allowable Bond/Concrete Capacity ²	Steel Bolt Strength ^{1,2}			
			Tensile $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	ASTM A 325 Carbon Steel		ASTM F Stainless Steel	
				Tensile ¹ lb (kN)	Shear ¹ lb (kN)	Tensile ¹ lb (kN)	Shear ¹ lb (kN)
3/8 (9.5)	4-3/8 (110)	(1) 1/2 x 4-1/4	3180 (14.1)	4370 (19.4)	2250 (10.0)	3645 (16.2)	1875 (8.3)
1/2 (12.7)	5 (127)	(1) 5/8 x 5	4570 (20.3)	7775 (34.6)	4005 (17.8)	6480 (28.8)	3335 (14.8)
5/8 (15.9)	6-5/8 (168)	(1) 7/8 x 6-5/8	7460 (33.2)	12150 (54.0)	6260 (27.8)	10125 (45.0)	5215 (23.2)
3/4 (19.1)	8-1/4 (210)	(1) 1 x 8-1/4	9165 (40.8)	17495 (77.8)	9010 (40.1)	12395 (55.1)	6385 (28.4)

HVA Ultimate Bond/Concrete Capacity and Steel Strength for HIS Carbon Steel and HIS-R Stainless Steel Internally Threaded Inserts

Anchor Dia. in (mm)	Embed. Depth in (mm)	Adhesive Capsule(s) Required	HVU Ultimate Bond/Concrete Capacity ²	Steel Bolt Strength ^{1,2}			
			Tensile $f'_c \geq 2000$ psi (13.8 MPa) lb (kN)	ASTM A 325 Carbon Steel		ASTM F 593 Stainless Steel	
				Tensile ¹ lb (kN)	Shear ¹ lb (kN)	Tensile ¹ lb (kN)	Shear ¹ lb (kN)
3/8 (9.5)	4-3/8 (110)	(1) 1/2 x 4-1/4	12715 (56.6)	9935 (44.2)	5960 (26.5)	8280 (36.8)	4970 (22.1)
1/2 (12.7)	5 (127)	(1) 5/8 x 5	18275 (81.3)	17665 (78.6)	10600 (47.2)	14720 (65.5)	8835 (39.3)
5/8 (15.9)	6-5/8 (168)	(1) 7/8 x 6-5/8	29840 (132.7)	27610 (122.8)	16565 (73.7)	23010 (102.4)	13805 (61.4)
3/4 (19.1)	8-1/4 (210)	(1) 1 x 8-1/4	36660 (163.1)	39760 (176.9)	23855 (106.1)	28165 (125.3)	16900 (75.1)

1 Steel values in accordance with AISC

ASTM A 325 bolts: $F_y = 92$ ksi, $F_u = 120$ ksi
ASTM F 593 (AISI 304/316): $F_y = 65$ ksi, $F_u = 100$ ksi for 3/8" thru 5/8"
 $F_y = 45$ ksi, $F_u = 85$ ksi for 3/4"

Allowable Load Values Ultimate Load Values
Tension = $0.33 \times F_u \times A_{nom}$ Tension = $0.75 \times F_u \times A_{nom}$
Shear = $0.17 \times F_u \times A_{nom}$ Shear = $0.45 \times F_u \times A_{nom}$

2 Use lower value of either bond/concrete capacity or steel strength.

3.2.10 HVA Capsule Adhesive Anchoring System

HVA Ultimate Bond Capacity and Steel Strength for Rebar in Concrete

Rebar Size	Embed. Depth in (mm)	Adhesive Capsule(s) Required	HVU Ultimate Bond Concrete Strength ¹				Grade 60 Rebar ¹	
			$f'_c = 2000$ psi (13.8 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)	Yield Strength lb (kN)	Tensile Strength lb (kN)
#4	4-1/4 (108)	(1) 1/2 X 4-1/4	9680 (43.1)	10980 (48.8)	12270 (54.6)	14850 (66.1)	12000 (53.4)	18000 (80.1)
	6-3/8 (162)	(1) 1/2 X 4-1/4 & (1) 3/8 X 3-1/2	14520 (64.6)	16460 (73.2)	18400 (81.9)	22280 (99.1)		
	8-1/2 (216)	(2) 1/2 X 4-1/4	19360 (86.1)	21950 (97.6)	24530 (109.1)	29710 (132.2)		
#5	5 (127)	(1) 5/8 X 5	15000 (66.7)	16920 (75.3)	18830 (83.8)	22650 (100.8)	18600 (82.7)	27900 (124.1)
	7-1/2 (184)	(1) 5/8 X 5 & (1) 1/2 X 4-1/4	22490 (100.4)	25370 (112.9)	28240 (125.6)	33980 (151.1)		
	10 (254)	(2) 5/8 X 5	29990 (133.4)	33820 (150.4)	37650 (167.5)	45310 (201.5)		
#6	6-5/8 (168)	(1) 7/8 X 6-5/8	21020 (93.5)	24250 (107.9)	27470 (122.2)	33930 (150.9)	26400 (117.4)	39600 (176.1)
	10 (254)	(2) 3/4 X 6-5/8	31530 (140.3)	36370 (161.8)	41210 (183.3)	50890 (226.4)		
	13-1/4 (337)	(2) 7/8 X 6-5/8	42040 (187.0)	48500 (215.7)	54950 (244.4)	67850 (301.8)		
#7	6-5/8 (168)	(1) 1 X 8-1/4	23650 (105.2)	27280 (121.3)	30910 (137.5)	38170 (169.8)	36000 (160.1)	54000 (240.2)
	10 (254)	(2) 3/4 X 6-5/8	35470 (157.8)	40920 (182.0)	46360 (206.2)	57250 (254.7)		
	13-1/4 (337)	(2) 1 X 8-1/4	47300 (210.4)	54560 (242.7)	61810 (274.9)	76330 (339.5)		
#8	8-1/4 (210)	(1) 1 X 8-1/4 & (1) 5/8 X 5	35640 (158.5)	40500 (180.2)	45360 (201.8)	55080 (245.0)	47400 (210.8)	71100 (316.3)
	12/3/8 (314)	(1) 7/8 X 6-5/8 & (1) 1 X 8-1/4	53460 (237.8)	60750 (270.2)	68040 (302.7)	82610 (367.5)		
	16/1/2 (419)	(2) 1 X 8-1/4 & (1) 3/4 X 6-5/8	71270 (317.0)	80990 (360.3)	90710 (403.5)	110150 (490.0)		

¹ Use lower of either bond/concrete or steel strength.

HVA Capsule Adhesive Anchoring System 3.2.10

HVA Allowable Bond Capacity and Steel Strength for Metric Rebar in Concrete (Canada Only)^{1,2,3}



Rebar Size	Embed. Depth mm (in)	Adhesive Capsule(s) Required	HVU Allowable Tensile Concrete/Bond Strength ¹				Strength Properties of Metric Rebar $f_y = 400 \text{ MPa}$	
			14 MPa (2000 psi) kN (lb)	20 MPa (3000 psi) kN (lb)	28 MPa (4000 psi) kN (lb)	40 MPa (6000 psi) kN (lb)	Yield Strength kN (lb)	Tensile Strength kN (lb)
15M	125 (5)	(1) M16	16.7 (3750)	18.8 (4230)	21.0 (4705)	25.2 (5660)	80 (17985)	120 (26975)
	185 (7-1/2)	(1) M16 & (1) M12	25.1 (5620)	28.2 (6340)	31.4 (7060)	37.8 (8495)		
	255 (10)	(2) M16	33.4 (7495)	37.6 (8455)	41.9 (9410)	50.4 (11325)		
20M	170 (6-5/8)	(1) M20	23.4 (5255)	27.0 (6060)	30.6 (6865)	37.7 (8480)	120 (26975)	180 (40465)
	255 (10)	(2) 3/4 x 6-5/8	35.1 (7880)	40.5 (9090)	45.8 (10300)	56.6 (12720)		
	340 (13-1/4)	(2) M20	46.8 (10510)	53.9 (12125)	61.1 (13735)	75.4 (16960)		
25M	210 (8-1/4)	(1) M24	39.6 (8910)	45.0 (10125)	50.4 (11340)	61.3 (13770)	200 (44960)	300 (67440)
	315 (12-3/8)	(1) M24 & (1) 3/4 x 6-5/8	59.4 (13365)	67.6 (15185)	75.7 (17010)	91.9 (20650)		
	420 (16-1/2)	(2) M24	79.2 (17815)	90.1 (20245)	100.9 (22675)	122.5 (27535)		

1 Allowable bond/concrete strength based on a safety factor of 4.0.

2 For anchor spacing and edge distance guidelines, refer to the following pages of this HVA Adhesive Anchor System section.

3 Steel values in accordance with AISC

Allowable Load Values

$$\text{Tension} = 0.33 \times F_u \times A_{\text{nom}}$$

$$\text{Shear} = 0.17 \times F_u \times A_{\text{nom}}$$

Ultimate Load Values

$$\text{Tension} = 0.75 \times F_u \times A_{\text{nom}}$$

$$\text{Shear} = 0.45 \times F_u \times A_{\text{nom}}$$

3.2.10 HVA Capsule Adhesive Anchoring System

HVA Ultimate Bond Capacity and Steel Strength for Metric Rebar in Concrete (Canada Only)^{1,2}



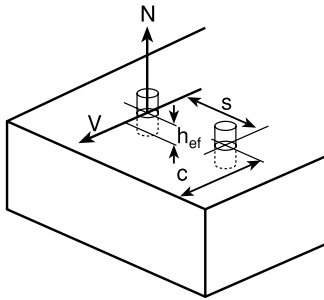
Rebar Size	Embed. Depth mm (in)	Adhesive Capsule(s) Required	HVU Ultimate Tensile Concrete/Bond Strength ¹				Strength Properties of Metric Rebar $f_y = 400 \text{ MPa}$	
			14 MPa (2000 psi) kN (lb)	20 MPa (3000 psi) kN (lb)	28 MPa (4000 psi) kN (lb)	40 MPa (6000 psi) kN (lb)	Yield Strength kN (lb)	Tensile Strength kN (lb)
15M	125 (5)	(1) M16	66.7 (15000)	75.3 (16920)	83.3 (18830)	100.8 (22650)	80 (17985)	120 (26975)
	185 (7-1/2)	(1) M16 & (1) M12	100.4 (22490)	112.9 (25370)	125.6 (28240)	151.1 (33980)		
	255 (10)	(2) M16	133.4 (29990)	150.4 (33820)	167.5 (37650)	201.5 (45310)		
20M	170 (6-5/8)	(1) M20	93.5 (21020)	107.9 (24250)	122.2 (27470)	150.9 (33930)	120 (26975)	180 (40465)
	255 (10)	(2) 3/4 x 6-5/8	140.3 (31530)	161.8 (36370)	183.3 (41210)	226.4 (50890)		
	340 (13-1/4)	(2) M20	187.0 (42040)	215.7 (48500)	244.4 (54950)	301.8 (67850)		
25M	210 (8-1/4)	(1) M24	158.5 (35640)	180.2 (40500)	201.8 (45360)	245.0 (55080)	200 (44960)	300 (67440)
	315 (12-3/8)	(1) M24 & (1) 3/4 x 6-5/8	237.8 (53460)	270.2 (60750)	302.7 (68040)	367.5 (82610)		
	420 (16-1/2)	(2) M24	317.0 (71270)	360.3 (80990)	403.5 (90710)	490.0 (110150)		

1 Actual tensile bond test data developed for imperial-sized rebar. Yield and ultimate rebar strengths are for metric sizes.

2 For anchor spacing and edge distance guidelines, refer to the following pages of this HVA Adhesive Anchor System section.

HVA Capsule Adhesive Anchoring System 3.2.10

Anchor Spacing and Edge Distance Guidelines in Concrete



Spacing Tension/Shear

$$s_{\min} = 0.5 h_{ef}, s_{cr} = 1.5 h_{ef}$$

$$f_A = 0.3(s/h_{ef}) + 0.55$$

for $s_{cr} > s > s_{\min}$

Edge Distance Tension

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 1.5 h_{ef}$$

$$f_{RN} = 0.4(c/h_{ef}) + 0.40$$

for $c_{cr} > c > c_{\min}$

Edge Distance Shear (⊥ toward edge)

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV1} = 0.54(c/h_{ef}) - 0.09$$

for $c_{cr} > c > c_{\min}$

Edge Distance Shear (|| to or away from edge)

$$c_{\min} = 0.5 h_{ef}, c_{cr} = 2.0 h_{ef}$$

$$f_{RV2} = 0.36(c/h_{ef}) + 0.28$$

for $c_{cr} > c > c_{\min}$

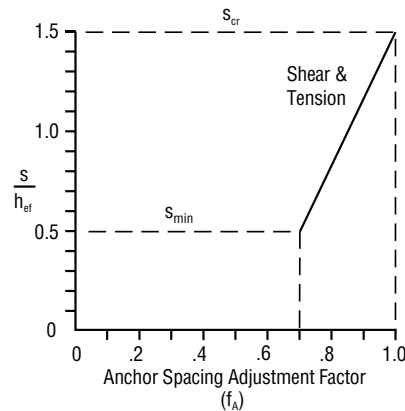
Anchor Spacing Adjustment Factors

$$s = \text{Actual spacing}$$

$$h_{ef} = \text{Actual embedment}$$

$$s_{\min} = 0.5 h_{ef}$$

$$s_{cr} = 1.5 h_{ef}$$



Edge Distance Adjustment Factors

$$c = \text{Actual edge distance}$$

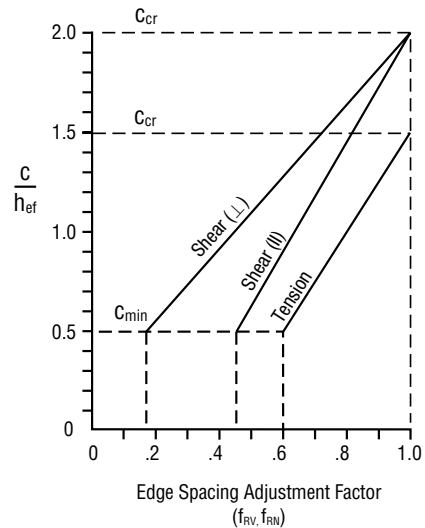
$$h_{ef} = \text{Actual embedment}$$

$$c_{\min} = 0.5 h_{ef} \text{ Tension and shear}$$

$$c_{cr} = 1.5 h_{ef} \text{ Tension}$$

$$= 2.0 h_{ef} \text{ Shear}$$

⊥ = Perpendicular to edge
|| = Parallel to edge



Load Adjustment Factors for 3/8" Diameter Anchors													
Anchor Diameter		3/8" diameter											
Adjustment Factor		Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}		
Embedment Depth, in		3-1/2	5-1/4	7	3-1/2	5-1/4	7	3-1/2	5-1/4	7	3-1/2	5-1/4	7
Spacing (s)/Edge Distance (c), in.	1-3/4	0.70			0.60			0.18			0.46		
	2	0.72			0.63			0.22			0.49		
	2-5/8	0.78	0.70		0.70	0.60		0.32	0.18		0.55	0.46	
	3	0.81	0.72		0.74	0.63		0.37	0.22		0.59	0.49	
	3-1/2	0.85	0.75	0.70	0.80	0.67	0.60	0.45	0.27	0.18	0.64	0.52	0.46
	4	0.89	0.78	0.72	0.86	0.70	0.63	0.53	0.32	0.22	0.69	0.55	0.49
	4-1/2	0.94	0.81	0.74	0.91	0.74	0.66	0.60	0.37	0.26	0.74	0.59	0.51
	5-1/4	1.00	0.85	0.78	1.00	0.80	0.70	0.72	0.45	0.32	0.82	0.64	0.55
	6		0.89	0.81		0.86	0.74	0.84	0.53	0.37	0.90	0.69	0.59
	7		0.95	0.85		0.93	0.80	1.00	0.63	0.45	1.00	0.76	0.64
	7-7/8		1.00	0.89		1.00	0.85		0.72	0.52		0.82	0.69
	8-1/2			0.89			0.86		0.78	0.57		0.86	0.72
	9			0.91			0.89		0.84	0.60		0.90	0.74
	10			0.94			0.91		0.94	0.68		0.97	0.79
	10-1/2			0.96			0.94		1.00	0.72		1.00	0.82
	12			0.98			0.97			0.84			0.90
13			1.00			1.00			0.91			0.95	
14									1.00			1.00	

3.2.10 HVA Capsule Adhesive Anchoring System

Load Adjustment Factors for 1/2" Diameter Anchors												
Anchor Diameter	1/2" diameter											
Adjustment Factor	Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}		
Embedment Depth, in	4-1/4	6-3/8	8-1/2	4-1/4	6-3/8	8-1/2	4-1/4	6-3/8	8-1/2	4-1/4	6-3/8	8-1/2
Spacing (s)/Edge Distance (c), in.	2-1/8	0.70		0.60			0.18			0.46		
	3	0.76		0.68			0.29			0.53		
	3-3/16	0.78	0.70	0.70	0.60		0.32	0.18		0.55	0.46	
	3-1/2	0.80	0.71	0.73	0.62		0.35	0.21		0.58	0.48	
	4	0.83	0.74	0.78	0.65		0.42	0.25		0.62	0.51	
	4-1/4	0.85	0.75	0.70	0.80	0.67	0.60	0.45	0.27	0.18	0.64	0.52
	5	0.90	0.79	0.73	0.87	0.71	0.64	0.55	0.33	0.23	0.70	0.56
	5-1/2	0.94	0.81	0.74	0.92	0.75	0.66	0.61	0.38	0.26	0.75	0.59
	6	0.97	0.83	0.76	0.96	0.78	0.68	0.67	0.42	0.29	0.79	0.62
	6-3/8	1.00	0.85	0.78	1.00	0.80	0.70	0.72	0.45	0.32	0.82	0.64
	7		0.88	0.80		0.84	0.73	0.80	0.50	0.35	0.87	0.68
	8		0.93	0.83		0.90	0.78	0.93	0.59	0.42	0.96	0.73
	8-1/2		0.95	0.85		0.93	0.80	1.00	0.63	0.45	1.00	0.76
	9		0.97	0.87		0.96	0.82		0.67	0.48		0.79
	9-9/16		1.00	0.89		1.00	0.85		0.72	0.52		0.82
	10			0.90			0.87		0.76	0.55		0.84
	10-1/2			0.92			0.89		0.80	0.58		0.87
	12			0.97			0.96		0.93	0.67		0.96
	12-3/4			1.00			1.00		1.00	0.72		1.00
	14									0.80		0.87
	16									0.93		0.96
	17									1.00		1.00

Spacing Tension/Shear

$$s_{\min} = 0.5 h_{ef} \quad s_{cr} = 1.5 h_{ef}$$

$$f_A = 0.3(s/h_{ef}) + 0.55$$

for $s_{cr} > s_{\min}$

Edge Distance Tension

$$c_{\min} = 0.5 h_{ef} \quad c_{cr} = 1.5 h_{ef}$$

$$f_{RN} = 0.4(c/h_{ef}) + 0.40$$

for $c_{cr} > c_{\min}$

Edge Distance Shear (⊥ toward edge)

$$c_{\min} = 0.5 h_{ef} \quad c_{cr} = 2.0 h_{ef}$$

$$f_{RV1} = 0.54(c/h_{ef}) - 0.09$$

for $c_{cr} > c_{\min}$

Edge Distance Shear (|| to or away from edge)

$$c_{\min} = 0.5 h_{ef} \quad c_{cr} = 2.0 h_{ef}$$

$$f_{RV2} = 0.36(c/h_{ef}) + 0.28$$

for $c_{cr} > c_{\min}$

Load Adjustment Factors for 5/8" and 3/4" Diameter Anchors																									
Anchor Diameter		5/8" diameter												3/4" diameter											
Adjustment Factor		Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}		
Embedment Depth, in		5	7-1/2	10	5	7-1/2	10	5	7-1/2	10	5	7-1/2	10	6-5/8	10	13-1/4	6-5/8	10	13-1/4	6-5/8	10	13-1/4	6-5/8	10	13-1/4
Spacing (s)/Edge Distance (c), in.	2-1/2	0.70			0.60			0.18			0.46														
	3-5/16	0.75			0.67			0.27			0.52			0.70			0.60			0.18			0.46		
	3-3/4	0.78	0.70		0.70	0.60		0.32	0.18		0.55	0.46		0.72			0.63			0.22			0.48		
	4	0.79	0.71		0.72	0.61		0.34	0.20		0.57	0.47		0.73			0.64			0.24			0.50		
	4-1/2	0.82	0.73		0.76	0.64		0.40	0.23		0.60	0.50		0.75			0.67			0.28			0.52		
	5	0.85	0.75	0.70	0.80	0.67	0.60	0.45	0.27	0.18	0.64	0.52	0.46	0.78	0.70		0.70	0.60		0.32	0.18		0.55	0.46	
	5-1/2	0.88	0.77	0.72	0.84	0.69	0.62	0.50	0.31	0.21	0.68	0.54	0.48	0.80	0.72		0.73	0.62		0.36	0.21		0.58	0.48	
	6	0.91	0.79	0.73	0.88	0.72	0.64	0.56	0.34	0.23	0.71	0.57	0.50	0.82	0.73		0.76	0.64		0.40	0.23		0.61	0.50	
	6-5/8	0.95	0.82	0.75	0.93	0.75	0.67	0.63	0.39	0.27	0.76	0.60	0.52	0.85	0.75	0.70	0.80	0.67	0.60	0.45	0.27	0.18	0.64	0.52	0.46
	7	0.97	0.83	0.76	0.96	0.77	0.68	0.67	0.41	0.29	0.78	0.62	0.53	0.87	0.76	0.71	0.82	0.68	0.61	0.48	0.29	0.20	0.66	0.53	0.47
	7-1/2	1.00	0.85	0.78	1.00	0.80	0.70	0.72	0.45	0.32	0.82	0.64	0.55	0.89	0.78	0.72	0.85	0.70	0.63	0.52	0.32	0.22	0.69	0.55	0.48
	8		0.87	0.79		0.83	0.72	0.77	0.49	0.34	0.86	0.66	0.57	0.91	0.79	0.73	0.88	0.72	0.64	0.56	0.34	0.24	0.71	0.57	0.50
	9		0.91	0.82		0.88	0.76	0.88	0.56	0.40	0.93	0.71	0.60	0.96	0.82	0.75	0.94	0.76	0.67	0.64	0.40	0.28	0.77	0.60	0.52
	9-15/16		0.95	0.85		0.93	0.80	0.98	0.63	0.45	1.00	0.76	0.64	1.00	0.85	0.78	1.00	0.80	0.70	0.72	0.45	0.32	0.82	0.64	0.55
	10		0.95	0.85		0.93	0.80	1.00	0.63	0.45		0.76	0.64		0.85	0.78		0.80	0.70	0.73	0.45	0.32	0.82	0.64	0.55
	11-1/4		1.00	0.89		1.00	0.85		0.72	0.52		0.82	0.69		0.89	0.80		0.85	0.74	0.83	0.52	0.37	0.89	0.69	0.59
	12			0.91			0.88		0.77	0.56		0.86	0.71		0.91	0.82		0.88	0.76	0.89	0.56	0.40	0.93	0.71	0.61
	13			0.94			0.92		0.85	0.61		0.90	0.75		0.94	0.84		0.92	0.79	0.97	0.61	0.44	0.99	0.75	0.63
	13-1/4			0.95			0.93		0.86	0.63		0.92	0.76		0.95	0.85		0.93	0.80	1.00	0.63	0.45	1.00	0.76	0.64
	15			1.00			1.00		1.00	0.72		1.00	0.82		1.00	0.89		1.00	0.85		0.72	0.52		0.82	0.69
	18									0.88			0.93			0.96			0.94		0.88	0.64		0.93	0.77
	20									1.00			1.00			1.00			1.00		1.00	0.73		1.00	0.82
	22																					0.81			0.88
	24																					0.89			0.93
	26-1/2																					1.00			1.00

HVA Capsule Adhesive Anchoring System 3.2.10

<p>Spacing Tension/Shear</p> $s_{\min} = 0.5 h_{ef} \quad s_{cr} = 1.5 h_{ef}$ $f_A = 0.3(s/h_{ef}) + 0.55$ <p>for $s_{cr} > s_{\min}$</p>
<p>Edge Distance Tension</p> $c_{\min} = 0.5 h_{ef} \quad c_{cr} = 1.5 h_{ef}$ $f_{RN} = 0.4(c/h_{ef}) + 0.40$ <p>for $c_{cr} > c_{\min}$</p>
<p>Edge Distance Shear (⊥ toward edge)</p> $c_{\min} = 0.5 h_{ef} \quad c_{cr} = 2.0 h_{ef}$ $f_{RV1} = 0.54(c/h_{ef}) - 0.09$ <p>for $c_{cr} > c_{\min}$</p>
<p>Edge Distance Shear (to or away from edge)</p> $c_{\min} = 0.5 h_{ef} \quad c_{cr} = 2.0 h_{ef}$ $f_{RV2} = 0.36(c/h_{ef}) + 0.28$ <p>for $c_{cr} > c_{\min}$</p>

Load Adjustment Factors for 7/8" Diameter Anchors												
Anchor Diameter	7/8" diameter											
Adjustment Factor	Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}		
Embedment Depth, in	6-5/8	10	13-1/4	6-5/8	10	13 1/4	6-5/8	10	13-1/4	6-5/8	10	13-1/4
Spacing (s)/Edge Distance (c), in.	3-5/16	0.70		0.60			0.18			0.46		
	4	0.73		0.64			0.24			0.50		
	4-1/2	0.75		0.67			0.28			0.52		
	5	0.78	0.70	0.70	0.60		0.32	0.18		0.55	0.46	
	6	0.82	0.73	0.76	0.64		0.40	0.23		0.61	0.50	
	6-5/8	0.85	0.75	0.70	0.80	0.60	0.45	0.27	0.18	0.64	0.52	0.46
	7	0.87	0.76	0.71	0.82	0.68	0.48	0.29	0.20	0.66	0.53	0.47
	8	0.91	0.79	0.73	0.88	0.72	0.56	0.34	0.24	0.71	0.57	0.50
	9	0.96	0.82	0.75	0.94	0.76	0.64	0.40	0.28	0.77	0.60	0.52
	9-15/16	1.00	0.85	0.78	1.00	0.80	0.72	0.45	0.32	0.82	0.64	0.55
	10		0.85	0.78		0.80	0.73	0.45	0.32	0.82	0.64	0.55
	11		0.88	0.80		0.84	0.73	0.81	0.50	0.88	0.68	0.58
	12		0.91	0.82		0.88	0.76	0.89	0.56	0.93	0.71	0.61
	13		0.94	0.84		0.92	0.79	0.97	0.61	0.99	0.75	0.63
	13-1/4		0.95	0.85		0.93	0.80	1.00	0.63	1.00	0.76	0.64
	14		0.97	0.87		0.96	0.82		0.67	0.48	0.78	0.66
	15		1.00	0.89		1.00	0.85		0.72	0.52	0.82	0.69
	16			0.91			0.88		0.77	0.56	0.86	0.71
	18			0.96			0.94		0.88	0.64	0.93	0.77
	20			1.00			1.00		1.00	0.73	1.00	0.82
	22									0.81		0.88
	24									0.89		0.93
	26-1/2								1.00			1.00

Load Adjustment Factors for 1" and 1-1/4" Diameter Anchors																									
Anchor Diameter		1" diameter												1-1/4" diameter											
Adjustment Factor		Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear (⊥ toward edge) f_{RV1}			Edge Distance Shear (to or away from edge) f_{RV2}		
Embedment Depth, in		8-1/4	12-3/8	16-1/2	8-1/4	12-3/8	16-1/2	8-1/4	12-3/8	16-1/2	8-1/4	12-3/8	16-1/2	12	15	18	12	15	18	12	15	18	12	15	18
Spacing (s)/Edge Distance (c), in.	4-1/8	0.70			0.60			0.18			0.46														
	4-1/2	0.71			0.62			0.20			0.48														
	5	0.73			0.64			0.24			0.50														
	6	0.77			0.69			0.30			0.54			0.70			0.60			0.18			0.46		
	6-3/16	0.78	0.70		0.70	0.60		0.32	0.18		0.55	0.46		0.70			0.61			0.19			0.47		
	7	0.80	0.72		0.74	0.63		0.37	0.22		0.59	0.48		0.73			0.63			0.23			0.49		
	7-1/2	0.82	0.73		0.76	0.64		0.40	0.24		0.61	0.50		0.74	0.70		0.65	0.60		0.25	0.18		0.51	0.46	
	8-1/4	0.85	0.75	0.70	0.80	0.67	0.60	0.45	0.27	0.18	0.64	0.52	0.46	0.76	0.72		0.68	0.62		0.28	0.21		0.53	0.48	
	9	0.88	0.77	0.71	0.84	0.69	0.62	0.50	0.30	0.20	0.67	0.54	0.48	0.78	0.73	0.70	0.70	0.64	0.60	0.32	0.23	0.18	0.55	0.50	0.46
	10	0.91	0.79	0.73	0.88	0.72	0.64	0.56	0.35	0.24	0.72	0.57	0.50	0.80	0.75	0.72	0.73	0.67	0.62	0.36	0.27	0.21	0.58	0.52	0.48
	11	0.95	0.82	0.75	0.93	0.76	0.67	0.63	0.39	0.27	0.76	0.60	0.52	0.83	0.77	0.73	0.77	0.69	0.64	0.41	0.31	0.24	0.61	0.54	0.50
	12-3/8	1.00	0.85	0.78	1.00	0.80	0.70	0.72	0.45	0.32	0.82	0.64	0.55	0.86	0.80	0.76	0.81	0.73	0.68	0.47	0.36	0.28	0.65	0.58	0.53
	13		0.87	0.79		0.82	0.72	0.76	0.48	0.34	0.85	0.66	0.56	0.88	0.81	0.77	0.83	0.75	0.69	0.50	0.38	0.30	0.67	0.59	0.54
	14		0.89	0.80		0.85	0.74	0.83	0.52	0.37	0.89	0.69	0.59	0.90	0.83	0.78	0.87	0.77	0.71	0.54	0.41	0.33	0.70	0.62	0.56
	16		0.94	0.84		0.92	0.79	0.96	0.61	0.43	0.98	0.75	0.63	0.95	0.87	0.82	0.93	0.83	0.76	0.63	0.49	0.39	0.76	0.66	0.60
	16-1/2		0.95	0.85		0.93	0.80	1.00	0.63	0.45	1.00	0.76	0.64	0.96	0.88	0.83	0.95	0.84	0.77	0.65	0.50	0.41	0.78	0.68	0.61
	18		0.99	0.88		0.98	0.84		0.70	0.50		0.80	0.67	1.00	0.91	0.85	1.00	0.88	0.80	0.72	0.56	0.45	0.82	0.71	0.64
	18-9/16		1.00	0.89		1.00	0.85		0.72	0.52		0.82	0.69		0.92	0.86		0.90	0.81	0.75	0.58	0.47	0.84	0.73	0.65
	22-1/2			0.96		0.95		0.89	0.65		0.93	0.77		1.00	0.93		1.00	0.90	0.92	0.72	0.59	0.96	0.82	0.73	
	24			0.99		0.98		0.96	0.70		0.98	0.80			0.95			0.93	1.00	0.77	0.63	1.00	0.86	0.76	
	24-3/4			1.00		1.00		1.00	0.72		1.00	0.82			0.96			0.95		0.80	0.65		0.87	0.78	
	27								0.79			0.87			1.00			1.00		0.88	0.72		0.93	0.82	
	30								0.89			0.93								1.00	0.81		1.00	0.88	
	33								1.00			1.00									0.90			0.94	
	36																				1.00			1.00	

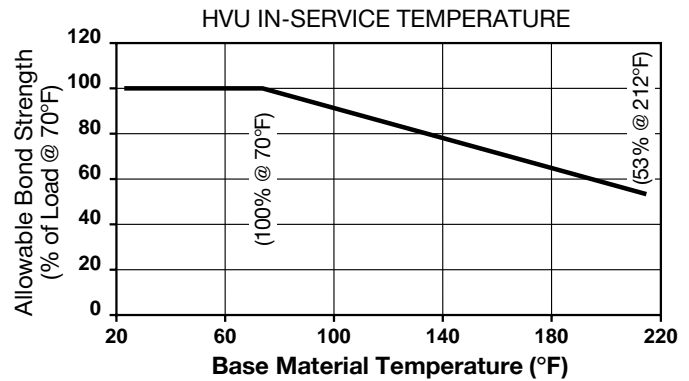
3.2.10 HVA Capsule Adhesive Anchoring System

Chemical Resistance Table

Chemical/Liquid	% by Weight	Not Resistant	Partially Resistant	Resistant
Acetic acid	conc. 10%		•	•
Acetone		•		
Ammonia	25% 5%	•	•	
Ammonium nitrate	10%			•
Ammonium sulphate	10%			•
Carbolic acid solution (Phenol)	10%	•		
Carbon tetrachloride	conc.			•
Caustic soda	40%			•
Sodium hydroxide	20%			•
Chlorinated lime solution	conc.			•
Citric acid	10%			•
Common salt solution	10%			•
Communal waste water				•
Diesel oil				•
Ethanol	96%		•	
Ethylene glycol	conc.			•
Formic acid	10%			•
Hydrochloric acid	20%		•	
Hydrogen peroxide	30% 5%		•	•
Lactic acid	50% 10%			•
Machine oil				•
Methanol	conc.	•		
Methyl isobutyl ketone	conc.			•
Mixture of amines	Vol% ¹			•
Mixture of aromatic hydrocarbons	Vol% ²			•
Nitric acid	40% 20%	•	•	
Petrol/Gasoline				•
Phosphoric acid	40% 20%			•
2-Propanol	conc.			•
Propylene glycol	conc.			•
Sodium carbonate	10%			•
Sodium Silicate (pH=14)	50%			•
Sulphuric acid	40% 20%			•
Xylene	conc.			•

Note: In actual use, the majority of the resin is encased in the concrete, leaving very little surface area exposed. In some cases, this would allow the HVA system to be used where it would be exposed to the "Partially Resistant" chemical compounds.

Influence of Temperature on Bond Strength



Note: Test procedure involves the concrete being held at the temperature for 24 hours then removing it from the controlled environment and testing to failure.

Long term creep test in accordance with AC58 is available; please contact Hilti Technical Services.

HVU Capsule Volume

Size	Vol (in ³)
HVU 3/8" (M10)	0.37
HVU 1/2" (M12)	0.61
HVU 5/8" (M16)	1.04
HVU 3/4"	2.07
HVU 7/8" (M20)	2.62
HVU 1" (M24)	4.21
HVU 1-1/4" (M32)	9.46

Curing Time Table (Approximate)

Base Material Temperature		Approx. Full Cure Time
°F	°C	
23	-5	5 hr
32	0	1 hr
50	10	30 min
above 68	20	20 mn

1 35 Vol% Triethanolamine, 30 Vol% n-Butylamine and 35 Vol% N,N-Dimethylaniline

2 60 Vol% Toluene, 30 Vol% Xylene and 10 Vol% Methylanththalene

Samples of the HVU Resin 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 **Partially Resistant**. Samples that were heavily damaged or destroyed were classified as **Not Resistant**.

Influence of High Energy Radiation

Radiation Exposure ^{1,2}	Detrimental Effect	Recommendation for Use
< 10 Mrad	Insignificant	Full Use
10 – 100 Mrad	Moderate	Restricted Use $F_{rec.} = 0.5 F_{perm.}$
> 100 Mrad	Medium to strong	No recommendation for use

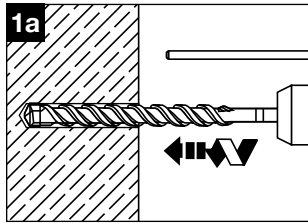
1 Mrad = Megarad

2 Dosage over life span.

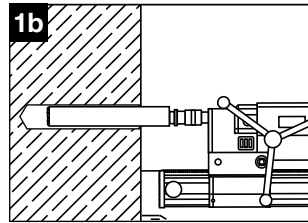
HVA Capsule Adhesive Anchoring System 3.2.10

3.2.10.4 Installation Instructions

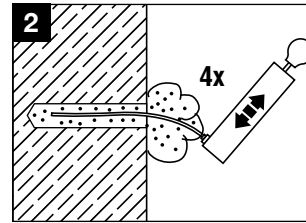
HAS Rod, Rebar and Insert Installation Instructions



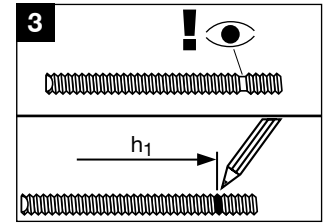
1a. Drilling the hole - Rotary hammer drill: Set the depth gauge to the correct drilling depth.



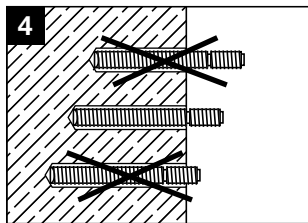
1b. Drilling the hole - Diamond coring: Mark the correct drilling depth on the height adjustment mechanism.



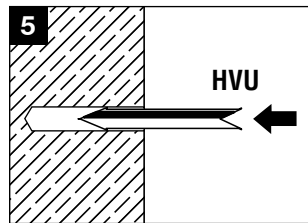
2. Clean the hole immediately before setting the anchor. Remove drilling dust and standing water from the base of the hole by blowing out well with at least 4 strokes of the blow-out pump, or using compressed air or an industrial vacuum cleaner. The anchor holes must be free of dust, water, ice, oil, bitumen, chemicals or any other foreign matter or contaminants. **Poorly-cleaned holes = poor hold.**



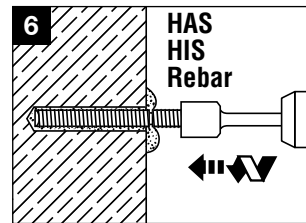
3. Ensure that the specified setting depth is marked on the anchor rod. If not, add an embedment mark, for example with tape or marker.



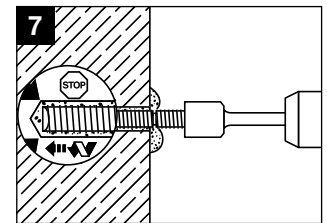
4. Caution! Check that the hole is drilled to the correct depth before setting the anchor. Hole depth is correct when the anchor rod contacts the base of the hole and the setting depth mark coincides with the concrete surface.



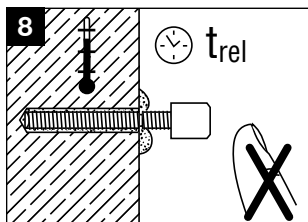
5. Push the anchor capsule into the drilled hole.



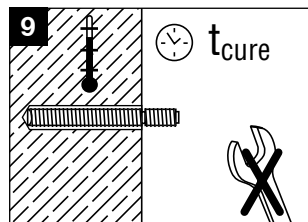
6. Use the setting tool at a speed of 250-1000 r.p.m. to drive the anchor rod into the hole, applying moderate pressure and with the hammering action switched on.



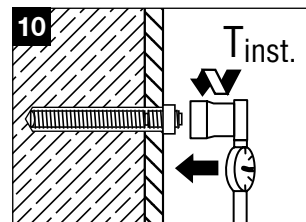
7. Switch off the rotary hammer drill immediately when the specified setting depth is reached (refer to mark on the anchor rod). After setting, adhesive mortar must fill the annular gap completely, right up to the concrete surface. Caution! Prolonged rotary action may cause mortar to be forced out of the hole, resulting in reduced anchor loading capacity.



8. The working time "t rel", which depends on base material temperature, must be observed (see fig. 11). The screwed-on setting tool may be removed only after the time "t rel" has elapsed.



9. After reaching the end of the working time "t rel", do not manipulate or disturb the anchor rod in any way until the curing time "t cure" has elapsed.



10. A load may be applied to the anchor only after the curing time "t cure" has elapsed.

°C	°F	t _{rel}	t _{cure}
min. -5° ... 0°	min. 23° ... 32°	60'	5 h
0° ... 10°	32° ... 50°	30'	1 h
10° ... 20°	50° ... 68°	20'	30'
20° ... max. 40°	68° ... max. 104°	8'	20'

11. The working time "t rel" and curing time "t cure", which depend on base material temperature, must be observed!

3.2.10 HVA Capsule Adhesive Anchoring System

3.2.10.5 Ordering Information

HVU Adhesive Capsule

Features and Applications

High loading capacity

- Small edge distance and anchor spacing allowance
- Excellent dynamic load resistance
- Excellent performance in diamond cored holes
- Excellent performance in freezing and thawing conditions
- No hole brushing required — just blow out the hole with compressed air — makes installation fast and eas
- Fast curing for high productivity

Technical Data

Product	Urethane Methacrylate
Base material temperature	23° F to 104° F (-5° C to 40° C)
Diameter range	3/8" to 1-1/4"

Listings/Approvals

- NSF/ANSI Standard 61
Certification for use in potable water

Gel/Full Cure Time Table (Approximate)

Base Material Temperature		t _{gel}	t _{cure}
° F	° C		
23	-5	60 min	5 hrs
32	0	30 min	1 hrs
50	10	20 min	30 min
68	20	8 min	20 min

HVU Adhesive Capsules

HVU Anchor System with Threaded Rods			Setting Nuts ^{2,3}		
Capsule Size	Qty	Description	Qty	Hole Dia	Std Embed
HVU 3/8" x 3-1/2"	10	3/8"	10	7/16"	3-1/2"
HVU 1/2" x 4-1/4"	10	1/2"	10	9/16"	4-1/4"
HVU 5/8 x 5"	10	5/8"	5	11/16"	5"
HVU 3/4" x 6-5/8"	5	3/4"	5	7/8"	6-5/8"
HVU 7/8" x 6-5/8"	5	7/8"	5	1"	6-5/8"
HVU 1" x 8-1/4"	5	1"	5	1-1/8"	8-1/4"
HVU 1-1/4" x 12"	4	1-1/4"	5	1-3/8"	12"
HVU Anchor System with Internal Threaded Inserts			HIS-S Setting Tool ¹		
Capsule Size	Qty	Description	Drive Socket	Hole Dia	Std Embed
HVU 1/2" x 4-1/4"	10	3/8"	9/16"	11/16"	4-1/4"
HVU 5/8" x 5"	10	1/2"	3/4"	7/8"	5"
HVU 7/8" x 6-5/8"	5	5/8"	15/16"	1-1/8"	6-5/8"
HVU 1" x 8-1/4"	5	3/4"	1-1/8"	1-1/4"	8-1/4"
HVU Anchor System with Rebar			Rebar Setting Tool TE-Y		
Rebar Size	Capsule Size	Qty	Description	Hole Dia	Std Embed
#4	HVU 1/2" x 4-1/4"	10	Rebar Adapter #4	5/8"	4-1/4"
#5	HVU 5/8" x 5"	10	Rebar Adapter #5	13/16"	5"
#6	HVU 7/8" x 6-5/8"	5	Rebar Adapter #6	1"	6-5/8"
#7	HVU 1" x 8-1/4"	5	Rebar Adapter #7	1-1/8"	6-5/8"
#8	HVU 5/8" x 5" and HVU 1" x 8-1/4" (both capsules needed)	10 5	Rebar Adapter #8	1-1/4"	8-1/4"

Setting Tools

HAS Rod Diameter	Square Drive Shaft 1/2"		Square Drive Shaft 3/4"		Square Drive Shaft 1"	
	Drive Socket		Drive Socket		Drive Socket	
3/8"	9/16" x 1/2"		-		-	
1/2"	3/4" x 1/2"		3/4" x 3/4"		-	
5/8"	15/16" x 1/2"		15/16" x 3/4"		-	
3/4"	-		1-1/8" x 3/4"		-	
7/8"	-		1-7/16" x 3/4"		-	
1"	-		1-1/2" x 3/4"		-	
1-1/4"	-		-		1-7/8" x 1"	

Drive Shaft & Socket
(Use when setting HAS rods and HIS inserts)

- 1 To be used with appropriate drive socket and drive shaft from selector chart at left. Setting nuts not required with HIS setting tools
- 2 Setting nuts are required for proper fit of drive socket
- 3 Setting nuts have a black finished coating except 7/8" which are HDG

HVA Capsule Adhesive Anchoring System 3.2.10

Threaded Anchors for Hilti Chemical Anchor Systems

HAS-E Rods 5.8 Steel			HAS-E B High Strength Steel		HAS-R 304 Stainless Steel		HAS-R 316 Stainless Steel	
Description	Qty	Master Carton Qty	Description	Qty	Description	Qty	Description	Qty
3/8" x 3"	10	360	-	-	-	-	-	-
3/8" x 4-3/8"	10	240	-	-	-	-	-	-
3/8" x 5-1/8"	20	200	3/8" x 5-1/8"	10	3/8" x 5-1/8"	20	3/8" x 5-1/8"	10
3/8" x 8"	10	160	-	-	3/8" x 8"	10	-	-
3/8" x 12"	10	90	-	-	-	-	3/8" x 8"	10
1/2" x 3-1/8"	10	240	-	-	-	-	-	-
1/2" x 4-1/2"	10	160	-	-	-	-	-	-
1/2" x 6-1/2"	20	160	1/2" x 6-1/2"	10	1/2" x 6-1/2"	20	1/2" x 6-1/2"	10
1/2" x 8"	10	120	-	-	1/2" x 8"	10	1/2" x 8"	10
1/2" x 10"	10	120	-	-	1/2" x 10"	10	-	-
-	-	-	-	-	-	-	1/2" x 11" *	10
1/2" x 12"	10	80	-	-	-	-	1/2" x 12"	10
5/8" x 8"	20	80	5/8" x 7-5/8"	10	5/8" x 7-5/8"	20	5/8" x 7-5/8"	10
-	-	-	-	-	5/8" x 10"	10	-	-
5/8" x 9"	10	60	-	-	-	-	5/8" x 9"	10
5/8" x 12"	10	60	-	-	-	-	5/8" x 12"	10
5/8" x 17"	10	40	-	-	-	-	-	-
3/4" x 10"	10	40	3/4" x 9-5/8"	5	3/4" x 9-5/8"	10	3/4" x 9-5/8" *	5
3/4" x 11"	10	30	-	-	-	-	3/4" x 10"	5
3/4" x 12"	10	30	-	-	3/4" x 12"	10	-	-
3/4" x 14"	10	30	3/4" x 14" *	5	3/4" x 14"	10	3/4" x 16"	5
-	-	-	-	-	3/4" x 16"	10	-	-
3/4" x 17"	10	20	-	-	-	-	7/8" x 10"	5
3/4" x 19"	10	20	-	-	-	-	-	-
3/4" x 21"	10	20	-	-	-	-	-	-
3/4" x 25"	10	20	-	-	-	-	7/8" x 16"	5
7/8" x 10"	10	20	7/8" x 10" (HDG)	5	7/8" x 10"	10	-	-
-	-	-	7/8" x 12" (HDG) *	5	-	-	-	-
7/8" x 13"	10	20	7/8" x 16" (HDG)	5	-	-	-	-
1" x 12"	4	16	1" x 12"	5	1" x 12"	4	1" x 12" *	4
1" x 14"	2	16	1" x 14" *	5	-	-	-	-
1" x 16"	2	12	1" x 16" *	5	-	-	1" x 16" *	4
1" x 20"	2	12	1" x 21" *	5	-	-	1" x 20" *	4
1-1/4" x 16"	4	8	1-1/4" x 16"	4	-	-	-	-
1-1/4" x 22"	4	8	-	-	-	-	-	-
-	-	-	1-1/4" x 23" *	4	-	-	-	-

*Item not returnable

HIS Carbon Steel and HIS-R 316 Stainless Steel Internally Threaded Inserts

Description	Useable Thread Length (in)	Qty	Qty
3/8" x 4-1/4"	1"	10	10
1/2" x 5"	1-3/16"	5	5
5/8" x 6-5/8"	1-1/2"	5	5
3/4" x 8-1/4"	2"	5	5

Hilti Rods are now stamped on the end to show grade of steel and overall anchor length!

E = ISO 898 Class 5.8 Steel

B = ASTM A 193, Grade B7 Steel

R1 = AISI 304 Stainless Steel

R2 = AISI 316 Stainless Steel

Mechanical Anchoring Systems 3.3

3.3.1 HDA Undercut Anchor

3.3.1.1 Product Description

The Hilti HDA Undercut Anchor is a heavy duty mechanical undercut anchor whose undercut segments incorporate carbide tips so as to perform a self-undercutting process designed to develop a ductile steel failure. The HDA system includes either the HDA-P preset or HDA-T through-set style anchors, stop drill bits, setting tool, and roto-hammer drill for M10, M12, M16 and M20 models. The HDA is available in a sherardized and type 316 stainless steel versions for outdoor environments offered in two lengths to accommodate various material thicknesses to be fastened.

Product Features

- Undercut segments provide cast-in-place like performance with limited expansion stresses
- Bolt meets ductility requirements of ACI 318 Section D1
- Self-undercutting wedges provide an easy, fast and reliable anchor installation
- Excellent performance in cracked concrete

- Undercut keying load transfer allows for reduced edge distances and anchor spacings
- Through-set style provides increased shear capacity
- Fully removable
- Type 316 stainless steel for corrosive environments
- Sherardized zinc coating has equivalent corrosion resistance to hot dipped galvanizing

Guide Specifications

Undercut Anchors Undercut anchors shall be of an undercut style with brazed tungsten carbides on the embedded end that perform the self-undercutting process. Undercut portion of anchor shall have a minimum projected bearing area equal to or greater than 2.5 times the nominal bolt area. The bolt shall conform to ISO 898 class 8.8 strength requirements. Anchors dimensioned and supplied by Hilti.

Installation Refer to 3.3.1.4.

3.3.1.1 Product Description

3.3.1.2 Material Specifications

3.3.1.3 Technical Data

3.3.1.4 Installation Instructions

3.3.1.5 Ordering Information

3.3.1.6 HDA Removal Tool

3.3.1.2 Material Specifications

	Mechanical Properties			
	f_y		f_{ut}	
	ksi	(MPa)	ksi	(MPa)
HDA-T/-TF/-P/-PF carbon steel cone bolt; strength requirements of ISO 898, class 8.8	92.8	(640)	116	(800)
HDA-T/-TF/-P/-PF carbon steel sleeve M10 & M12	–		123	(850)
HDA-T/-TF/-P/-PF carbon steel sleeve M16	–		101.5	(700)
HDA-T/-TF/-P/-PF carbon steel sleeve M20	–		79.8	(550)
HDA-TR/-PR stainless steel cone bolt M10, M12 and M16	87	(600)	116	(800)
HDA-TR/-PR stainless steel sleeve M10 and M12	–		123	(850)
HDA-TR/-PR stainless steel sleeve M16	–		101.5	(700)
HDA-T/-TF/-P/-PF galvanized carbon steel hexagonal nut				
HDA-TR/-PR nut conforms to DIN 934, grade A4-80				
HDA-T/-TF/-TR/-P/-PF/-PR galvanized carbon steel washer				
HDA-T/-P components are electroplated min. 5 µm zinc				
HDA-TF/-PF sherardized components have average 53 µm zinc				

HDA-P
Undercut Anchor
Pre-Set Type

HDA-T
Undercut Anchor
Through-Set Type

Listings/Approvals

ICC-ES (International Code Council)
ESR-1546

City of Los Angeles
Research Report based on 2011
LABC pending

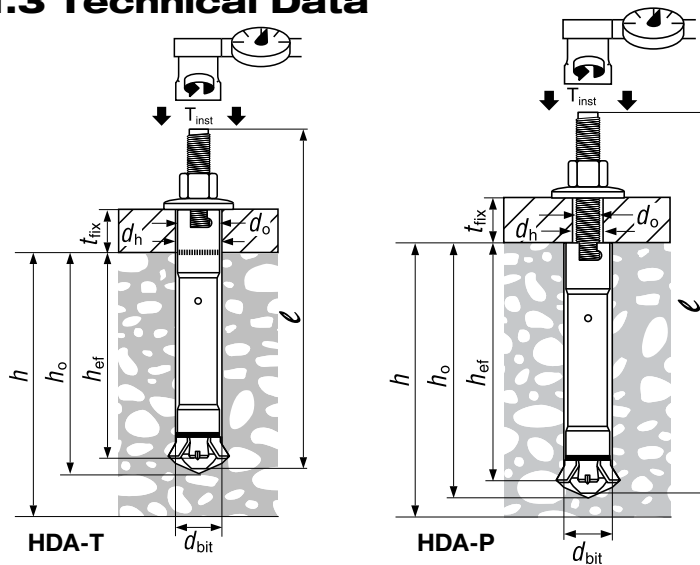
European Technical Approval (ETA)
ETA-99/0009
ETA-99/0016
Qualified under NQA-1 Nuclear Quality
Program

Independent Code Evaluation

IBC 2009 pending
IBC® / IRC® 2006 (AC 193 / ACI 355.2)

3.3.1 HDA Undercut Anchor

3.3.1.3 Technical Data



Anchor Nomenclature

Hilti Design Anchor
P pre-set before baseplate
T through-set after/through baseplate
Blank carbon steel zinc plated
F carbon steel sherardized
R 316 stainless steel
Drill bit diameter (mm)
Metric
Thread diameter (mm)
HDA-PF 22 M 12 x 125 / 50
Minimum embedment of undercut
Maximum fastening thickness

Table 1 - HDA Specifications

Anchor Size	HDA-T/HDA-P	M10 x 100/20	M12 x 125/30	M12 x 125/50	M16 x 190/40	M16 x 190/60	M20 x 250/50	M20 x 250/100
h_{min} Minimum thickness of concrete	mm (in.)	170 (6-3/4)	190 (7-1/2)	190 (7-1/2)	270 (10-5/8)	270 (10-5/8)	350 (13-3/4)	350 (13-3/4)
ℓ Total anchor length	mm (in.)	150 (5.90)	190 (7.48)	210 (8.27)	275 (10.83)	295 (11.61)	360 (14.17)	410 (16.14)
length I.D. code		I	L	N	R	S	V	W
t_{fix} Fastening Thickness								
HDA-T, min. ¹	mm (in.)	10 (0.39)	10 (0.39)	10 (0.39)	15 (0.59)	15 (0.59)	20 (0.79)	20 (0.79)
HDA-T, max.	mm (in.)	20 (0.79)	30 (1.18)	50 (1.97)	40 (1.58)	60 (2.36)	50 (1.97)	100 (3.94)
HDA-P, max.	mm (in.)	20 (0.79)	30 (1.18)	50 (1.97)	40 (1.58)	60 (2.36)	50 (1.97)	100 (3.94)
d_{bit} Nom. dia. of drill bit ²	mm	20	22	22	30	30	37	37
h_o Min. depth of drill hole	mm (in.)	107 (4.21)	134.5 (5.30)	134.5 (5.30)	203 (7.99)	203 (7.99)	266 (10.47)	266 (10.47)
h_{ef} Effective anchoring depth	mm (in.)	100 (3.94)	125 (4.92)	125 (4.92)	190 (7.48)	190 (7.48)	250 (9.84)	250 (9.847)
d_h Recommended clearance hole (min.)								
HDA-T	mm (in.)	21 (7/8)	23 (15/16)	23 (15/16)	32 (1-1/4)	32 (1-1/4)	40 (1-9/16)	40 (1-9/16)
HDA-P	mm (in.)	12 (1/2)	14 (9/16)	14 (9/16)	18 (3/4)	18 (3/4)	22 (7/8)	22 (7/8)
d_o Anchor Diameter	HDA-T mm (in.)	19 (0.748)	21 (0.827)	21 (0.827)	29 (1.142)	29 (1.142)	36 (1.42)	36 (1.42)
	HDA-P mm (in.)	10 (0.394)	12 (0.472)	12 (0.472)	16 (0.630)	16 (0.630)	20 (0.78)	20 (0.78)
d_w Washer diameter	mm (in.)	27.5 (1.08)	33.5 (1.32)	33.5 (1.32)	45.5 (1.79)	45.5 (1.79)	50 (1.97)	50 (1.97)
S_w Width across flats	mm (in.)	17	19	19	24	24	30	30
T_{inst} Installation torque	Nm (ft-lb)	50 (37)	80 (59)	80 (59)	120 (88)	120 (88)	300 (221)	300 (221)
Sleeve properties								
A_{sl} Cross sectional area	mm ² (in ²)	196 (0.304)	223 (0.346)	223 (0.346)	445 (0.690)	445 (0.690)	675.6 (1.047)	675.6 (1.047)
S_{sl} Elastic section modulus	mm ³ (in ³)	596 (0.0364)	779 (0.0475)	779 (0.0475)	2110 (0.1288)	2110 (0.1288)	3950 (0.241)	3950 (0.241)
Bolt properties								
A_b Bolt nominal area	mm ² (in ²)	78.5 (0.122)	113 (0.175)	113 (0.175)	201 (0.312)	201 (0.312)	314.16 (0.487)	314.16 (0.487)
A_t Bolt tension area	mm ² (in ²)	58 (0.090)	84.3 (0.131)	84.3 (0.131)	157 (0.243)	157 (0.243)	245 (0.380)	245 (0.380)
S_b Elastic section modulus	mm ³ (in ³)	67 (0.0041)	117 (0.0071)	117 (0.0071)	293 (0.0179)	293 (0.0179)	541.3 (0.033)	541.3 (0.033)

¹ Minimum thickness of fastened part as required to ensure engagement of full sleeve cross section in shear.

² Metric stop drill bit must be used. See Section 3.3.1.4 for correct procedure and use of matched tolerance diamond core bits if required.

HDA Undercut Anchor 3.3.1

3.3.1.3.1 Design Information – Undercut Anchors

Undercut anchors represent the state of the art in post-installed anchor technology. When properly designed and proportioned, they transfer tension loads to the concrete in much the same way as cast-in-place headed bolts, that is, via bearing. Since friction is less critical in developing tension capacity, lower expansion forces are transmitted to the concrete. This reduces the overall stress state in the concrete prior to and during loading. The Hilti HDA Undercut Anchor System is the result of extensive research to determine the optimum geometry for load transfer at the bearing surface. Besides allowing for easy installation, the self-undercutting system automatically results in an excellent fit between the anchor bearing surface and the undercut, critical for limiting initial displacements. The HDA is equipped with a shear sleeve machined from high grade carbon steel. When used in the HDA-P preset configuration, shear loads are transferred through the threaded bolt to the sleeve and subsequently to the concrete in bearing. In HDA-T through-set applications, the sleeve engages the part to be fastened, thus substantially increasing the ultimate shear capacity of the anchorage. At ultimate, the sleeve and bolt act in concert to develop the full shear capacity of the anchor.

The HDA Undercut Anchor is proportioned to consistently develop the bolt strength in tension at critical edge distances and spacings. At spacings and edge distances less than critical, concrete cone failure will generally limit the ultimate load. The reduction of expansion forces allows for designed installations at minimum edge distances and spacings significantly less than those typically used for other types of mechanical expansion anchors. The predictability of the failure modes associated with the HDA Undercut Anchor allow for increased repeatability in determining ultimate capacities for a particular design condition.

The HDA Undercut Anchor was extensively tested prior to market introduction. Testing included static tension, shear, and oblique loading of both single anchors and groups, shock, seismic groups, seismic and shock loading. Exhaustive testing of the HDA performance in cracks confirms its suitability for installation in tension zones.

3.3.1.3.2 Design Method

3.3.2.3.2.1 Strength Design (LRFD)

ACI 318 Appendix D replaces the strength design provisions of the IBC and provides a comprehensive and rational framework for calculating anchor capacity. The applicability of the method to the HDA Undercut Anchor is based on the similarity of performance and failure modes established for the HDA with those associated for cast-in-place headed bolts.

This method can also be used for design in Canada according to CSA A23.3-94 providing the appropriate f factors for steel and concrete. See Table 9.

3.3.2.3.2.2 Allowable Stress Design (ASD)

Compatible with existing Hilti design methods. Test data to develop the average ultimate load capacity, and evaluating the data using the 5% fractile method to determine the allowable working load. See ESR-1546 Section 4.2.

3.3.1 HDA Undercut Anchor

Table 2 — HDA Strength Design Information

Design parameter	Symbol	Units			Nominal anchor diameter					
			M10		M12		M16		M20	
			HDA	HDA-F HDA-R	HDA	HDA-F HDA-R	HDA	HDA-F HDA-R	HDA	
Anchor O.D.	d _o	mm	19		21		29		35	
		(in.)	(0.75)		(0.83)		(1.14)		(1.38)	
Effective min. embedment depth ¹	h _{ef,min}	mm	100		125		190		250	
		(in.)	(3.94)		(4.92)		(7.48)		(9.84)	
Minimum edge distance	c _{min}	mm	80		100		150		200	
		(in.)	(3-1/8)		(4)		(5-7/8)		(7-7/8)	
Minimum anchor spacing	s _{min}	mm	100		125		190		250	
		(in.)	(4)		(5)		(7-1/2)		(9-7/8)	
Minimum member thickness	h _{min}	mm	170		190		270		350	
		(in.)	(6-3/4)		(7-1/2)		(10-5/8)		(13-3/4)	
Anchor category ²	1,2 or 3	–	1							
Strength reduction factor for tension, steel failure modes ³	Φ	–	0.75							
Strength reduction factor for shear steel failure modes	Φ	–	0.65							
Strength reduction factor for tension, concrete failure modes ³	Φ	Cond. A	0.75							
		Cond. B	0.65							
Strength reduction factor for shear, concrete failure modes ³	Φ	Cond. A	0.75							
		Cond. B	0.70							
Yield strength of anchor steel	f _{ya}	lb/in ²	92,800	87,000	92,800	87,000	92,800	87,000	92,800	
Ultimate strength of anchor steel	f _{uta}	lb/in ²	116,000							
Tensile stress area	A _{se}	in ²	0.090		0.131		0.234		0.380	
Steel strength in tension	N _{sa}	lb	10,440		15,196		28,188		44,080	
Effectiveness factor cracked concrete ⁴	k _{cr}	–	30							30
Effectiveness factor uncracked concrete ⁴	k _{cr}	–	24							24
k _{uncr} /k _{cr} ⁵	Ψ _{c,N}	–	1.25							1.25
Pullout strength cracked concrete ⁶	N _{p,cr}	lb	8,992		11,240		22,481		33,721	
Steel strength in shear static ⁷ HDA-P/PF/PR	V _{sa}	lb	5,013	6,070	7,284	8,992	13,556	16,861	20,772	
Steel strength in shear, seismic ^{7,8} HDA-P/PF/PR	V _{eq}	lb	4,496	5,620	6,519	8,093	12,140	15,062	18,659	
Axial stiffness in service load range in cracked/uncracked concrete	β	1000 lb/in	80/100							

1 Actual h_{ef} for HDA-T is given by $h_{ef,min} + (t_{fix} - t_{actual})$ where t_{fix} is given in Table 1 and t_{actual} is the thickness of the part(s) being fastened.

2 See ACI 318 D.4.4.

3 For use with the load combinations of ACI 318 9.2. Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.

4 See ACI 318 D.5.2.2.

5 See ACI 318 D.5.2.6.

6 See ESR-1546, Section 4.1.3.

7 For HDA-T see Table 3.

8 See ESR-1546, Section 4.1.6.

9 See ACI 318 RD.5.2.7. The critical edge distance c_{ac} does not exceed $1.5 h_{ef}$. Therefore, ψ equals 1.0.

HDA Undercut Anchor 3.3.1

Table 3 - Steel Strength in Shear, HDA-T (lb)

Anchor Designation		Thickness of fastened part(s)		Steel Strength in Shear, Static	Steel Strength in Shear, Seismic ¹
		mm	in.	V _{sa}	V _{eq}
HDA-T	HDA-T 20-M10x100	10 ≤ t < 15	3/8 ≤ t < 5/8	13,938	12,589
		15 ≤ t < 20	5/8 ≤ t < 13/16	15,737	14,163
	HDA-T 22-M12x125	10 ≤ t < 15	3/8 ≤ t < 5/8	16,636	15,062
		15 ≤ t ≤ 50	5/8 ≤ t < 2	18,659	16,636
	HDA-T 30-M16x190	15 ≤ t < 20	5/8 ≤ t < 13/16	30,574	27,427
		20 ≤ t < 25	13/16 ≤ t < 1	34,621	31,248
		25 ≤ t < 30	1 ≤ t < 1-3/16	38,218	34,396
		30 ≤ t ≤ 60	1-3/16 ≤ t < 2-3/8	41,365	37,093
	HDA-T 37-M20x250	20 ≤ t < 35	13/16 ≤ t < 1-3/8	45,187	40,690
		35 ≤ t < 50	1 ≤ t < 2	50,807	45,636
		50 ≤ t ≤ 100	2 ≤ t < 4	54,629	49,233
	HDA-T 37-M20x250	10 ≤ t < 15	3/8 ≤ t < 5/8	15,512	13,938
		15 ≤ t < 20	5/8 ≤ t < 13/16	16,186	14,613
HDA-TR	HDA-TR 22-M12x125	10 ≤ t < 15	3/8 ≤ t < 5/8	20,233	17,985
		15 ≤ t ≤ 50	5/8 ≤ t < 2	22,256	20,008
	HDA-TR 30-M16x190	15 ≤ t < 20	5/8 ≤ t < 13/16	35,745	32,148
		20 ≤ t < 25	13/16 ≤ t < 1	37,768	33,946
		25 ≤ t < 30	1 ≤ t < 1-3/16	39,566	35,520
		30 ≤ t ≤ 60	1-3/16 ≤ t < 2-3/8	40,915	36,869

1 The nominal steel strength V_{eq} for the HDA-P shall be taken from Table 2.

Table 4 - HDA-P/T and HDA-PF/TF and HDA-PR/TR Allowable Nonseismic Tension (ASD), Normal Weight Uncracked Concrete (lb) ^{1,2,3,4,5,6}

Nominal Anchor Diameter	Effective Embedment h _{ef}		Concrete Compressive Strength			
	mm	in.	f' _c = 2,500 psi	f' _c = 3,000 psi	f' _c = 4,000 psi	f' _c = 6,000 psi
M10	100	3.94	5,440	5,960	6,880	8,430
M12	125	4.92	7,605	8,330	9,615	11,880
M16	190	7.48	14,250	15,610	18,025	22,075
M20	250	9.84	21,505	23,555	27,200	33,315

- Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- Concrete determined to remain uncracked for the life of the anchorage.
- Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- For strength design, the required strength = 1.6D + 1.2L. For ASD, the factored load = 1.0D + 1.0L. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- Assuming a 50% dead and 50% live contributions, α = (1.6 · 0.5 + 1.2 · 0.5) / (1.0 · 0.5 + 1.0 · 0.5) = 1.4
- ASD = Φ_{concrete} · N_{p,uncr} / α = 0.65 · N_{p,uncr} / 1.4

Table 5 - HDA-P/T and HDA-PF/TF and HDA-PR/TR Allowable Nonseismic Tension (ASD), Normal Weight Cracked Concrete (lb) ^{1,2,3,4,5}

Nominal Anchor Diameter	Effective Embedment h _{ef}		Concrete Compressive Strength			
	mm	in.	f' _c = 2,500 psi	f' _c = 3,000 psi	f' _c = 4,000 psi	f' _c = 6,000 psi
M10	100	3.94	4,350	4,770	5,505	6,745
M12	125	4.92	6,080	6,665	7,695	9,425
M16	190	7.48	11,400	12,485	14,420	17,660
M20	250	9.84	17,205	18,845	21,760	26,650

- Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- For strength design, the required strength = 1.6D + 1.2L. For ASD, the factored load = 1.0D + 1.0L. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
4. Assuming a 50% dead and 50% live contributions, α = (1.6 · 0.5 + 1.2 · 0.5) / (1.0 · 0.5 + 1.0 · 0.5) = 1.4.
- ASD = Φ_{concrete} · N_{p,cr} / α = 0.65 · N_{p,cr} / 1.4

3.3.1 HDA Undercut Anchor

Table 6 - HDA-P/T and HDA-PF/TF and HDA-PR/TR Allowable Seismic Tension (ASD), Normal Weight Cracked Concrete (lb)^{1,2,3,4,5}

Nominal Anchor Diameter	Effective Embedment h_{ef}		Concrete Compressive Strength			
	mm	in.	$f'_c = 2,500$ psi	$f'_c = 3,000$ psi	$f'_c = 4,000$ psi	$f'_c = 6,000$ psi
M10	100	3.94	3,531	3,870	4,465	5,470
M12	125	4.92	4,560	5,405	6,245	7,645
M16	190	7.48	9,250	10,130	11,700	14,330
M20	250	9.84	13,960	15,290	17,660	21,625

- 1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- 2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- 3 For strength design, the required strength = $1.2D + 1.0E$. For ASD, the factored load = $1.0D + 0.7E$. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- 4 Assuming a 50% dead and 50% earthquake contributions, $\alpha = (1.2 \cdot 0.5 + 1.0 \cdot 0.5) / (1.0 \cdot 0.5 + 0.7 \cdot 0.5) = 1.294$
- 5 $ASD = \Phi_{concrete} \cdot \Phi_{seismic} \cdot N_{p,cr} / \alpha = 0.65 \cdot 0.75 \cdot N_{p,cr} / 1.294$

Table 7 - HDA-P/PF/PR Allowable Nonseismic and Seismic Shear (ASD), Steel (lb)^{1,2}

Design parameter	M10		M12		M16		M20
	HDA	HDA-R	HDA	HDA-R	HDA	HDA-R	HDA
Allowable steel capacity, nonseismic ^{3,4,5}	2,685	3,250	3,900	4,815	7,260	9,035	10,385
Allowable steel capacity, seismic ^{6,7,8}	2,410	3,010	3,260	4,045	6,070	7,530	9,330

- 1 For single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- 2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- 3 For nonseismic, the ACI 318 required strength = $1.6D + 1.2L$ and the ACSE 7-05 factored load = $1.0D + 1.0L$. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- 4 Assuming a 50% dead and 50% live contributions, $\alpha = (1.6 \cdot 0.5 + 1.2 \cdot 0.5) / (1.0 \cdot 0.5 + 1.0 \cdot 0.5) = 1.4$
- 5 Nonseismic $ASD = \Phi_{steel} \cdot V_{sa} / \alpha = 0.75 \cdot V_{sa} / 1.4$
- 6 For seismic, the ACI 318 required strength = $1.2D + 1.0E$ and the ACSE 7-05 factored load = $1.0D + 0.7E$.
- 7 Assuming a 50% dead and 50% earthquake contributions, $\alpha = (1.2 \cdot 0.5 + 1.0 \cdot 0.5) / (1.0 \cdot 0.5 + 0.7 \cdot 0.5) = 1.294$
- 8 Seismic $ASD = \Phi_{steel} \cdot \Phi_{seismic} \cdot V_{eq} / \alpha = 0.75 \cdot 0.75 \cdot V_{eq} / 1.294$

Table 8 - HDA-T/TF/TR Allowable Nonseismic and Seismic Shear (ASD), Steel^{1,2}

Anchor Designation	Fixture Thickness		Allowable Steel Capacity	
	mm	in.	V_{sa} Nonseismic ^{3,4,5}	V_{eq} Seismic ^{6,7,8}
HDA-T 20-M10x100	10<t<15	3/8<t<5/8	7,465	5,470
	15<t<20	5/8<t<13/16	8,430	6,155
HDA-T 22-M12x125	10<t<15	3/8<t<5/8	8,910	6,545
	15<t<50	5/8<t<2	9,995	7,230
HDA-T 30-M16x190	15<t<20	5/8<t<13/16	16,380	11,920
	20<t<25	13/16<t<1	18,545	13,585
	25<t<20	1<t<1-3/16	20,475	14,950
	30<t<60	1-3/16<t<2-3/8	22,160	16,125
HDA-T 37-M20x250	20<t<35	13/16<t<1-3/8	24,205	17,690
	35<t<50	1-3/8<t<2	27,220	19,840
	50<t<100	2<t<4	29,265	21,400
HDA-TR 20-M10x100	10<t<15	3/8<t<5/8	8,310	6,060
	15<t<20	5/8<t<13/16	8,670	6,350
HDA-TR 22-M12x125	10<t<15	3/8<t<5/8	10,840	7,820
	15<t<50	5/8<t<2	11,925	8,695
HDA-TR 30-M16x190	15<t<20	5/8<t<13/16	19,150	13,975
	20<t<25	13/16<t<1	20,235	14,755
	25<t<20	1<t<1-3/16	21,195	15,440
	30<t<60	1-3/16<t<2-3/8	21,920	16,025

- 1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- 2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- 3 For nonseismic, the ACI 318 required strength = $1.6D + 1.2L$ and the ACSE 7-05 factored load = $1.0D + 1.0L$. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- 4 Assuming a 50% dead and 50% live contributions, $\alpha = (1.6 \cdot 0.5 + 1.2 \cdot 0.5) / (1.0 \cdot 0.5 + 1.0 \cdot 0.5) = 1.4$
- 5 Nonseismic $ASD = \Phi_{steel} \cdot V_{sa} / \alpha = 0.75 \cdot V_{sa} / 1.4$
- 6 For seismic, the ACI 318 required strength = $1.2D + 1.0E$ and the ACSE 7-05 factored load = $1.0D + 0.7E$.
- 7 Assuming a 50% dead and 50% earthquake contributions, $\alpha = (1.2 \cdot 0.5 + 1.0 \cdot 0.5) / (1.0 \cdot 0.5 + 0.7 \cdot 0.5) = 1.294$
- 8 Seismic $ASD = \Phi_{steel} \cdot \Phi_{seismic} \cdot V_{eq} / \alpha = 0.75 \cdot 0.75 \cdot V_{eq} / 1.294$

HDA Undercut Anchor 3.3.1

TABLE 9 - HDA Design Information in accordance with CSA A23,3-04 Annex D 1



Design parameter	Symbol	Units	Nominal anchor diameter						M20	Ref.
			M10		M12		M16			
			HDA	HDA-R	HDA	HDA-R	HDA	HDA-R	HDA	
Anchor O.D.	d _o	mm	19		21		29		35	
Effective min. embedment depth ¹	h _{ef,min}	mm	100		125		190		250	
Minimum edge distance	c _{min}	mm	80		100		150		200	
Minimum anchor spacing	s _{min}	mm	100		125		190		250	
Minimum member thickness	h _{min}	mm	170		190		270		350	
Anchor category ²	1,2 or 3	–	1		1		1		1	D.5.4c
Concrete material resistance factor for concrete	Φ _c	–	0.65		0.65		0.65		0.65	8.4.2
Steel embedment material resistance factor for reinforcement	Φ _s	–	0.85		0.85		0.85		0.85	8.4.3
Strength reduction factor for tension, steel failure modes ³	R		0.80		0.80		0.80		0.80	D.4.3
Strength reduction factor for shear, steel failure modes	R		0.75		0.75		0.75		0.75	8.5.4a
Strength reduction factor for tension, concrete failure modes	R	Cond. A	1.15		1.15		1.15		1.15	8.5.4c
	R	Cond. B	1.00		1.00		1.00		1.00	8.5.4c
Strength reduction factor for shear, concrete failure modes	R	Cond. A	1.15		1.15		1.15		1.15	8.5.4c
	R	Cond. B	1.00		1.00		1.00		1.00	8.5.4c
Yield strength of anchor steel	f _y	MPa	640	600	640	600	640	600	640	
Ultimate strength of anchor steel	f _{ut}	MPa	800		800		800		800	
Effective cross-sectional area of anchor	A _{se}	mm ²	58.1		84.5		156.8		245.2	D.6.1.2
Factored steel resistance in tension	N _{sr}	kN	31.6		46.0		85.3		133.4	D.6.1.2
Coefficient for factored concrete breakout resistance in tension	k		10		10		10		10	D.6.2.6
Steel strength in shear, seismic ^{7,8} HDA-P/PF/PR	Ψ _{c,N}		1.25		1.25		1.25		1.25	D.6.2.6
Factored pullout resistance in 20 MPa cracked concrete	N _{pr,cr}	kN	27.9	27.9	34.9	34.9	69.8	69.8	104.7	D.6.3.6
Factored steel resistance in shear HDA-P/PR, static	V _{sr}	kN	14.2	17.2	20.7	25.5	38.4	47.8	58.9	D.7.1.2c
Factored steel resistance in shear HDA-P/PR, seismic	V _{sr,seismic}	kN	12.7	15.9	18.5	22.9	34.4	42.7	52.9	

- For more information, please visit www.hilti.ca and navigate Service/Downloads, then Technical Downloads and open the Limit States Design Guide.
- Effective area A_{se} was revised in the document in 2011. The original area were estimates based on 70% of the gross area calculated using the nominal diameter. The revised values are the actual tensile stress areas.

3.3.1 HDA Undercut Anchor

Table 10 - Steel Strength in Shear, HDA -T (kN), in accordance with CSA A233,3-04 Annex D1



Anchor Designation	Thickness of fastened part(s)	Steel Strength in Shear, Static (kN) ^b	Steel Strength in Shear, Seismic ¹ (kN) ^{a,b}
	mm	V_{sr}	$V_{sr, seismic}$
HDA-T 20-M10x100	$10 \leq t < 15$	39.5	35.7
	$15 \leq t < 20$	44.6	40.2
HDA-T 22-M12x125	$10 \leq t < 15$	47.2	42.7
	$15 \leq t \leq 50$	52.9	47.2
HDA-T 30-M16x190	$15 \leq t < 20$	86.7	77.8
	$20 \leq t < 25$	98.2	88.6
	$25 \leq t < 30$	108.4	97.5
	$30 \leq t \leq 60$	117.3	105.2
HDA-T 37-M20x250	$20 \leq t < 35$	128.1	115.4
	$35 \leq t < 50$	144.1	129.4
	$50 \leq t \leq 100$	154.9	139.6

Stainless Steel Anchors	mm	V_{sr}	$V_{sr, seismic}$
HDA-T 20-M10x100	$10 \leq t < 15$	44.0	39.5
	$15 \leq t < 20$	45.9	41.4
HDA-TR 22-M12x125	$10 \leq t < 15$	57.4	51.0
	$15 \leq t \leq 50$	63.1	56.7
HDA-TR 30-M16x190	$15 \leq t < 20$	101.4	91.2
	$20 \leq t < 25$	107.1	96.3
	$25 \leq t < 30$	112.2	100.7
	$30 \leq t \leq 60$	116.0	104.6


a The nominal steel strength $V_{sr, seismic}$ for the HDA-P shall be taken from the HDA Design Information Table

b For groups of anchors, multiply value by number of anchors, n

HDA Undercut Anchor 3.3.1


Table 11 - Equipment required for setting HDA Anchors

HDA Carbon Steel - Zinc Plated

Anchor 	Hilti Hammer Drill ¹								
	TE 25 (1st gear)	TE 35	TE 40/ 40-AVR	TE 56/ 56-ATC	TE 60- ATC	TE 70/ 70-ATC	TE 75	TE-76/ 76-ATC	TE 80- ATC
	TE-C				connection end				
					TE-Y				
HDA-P 20-M10x100/20	•		•	•	•				
HDA-T 20-M10x100/20	•		•	•	•				
HDA-P 22-M12x125/30	•		•	•	•				
HDA-T 22-M12x125/30	•		•	•	•				
HDA-P 22-M12x125/50	•		•	•	•				
HDA-T 22-M12x125/50	•		•	•	•				
HDA-P 30-M16x190/40						•	•	•	•
HDA-T 30-M16x190/40						•	•	•	•
HDA-P 30-M16x190/60						•	•	•	•
HDA-T 30-M16x190/60						•	•	•	•
HDA-P 37-M20x250/50						•		•	•
HDA-T 37-M20x250/50						•		•	•
HDA-P 37-M20x250/100						•		•	•
HDA-T 37-M20x250/100						•		•	•


1 To ensure IBC compliance, please reference ICC-ES ESR-1546 or call Hilti Technical Support.

HDA-R Stainless Steel

Anchor 	Hilti Hammer Drill ¹								
	TE 25 (1st gear)	TE 35	TE 40/ 40-AVR	TE 56/ 56-ATC	TE 60- ATC	TE 70/ 70-ATC	TE 75	TE-76/ 76-ATC	TE 80- ATC
	TE-C				connection end				
					TE-Y				
HDA-PR 20-M10x100/20	•	•	•						
HDA-TR 20-M10x100/20	•	•	•	•	•				
HDA-PR 22-M12x125/30	•	•	•	•	•				
HDA-TR 22-M12x125/30	•	•	•	•	•				
HDA-PR 22-M12x125/50	•	•	•	•	•				
HDA-TR 22-M12x125/50	•	•	•	•	•				
HDA-PR 30-M16x190/40						•	•	•	•
HDA-PR 30-M16x190/60						•	•	•	•
HDA-PR 30-M16x190/60						•	•	•	•
HDA-TR 30-M16x190/60						•	•	•	•

1 To ensure IBC compliance, please reference ICC-ES ESR-1546 or call Hilti Technical Support.

HDA-F Carbon Steel - Sherardized (Heavy-Duty Galvanization)

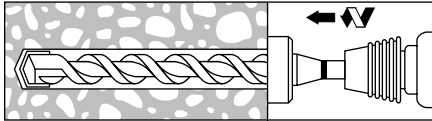
Anchor 	Hilti Hammer Drill ¹								
	TE 25 (1st gear)	TE 35	TE 40/ 40-AVR	TE 56/ 56-ATC	TE 60- ATC	TE 70/ 70-ATC	TE 75	TE-76/ 76-ATC	TE 80- ATC
	TE-C				connection end				
					TE-Y				
HDA-PF 20-M10x100/20		•	•		•				
HDA-TF 20-M10x100/20		•	•		•				
HDA-PF 22-M12x125/30		•	•		•				
HDA-TF 22-M12x125/30		•	•		•				
HDA-PF 22-M12x125/50		•	•		•				
HDA-TF 22-M12x125/50		•	•		•				
HDA-PF 30-M16x190/40						•	•	•	•
HDA-TF 30-M16x190/40						•	•	•	•
HDA-PF 30-M16x190/60						•	•	•	•
HDA-TF 30-M16x190/60						•	•	•	•

1 To ensure IBC compliance, please reference ICC-ES ESR-1546 or call Hilti Technical Support.

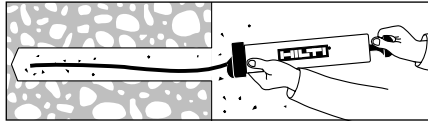
3.3.1 HDA Undercut Anchor

3.3.1.4 Installation Instructions

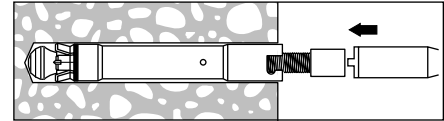
Setting Operation HDA-P/-PR/-PF (Preset Style)



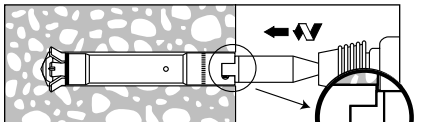
1. Drill a hole to the required depth using a stop drill bit matched to the anchor, (refer to specification table and ordering info.). If rebar is encountered, use a Hilti metric matched tolerance diamond core bit to drill through the rebar. Remove the concrete core and finish drilling the hole with the stop drill bit. Always consult with the Engineer of Record before cutting rebar.



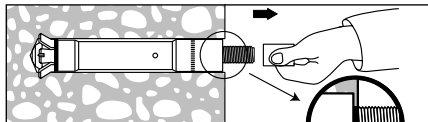
2. Clean hole with a shop vacuum, compressed air or a hand air pump to remove drilling debris.



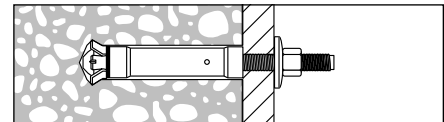
3. Insert the anchor into the hole by hand, so that the cone sits on the bottom of the drilled hole. Do not remove the plastic cap which protects the threaded rod. Using the assigned setting tool and Hilti hammer drill, the setting tool is guided over the anchor rod and engages the grooves in the sleeve. **It is critical to use the specified Hilti hammer drills.**



4. The anchor is set with the specified Hilti hammer drill in hammer drill mode and in the specified gear. During the setting procedure, both drilling and impact energy are transferred to the sleeve by the setting tool, causing the sleeve to slide over the conical end of the anchor bolt while forming the undercut in the base material. On the setting tool, the red ring indicates the progress of the setting operation. When this marking is flush with the concrete surface, check the anchor for proper setting (refer to step 5).

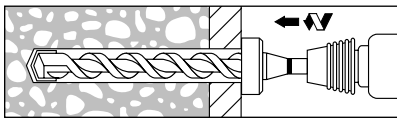


5. The anchor is correctly set and the undercut is fully formed when the red mark on the anchor bolt is visible above the top edge of the sleeve. The top edge of the anchor sleeve must be positioned dimension h_s below the concrete surface. If the anchor setting time exceeds 60 seconds for M10, M12 or M16 anchors or 120 seconds for M20 anchors the installation failed and the anchors must not be loaded.

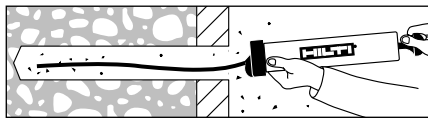


6. Remove the plastic thread protector cap. Secure the part to be fastened by using the conical spring washer and nut provided. Apply a torque not to exceed the maximum values given in the Specification Table. Torque is not required to set the anchor.

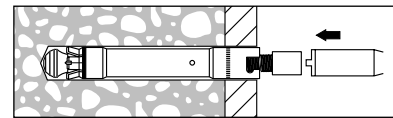
Setting Operation HDA-T/-TR/-TF (Through-Set Style)



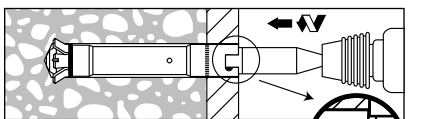
1. Drill a hole to the required depth using a stop drill bit matched to the anchor, (refer to specification table and ordering info.). If rebar is encountered, use a Hilti metric matched tolerance diamond core bit to drill through the rebar. Remove the concrete core and finish drilling the hole with the stop drill bit. Always consult with the Engineer of Record before cutting rebar.



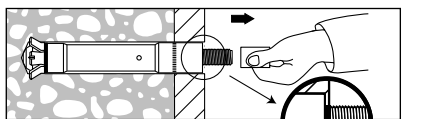
2. Clean hole with a shop vacuum, compressed air or a hand pump.



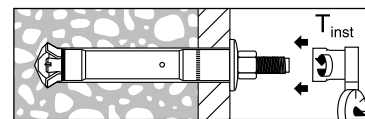
3. Insert the anchor into the hole by hand, so that the cone sits on the bottom of the drilled hole. Do not remove the plastic cap which protects the threaded rod. Using the assigned setting tool and Hilti hammer drill, the setting tool is guided over the anchor rod and engages the grooves in the sleeve. **It is critical to use the specified Hilti hammer drills.**



4. The anchor is set with the specified Hilti hammer drill in hammer drill mode and in the specified gear. During the setting procedure, both drilling and impact energy are transferred to the sleeve by the setting tool, causing the sleeve to slide over the conical end of the anchor bolt while forming the undercut in the base material. On the setting tool, the red ring indicates the progress of the setting operation. When this marking is flush with the connected part, check the anchor for proper setting (refer to step 5).



5. The anchor is set and the undercut is fully formed when the red marking on the anchor bolt is visible above the top edge of the sleeve. The top edge of the anchor sleeve must be positioned dimension h_s below the surface of the fixture. If anchor setting time exceeds 60 seconds for M10, M12 or M16 anchors or 120 seconds for M20 anchors the installation failed and the anchor must not be loaded.



6. Remove the plastic thread protector cap. Secure the part to be fastened by using the conical spring washer and nut provided. Apply a torque not to exceed the maximum values given in the Specification Table. Torque is not required to set the anchor.

dia.	h_s (mm)	
	min.	max.
M10	2	6
M12	2	7
M16	2	8
M20	2	8

The HDA Undercut Anchor, designed to carry significant, safety-relevant loads, **must** be installed correctly with the prescribed tools to function properly. Carefully follow **all** instructions located inside the box. Installer training is also available upon request.

HDA Undercut Anchor 3.3.1

3.3.1.5 Ordering Information

HDA-T Anchor



Description	HDA-T	HDA-TF	HDA-TR	HDA	Stop Drill Bit	Diamond Core Bit	Setting Tool
rod dia. x embed./ max. fixture thickness	Galvanized	Sherardised	316 Stainless	Box Qty	Description (mm) dia. x drill depth	Diameter	Description
M10x100/20	•	•	•	12	TE-C-B20x120	20mm	TE-C-ST 20 M10
					TE-Y-B20x120		TE-Y-ST 20 M10
M12x125/30	•	•	•	8	TE-C-B22x155	22mm	TE-C-ST 22 M12
					TE-Y-B22x155		TE-Y-ST 22 M12
M12x125/50	•	•	•	8	TE-C-B22x175	22mm	TE-C-ST 22 M12
					TE-Y-B22x175		TE-Y-ST 22 M12
M16x190/40	•	•	•	4	TE-Y B30x230	30mm	TE-Y-ST 30 M16
M16x190/60	•	•	•	4	TE-Y B30x250		
M20x250/50	•	•	•	2	TE-Y B37x300	37mm (1-3/8")	TE-Y-ST 37 M20
M20x250/100	•	•	•	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 stop drill bit (hammer drill). 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	Setting Tool
rod dia. x embed./ max. fixture thickness	Galvanized	Sherardised	316 Stainless	Box Qty	Description (mm) dia. x drill depth	Diameter	Description
M10x100/20	•	•	•	12	TE-C B20x100	20mm	TE-C-ST 20 M10
					TE-Y B20x100		TE-Y-ST 20 M10
M12x125/30	•	•	•	8	TE-C B22x125	22mm	TE-C-ST 22 M12
					TE-Y B22x125		TE-Y-ST 22 M12
M12x125/50	•	•	•	8	TE-C-B22x125	22mm	TE-C-ST 22 M12
					TE-Y-B22x125		TE-Y-ST 22 M12
M16x190/40	•	•	•	4	TE-Y B30x190	30mm	TE-Y-ST 30 M16
M16x190/60	•	•	•	4			
M20x250/50	•	•	•	2	TE-Y B37x250	37mm	TE-Y-ST 37 M20
M20x250/100	•	•	•	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 stop drill bit (hammer drill). Always consult the engineer of record before cutting rebar.

3.3.1 HDA Removal Tool

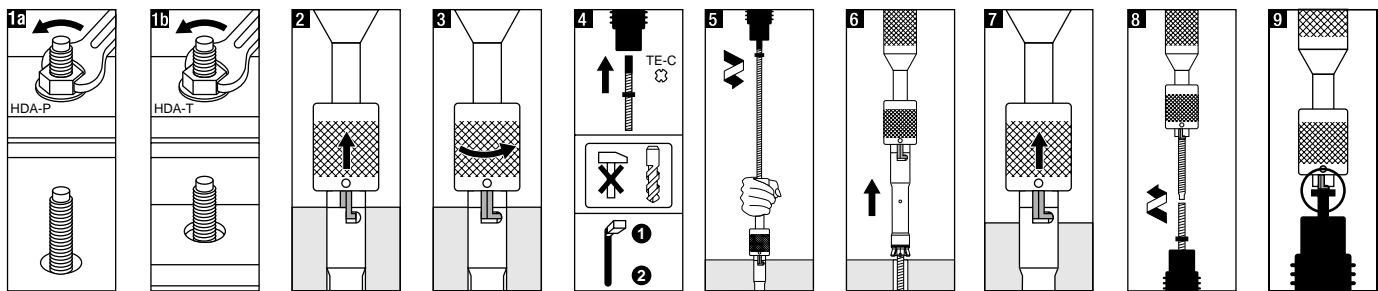
3.3.1.6 HDA Removal

The Hilti HDA Removal Tool is designed to remove the Hilti HDA Undercut Mechanical Anchor that were installed in standard applications in accordance with Hilti guidelines.

Product Features

- Complete removal of HDA design anchors for temporary applications
- The removal process strips the threads to prevent reuse of anchors for safety purposes
- Suitable for rotary hammers with TE-C style chucks

Removal Instructions



1. Remove the nut and washer from the threaded rod, (also remove fastening part for HDA-P applications).

2. Push back the grip (against this spring pressure).

3. Allow the two drive lugs to engage the groove in the anchor sleeve using a slight twisting movement of the grip. Release the grip.

4. Insert the adapter (drive) into the drill chuck and lock. The TE 40 is recommended.

Important:

- Switch off the hammering action (the removal tool will be permanently damaged if this step is neglected.).
- Use slow speed. This is setting 1 for the TE 40.

5. Put adapter (drive) onto the threaded spindle of the removal tool and switch on the drill.

6. The anchor sleeve will be extracted.

7. Disengage the drive lugs from the groove by lifting up and twisting the grip.

8. To return the tool to its starting position, put the adapter (drive) on the other end of the threaded spindle.

9. Switch on the hammer drill until the adapter stop reaches the removal tool.

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

HSL-3 Heavy-duty Expansion Anchor 3.3.2

3.3.2.1 HSL-3 Product Description

HSL-3 Heavy-duty Expansion Anchor

HSL-3-G Heavy-duty Expansion Anchor with Threaded Rod

Counter sunk version available as special

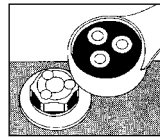
Maximum fastened thickness (mm)

Metric

HSL-3-G M 12 / 25

Heavy duty Expansion Anchor blank-bolt G stud B torque cap Metric thread size (mm); not hole diameter

HSL-3-B Heavy-duty Expansion Anchor with Torque Cap



Red Setting Indicator

Three accurately sized shear pins are provided in the red indicator cap. As the required installation torque (T_{inst}) is reached the red indicator cap shears off. A green seal on the bolt head appears which indicates that the anchor has been set properly.

Example: HSL-3-G M12/25

This is an HSL-3 stud anchor. The thread size is 12 mm and this anchor can attach up to a 25 mm thick plate

The Hilti HSL-3 Heavy-duty Expansion Anchor is a torque-controlled expansion bolt designed for high performance in static and dynamic application including the tension zone of concrete structures where cracking can be expected. HSL-3 anchors are available in metric sizes from M8 to M24. With a variety of head configurations, including bolt, stud and torque cap. All versions are available in zinc-plated carbon steel.

Product Features

- Approved for use in the concrete tension zone (cracked concrete)
- Data for use with the Strength Design provisions of ACI 318 Appendix D and ACI 349 Appendix B
- Allowable Stress Design data for use with ASD
- High load capacity

Guide Specifications

Expansion Anchors: Carbon steel anchor consists of hex head bolt (threaded stud), sleeve, expansion sleeve, expansion cone, collapsible plastic sleeve, (nut) and washer. Anchors shall be torque controlled expansion bolt as manufactured by Hilti.

3.3.2.1 Product Description

3.3.2.2 Material Specifications

3.3.2.3 Technical Data

3.3.2.4 Installation Instructions

3.3.2.5 Ordering Information

Bolt

Washer

Minimum Embedment Mark

Spacer Sleeve

Plastic collapsible section with anchor rotation prevention

Expansion Sleeve

Cone

Listings/Approvals

ICC-ES (International Code Council)
ESR-1545

European Technical Approval (ETA)
ETA-02/0042

Qualified under NQA-1 Nuclear Quality Program

Independent Code Evaluation

IBC® / IRC® 2009 (AC 193 / ACI 355.2)

IBC® / IRC® 2006 (AC 193 / ACI 355.2)

UBC® 1997 (AC 01)

3.3.2.2 Material Specifications

Carbon Steel Bolt or Threaded Rod for HSL-3 (Bolt), HSL-3 (Stud) and HSL-3-B conform to DIN EN ISO 898-1, Grade 8.8, $f_y > 93$ ksi, $f_u > 116$ ksi

Carbon Steel Nut conforms to DIN 934, Grade 8, $f_u > 116$ ksi

Carbon Steel Washer conforms to DIN 1544, Grade St37, $f_u > 100$ ksi

Carbon Steel Expansion Cone conforms to DIN 1654-4, $f_u > 80$ ksi

Carbon Steel Expansion Sleeve (M8-M16) conforms to DIN 10139 and (M20-M24) conforms to DIN 2393-2

Carbon Steel Spacing Sleeve conforms to DIN 2393 T1, $f_u > 100$ ksi

Collapsible Sleeve is made from acetal polyoxymethylene (POM) resin

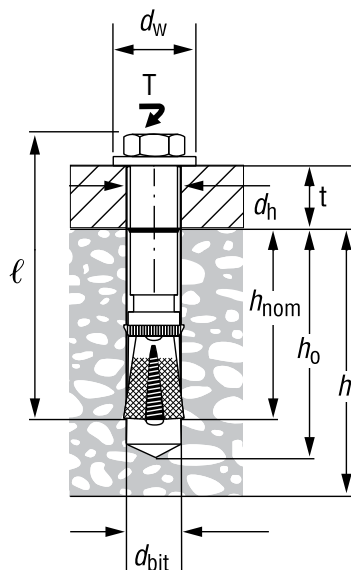
3.3.2 HSL-3 Heavy-duty Expansion Anchor

3.3.2.3 Technical Data

Table 1 — HSL-3 Specifications

Details			HSL-3 Anchor Thread Diameter (mm)											
			M8		M10		M12		M16		M20		M24	
nominal drill bit diameter ¹	d_{bit}	mm	12		15		18		24		28		32	
Hilti matched-tolerance carbide-tipped drill bit	-	-	TE-CX 12/22		TE-CX 15/27		TE-C 18/22		TE-C-T 24/27		TE-C-T 28/27		TE-YX 32/3	
			TE-YX 12/35		TE-YX 15/35		TE-YX 18/32		TE-YX 24/32		TE-YX 28/32			
minimum base material thickness to obtain smallest critical edge distance	h_{min}	mm	110 (120)		120 (140)		135 (160)		160 (200)		190 (250)		225 (300)	
		(in.)	4 3/8 (4-3/4)		4 3/4 (5-1/2)		5 3/8 (6 1/4)		6 1/4 (7-7/8)		7 1/2 (9-7/8)		8 7/8 (11-7/8)	
minimum hole depth	h_o	mm	80		90		105		125		155		180	
		(in.)	(3-1/8)		(3-1/2)		(4-1/8)		(4-7/8)		(6-1/8)		(7-1/8)	
effective embedment depth	$h_{ef,min}$	mm	60		70		80		100		125		150	
		(in.)	(2-3/8)		(2-3/4)		(3-1/8)		(3-7/8)		(4-7/8)		(5-7/8)	
minimum clearance hole diameter in part being fastened	d_h	mm	14		17		20		26		31		35	
		(in.)	(9/16)		(11/16)		(13/16)		(1)		(1-1/4)		(1-3/8)	
max. cumulative gap between part(s) being fastened and concrete surface	-	mm	4		5		8		9		12		16	
		(in.)	(1/8)		(3/16)		(5/16)		(3/8)		(1/2)		(5/8)	
maximum thickness of part fastened HSL-3, HSL-3-B	t	mm	20	40	20	40	25	50	25	50	30	60	30	60
		(in.)	(3/4)	(1-1/2)	(3/4)	(1-1/2)	(1)	(2)	(1)	(2)	(1-1/8)	(2-1/4)	(1-1/8)	(2-1/4)
overall length of anchor HSL-3, HSL-3-B	-	mm	98	118	110	130	131	156	153	178	183	213	205	235
		(in.)	(3-7/8)	(4-5/8)	(4-3/8)	(5 1/8)	(5-1/8)	(6 1/8)	(6)	(7)	(7-1/4)	(8-3/8)	(8)	(9-1/4)
maximum thickness of part fastened HSL-3-G	t	mm	20		20		25	50	25	50	30	60		
		(in.)	(3/4)		(3/4)		(1)	(2)	(1)	(2)	(1-1/8)	(2-1/4)		
overall length of anchor HSL-3-G	-	mm	102		115		139	164	163	188	190	220		
		(in.)	(4)		(4-1/2)		(5-1/2)	(6-3/8)	(6-3/8)	(7-3/8)	(7-1/2)	(8-3/4)		
washer diameter	d_w	mm	20		25		30		40		45		50	
		(in.)	(3/4)		(1)		(1-1/8)		(1-9/16)		(1-3/4)		(2)	
installation torque HSL-3	T_{inst}	Nm	25		50		80		120		200		250	
		(ft-lb)	(18)		(37)		(59)		(89)		(148)		(185)	
installation torque HSL-3-G	T_{inst}	Nm	20		35		60		80		160			
		(ft-lb)	(15)		(26)		(44)		(59)		(118)			
wrench size HSL-3, HSL-3-G	-	mm	13		17		19		24		30		36	
wrench size HSL-3-B	-	mm					24		30		36		41	

1 Use metric bits only.



HSL-3 Heavy-duty Expansion Anchor 3.3.2

Table 2 — HSL-3 Strength Design Information

Design Parameter	Symbol	Units	Nominal Anchor Diameter					
			M8	M10	M12	M16	M20	M24
Anchor O.D.	d_o	mm	12	15	18	24	28	32
		in.	0.47	0.59	0.71	0.94	1.10	1.26
Effective min. embedment depth ¹	$h_{ef,min}$	mm	60	70	80	100	125	150
		in.	2.36	2.76	3.15	3.94	4.92	5.91
Anchor category ²	1,2 or 3	–	1					
Strength reduction factor for tension, steel failure modes ³	Φ	–	0.75					
Strength reduction factor for shear, steel failure modes ³	Φ	–	0.65					
Strength reduction factor for tension, concrete failure modes ³	Φ	Cond. A	0.75					
		Cond. B	0.65					
Strength reduction factor for shear, concrete failure modes ³	Φ	Cond. A	0.75					
		Cond. B	0.70					
Yield strength of anchor steel	f_y	lb/in ²	92,800					
Ultimate strength of anchor steel	f_u	lb/in ²	116,000					
Tensile stress area	A_{se}	in ²	0.057	0.090	0.131	0.243	0.280	0.547
Steel strength in tension	N_{sa}	lb	6,612	10,440	15,196	28,188	44,080	63,452
Effectiveness factor uncracked concrete	k_{uncr}	–	24					
Effectiveness factor cracked concrete	k_{cr}	–	17	24				
k_{uncr}/k_{cr}^5	$\Psi_{c,N}$	–	1.41	1.00				
Pullout strength uncracked concrete	$N_{p,uncr}$	lb	4,204	-	-	-	-	-
Pullout strength cracked concrete	$N_{p,cr}$	lb	2,810	4,496	-	-	-	-
Steel strength in shear HSL-3,-B	V_{sa}	lb	7,239	10,229	14,725	26,707	39,521	45,951
Steel strength in shear HSL-3,-G	V_{sa}	lb	6,070	8,385	12,162	22,683	33,159	
Tension pullout strength seismic	N_{eq}	lb	-	-	-	-	-	14,320
Steel strength in shear, seismic HSL-3,-SH,-SK	V_{eq}	lb	4,609	8,453	11,892	24,796	29,135	38,173
Steel strength in shear, seismic HSL-3,-G		lb	3,777	6,924	9,824	21,065	24,459	
Axial stiffness in service load range	uncracked concrete	β_{uncr}	300					
	cracked concrete	β_{uncr}	30	70	130			

1 See Table 1.

2 See ACI 318 Section D.4.4.

3 For use with the load combinations of ACI 318 Section 9.2. Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.

4 See ACI 318 Section D.5.2.2.

5 See ACI 318 Section D.5.2.6.

3.3.2 HSL-3 Heavy-duty Expansion Anchor

Table 3 — Edge Distance, Spacing and Member Thickness Requirements^{1,2}

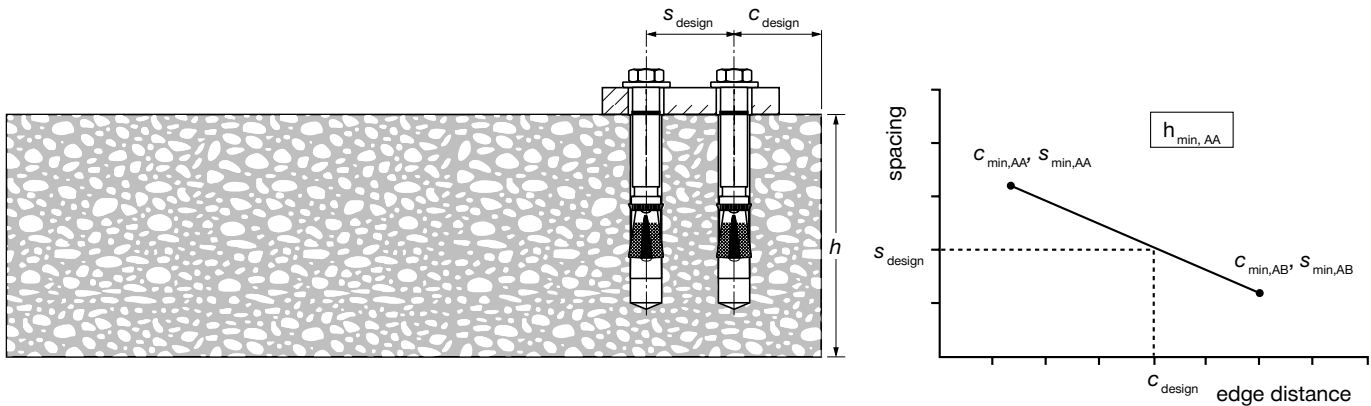
Case ³	Dimensional Parameter	Symbol	Units	Nominal Anchor Diameter					
				M8	M10	M12	M16	M20	M24
A	Minimum concrete thickness	$h_{min,A}$	in.	4-3/4	5-1/2	6-1/4	7-7/8	9-7/8	11-7/8
			(mm)	(120)	(140)	(160)	(200)	(250)	(300)
A	Critical edge distance ²	$c_{cr,A}$	in.	4-3/8	4-3/8	4-3/4	5-7/8	8-7/8	8-7/8
			(mm)	(110)	(110)	(120)	(150)	(225)	(225)
A	Minimum edge distance ³	$c_{min,AA}$	in.	2-3/8	2-3/4	3-1/2	4-3/4	5	5-7/8
			(mm)	(60)	(70)	(90)	(120)	(125)	(150)
A	Minimum anchor spacing ³	$s_{min,AA}$	in.	5-1/2	9-1/2	11	12-5/8	13-3/4	11-7/8
			(mm)	(140)	(240)	(280)	(320)	(350)	(300)
A	Minimum edge distance	$c_{min,AB}$	in.	3-3/8	5	6-1/8	7-7/8	8-1/4	8-1/4
			(mm)	(85)	(125)	(155)	(200)	(210)	(210)
A	Minimum anchor spacing	$s_{min,AB}$	in.	2-3/8	2-3/4	3-1/8	4	5	5-7/8
			(mm)	(60)	(70)	(80)	(100)	(125)	(150)
B	Minimum concrete thickness	$h_{min,B}$	in.	4-3/8	4-3/4	5-3/8	6-1/4	7-1/2	8-7/8
			(mm)	(110)	(120)	(135)	(160)	(190)	(225)
B	Critical edge distance ²	$c_{cr,B}$	in.	5-7/8	6-7/8	7-7/8	9-7/8	12-3/8	14-3/4
			(mm)	(150)	(175)	(200)	(250)	(312.5)	(375)
B	Minimum edge distance ³	$c_{min,BA}$	in.	2-3/8	3-1/2	4-3/8	6-1/4	7-7/8	8-7/8
			(mm)	(60)	(90)	(110)	(160)	(200)	(225)
B	Minimum anchor spacing ³	$s_{min,BA}$	in.	7	10-1/4	12-5/8	15	15-3/4	15
			(mm)	(180)	(260)	(320)	(380)	(400)	(380)
B	Minimum edge distance ³	$c_{min,BB}$	in.	4	6-1/4	7-7/8	10-5/8	11-7/8	12-5/8
			(mm)	(100)	(160)	(200)	(270)	(300)	(320)
B	Minimum anchor spacing ³	$s_{min,BB}$	in.	2-3/8	2-3/4	3-1/8	4	5	5-7/8
			(mm)	(60)	(70)	(80)	(100)	(125)	(150)

1 In lieu of ACI 318 D.3.3. minimum edge distance, spacing and member thickness shall comply with ESR-1545 Table 4.

2 The concrete breakout strength calculated according to ACI 318 D.5.2, shall be further multiplied by $\psi_{ed,N}$. See ESR-1545 Section 4.1.2.

3 Denotes admissible combinations of h_{min} , c_{cr} , c_{min} , and s_{min} . For example, $h_{min,A} + c_{min,AA} + s_{min,AA}$ or $h_{min,A} + c_{cr,A} + c_{min,AB} + s_{min,AB}$ are admissible, but $h_{min,A} + c_{cr,B} + c_{min,AB} + s_{min,BB}$ is not. However, other admissible combinations for minimum edge distance c_{min} and spacing s_{min} for $h_{min,A}$ or $h_{min,B}$ may be derived by linear interpolation between boundary values (see example for $h_{min,A}$ below).

Example of Allowable Interpolation of Minimum Edge Distance and Minimum Spacing



HSL-3 Heavy-duty Expansion Anchor 3.3.2

TABLE 4 - HSL-3 Allowable Nonseismic Tension (ASD), Normal Weight Uncracked Concrete (lb)^{1,2,3,4,5,6}

Nominal Anchor Diameter	Effective Embedment h_{ef}		Concrete Compressive Strength			
	mm	in.	$f'_c = 2,500$ psi	$f'_c = 3,000$ psi	$f'_c = 4,000$ psi	$f'_c = 6,000$ psi
M8	60	2.36	1,950	2,140	2,470	3,024
M10	70	2.76	2,550	2,790	3,225	3,950
M12	80	3.15	3,115	3,410	3,940	4,825
M16	100	3.94	4,350	4,770	5,505	6,745
M20	125	4.92	6,080	6,665	7,694	9,425
M24	150	5.91	7,995	8,760	10,115	12,385

- 1 Single anchors with nonseismic tension with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- 2 Concrete determined to remain uncracked for the life of the anchorage.
- 3 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- 4 For strength design, the required strength = $1.6D + 1.2L$. For ASD, the factored load = $1.0D + 1.0L$. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- 5 Assuming a 50% dead and 50% live contributions, $\alpha = (1.6 \cdot 0.5 + 1.2 \cdot 0.5) / (1.0 \cdot 0.5 + 1.0 \cdot 0.5) = 1.4$
- 6 $ASD = \Phi_{concrete} \cdot N_{p,uncr} / \alpha = 0.65 \cdot N_{p,uncr} / 1.4$

TABLE 5 - HSL-3 Allowable Nonseismic Tension (ASD), Normal Weight Cracked Concrete (lb)^{1,2,3,4,5}

Nominal Anchor Diameter	Effective Embedment h_{ef}		Concrete Compressive Strength			
	mm	in.	$f'_c = 2,500$ psi	$f'_c = 3,000$ psi	$f'_c = 4,000$ psi	$f'_c = 6,000$ psi
M8	60	2.36	1,435	1,570	1,812	2,220
M10	70	2.76	2,550	2,790	3,225	3,950
M12	80	3.15	3,115	3,410	3,940	4,825
M16	100	3.94	4,350	4,770	5,505	6,745
M20	125	4.92	6,080	6,665	7,694	9,425
M24	150	5.91	7,995	7,285	8,410	10,300

- 1 Single anchors with nonseismic tension with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- 2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- 3 For strength design, the required strength = $1.6D + 1.2L$. For ASD, the factored load = $1.0D + 1.0L$. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- 4 Assuming a 50% dead and 50% live contributions, $\alpha = (1.6 \cdot 0.5 + 1.2 \cdot 0.5) / (1.0 \cdot 0.5 + 1.0 \cdot 0.5) = 1.4$
- 5 $ASD = \Phi_{concrete} \cdot N_{p,cr} / \alpha = 0.65 \cdot N_{p,cr} / 1.4$

TABLE 6 - HSL-3 Allowable Nonseismic Shear (ASD), Steel^{1,2,3,4,5}

Nominal Anchor Diameter	Effective Embedment h_{ef}		Allowable steel capacity, shear	
	mm	in.	HSL-3, HSL-3-B	HSL-3-G
M8	60	2.36	2,470	2,025
M10	70	2.76	4,530	3,710
M12	80	3.15	6,370	5,265
M16	100	3.94	13,285	11,285
M20	125	4.92	15,610	13,105
M24	150	5.91	20,450	

- 1 Single anchors with nonseismic shear with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- 2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- 3 For strength design, the required strength = $1.6D + 1.2L$. For ASD, the factored load = $1.0D + 1.0L$. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- 4 Calculation for weighted average for $\alpha = 0.5 \cdot 1.6 + 0.5 \cdot 1.2 = 1.4$.
- 5 $ASD = \Phi_{steel} \cdot V_{sa} / \alpha = 0.75 \cdot V_{sa} / 1.4$

3.3.2 HSL-3 Heavy-duty Expansion Anchor

TABLE 7 - HSL-3 Allowable Seismic Tension (ASD), Normal Weight Cracked Concrete (lb)^{1,2,3,4,5}

Nominal Anchor Diameter	Effective Embedment h_{ef}		Concrete Compressive Strength			
	mm	in.	$f'_c = 2,500$ psi	$f'_c = 3,000$ psi	$f'_c = 4,000$ psi	$f'_c = 6,000$ psi
M8	60	2.36	1,165	1,570	1,470	1,800
M10	70	2.76	2,070	2,265	2,615	3,205
M12	80	3.15	2,525	2,770	3,195	3,915
M16	100	3.94	3,530	3,870	4,465	5,470
M20	125	4.92	4,935	5,405	6,245	7,645
M24	150	5.91	5,395	5,910	6,824	8,360

1 Single anchors with seismic tension with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).

2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.

3 For strength design, the required strength = $1.2D + 1.0E$. For ASD, the factored load = $1.0D + 0.7E$. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.

4 Assuming a 50% dead and 50% earthquake contributions, $\alpha = (1.2 \cdot 0.5 + 1.0 \cdot 0.5) / (1.0 \cdot 0.5 + 0.7 \cdot 0.5) = 1.294$

5 $ASD = \Phi_{concrete} \cdot \Phi_{seismic} \cdot N_{p,cr} / \alpha = 0.65 \cdot 0.75 \cdot N_{p,cr} / 1.294$

TABLE 8 - HSL-3 Allowable Seismic Shear (ASD), Steel^{1,2,3,4,5}

Nominal Anchor Diameter	Effective Embedment h_{ef}		Allowable steel capacity, shear	
	mm	in.	HSL-3, HSL-3-B	HSL-3-G
M8	60	2.36	2,005	1,640
M10	70	2.76	3,675	3,010
M12	80	3.15	5,170	4,270
M16	100	3.94	10,780	9,155
M20	125	4.92	12,665	10,630
M24	150	5.91	16,595	

1 Single anchors with seismic shear with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).

2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.

3 For strength design, the required strength = $1.2D + 1.0E$. For ASD, the factored load = $1.0D + 0.7E$. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.

4 Assuming a 50% dead and 50% earthquake contributions, $\alpha = (1.2 \cdot 0.5 + 1.0 \cdot 0.5) / (1.0 \cdot 0.5 + 0.7 \cdot 0.5) = 1.294$.

5 Seismic ASD = $\Phi_{steel} \cdot \Phi_{seismic} \cdot V_{eq} / \alpha = 0.75 \cdot 0.75 \cdot V_{eq} / 1.294$

HSL-3 Heavy-duty Expansion Anchor 3.3.2

TABLE 9 - HSL- 3 Design Information in accordance with CSA A23.3-04 Annex D¹



Design Parameter	Symbol	Units	Nominal Anchor Diameter						Ref.
			M8	M10	M12	M16	M20	M24	
Anchor O.D.	d_o	mm	12	15	18	24	28	32	A23.3-04
		in.	0.47	0.59	0.71	0.94	1.1	1.26	
Effective minimum embedment depth	$h_{ef,min}$	mm	60	70	80	100	125	150	
		in.	2.36	2.76	3.15	3.94	4.92	5.91	
Anchor category	1,2 or 3	–	1						D.5.4c
Concrete material resistance factor for concrete	ϕ_c	–	0.65						8.4.2
Steel embedment material resistance factor for reinforcement	ϕ_s	–	0.85						8.4.3
Strength reduction factor for tension, steel failure modes	R	–	0.80						D.5.4a
Strength reduction factor for shear, steel failure modes	R	–	0.75						D.5.4a
Strength reduction factor for tension, concrete failure modes	R	Cond. A	1.15						D.5.4c
	R	Cond. B	1.00						D.5.4c
Strength reduction factor for shear, concrete failure modes	R	Cond. A	1.15						D.5.4c
	R	Cond. B	1.00						D.5.4c
Yield strength of anchor steel	f_y	MPa	640						
Ultimate strength of anchor steel	f_{ut}	MPa	800						
Effective cross-sectional area of anchor	A_{se}	mm ²	36.8	58.1	84.5	156.8	245.2	352.9	D.6.1.2
Factored Steel Resistance in tension	N_{sr}	kN	20.0	31.6	46.0	85.3	133.3	191.9	D.6.1.2
Coefficient for factored concrete breakout resistance in tension	k	–	7	10					D.6.2.6
Modification factor for resistance in tension to account for uncracked concrete	$\psi_{c,n}$	–	1.40	1.00					D.6.2.6
Factored pullout resistance in 20 Mpa uncracked concrete	$N_{p,uncr}$	kN	12.3	N/A					D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete	N_{pr}	kN	8.7	14.0	N/A				D.6.3.2
Factored Steel Resistance in shear HSL-3, -B	V_{sr}	kN	20.5	29.0	41.8	75.7	112.1	130.3	D.7.1.2c
Factored Steel Resistance in shear HSL-3-G	V_{sr}	kN	17.2	23.8	34.5	64.3	94.0	N/A	D.7.1.2c
Factored pullout resistance in 20 MPa Concrete, seismic	$N_{pr,seismic}$	kN	N/A						33.4
Factored Steel Resistance in shear, seismic HSL-3, -B, -SH, -SK	$V_{sr,seismic}$	kN	13.1	24.0	33.7	70.3	82.6	108.2	
Factored Steel Resistance in shear, seismic HSL-3-G	$V_{sr,seismic}$	kN	10.7	19.6	27.9	59.7	69.4	N/A	
Axial stiffness in service load range, uncracked concrete	β_{uncr}	kN/mm	52.5						
Axial stiffness in service load range, cracked concrete	β_{cr}	kN/mm	5.3	12.3	22.8				

- For more information, please visit www.hilti.ca and navigate Service/Downloads, then Technical Downloads and open the Limit States Design Guide.
- Effective area A_{se} was revised in the document in 2011. The original area were estimates based on 70% of the gross area calculated using the nominal diameter. The revised values are the actual tensile stress areas.

3.3.2 HSL-3 Heavy-duty Expansion Anchor

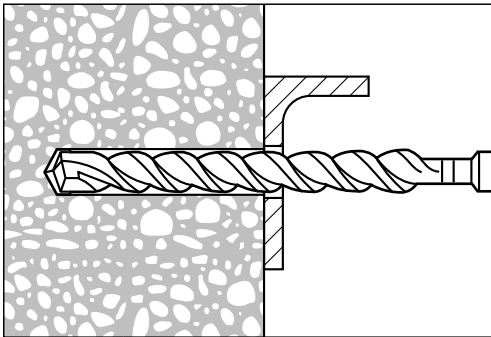
TABLE 10 - HSL- 3 Design Information in accordance with CSA A23.3-04 Annex D¹



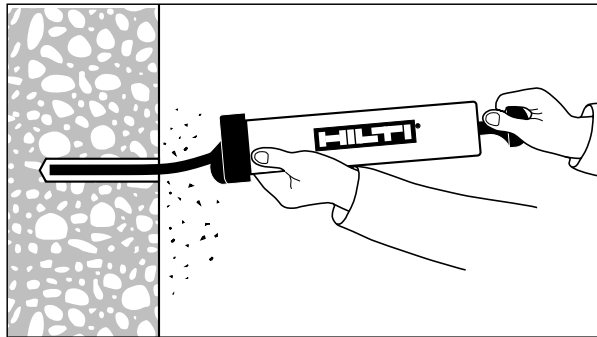
Edge Distance, Spacing and Member Thickness Requirements	Symbol	Units	Nominal Anchor Diameter					
			M8	M10	M12	M16	M20	M24
Minimum member thickness	h_{min}	mm	120	140	160	200	250	300
Critical edge distance	c_{ac}	mm	110	110	120	150	225	225
Minimum edge distance	c_{min}	mm	60	70	90	120	125	150
Minimum anchor spacing	s_{min}	mm	60	70	80	100	125	150
Combination of edge distance and spacing								
For M8:	$s_{design} \geq$	mm	greater of $[332 - (3.20 \times c_{design})]$ mm or s_{min}					
For M10:	$s_{design} \geq$	mm	greater of $[456 - (3.09 \times c_{design})]$ mm or s_{min}					
For M12:	$s_{design} \geq$	mm	greater of $[557 - (3.08 \times c_{design})]$ mm or s_{min}					
For M16:	$s_{design} \geq$	mm	greater of $[650 - (2.75 \times c_{design})]$ mm or s_{min}					
For M20:	$s_{design} \geq$	mm	greater of $[681 - (2.65 \times c_{design})]$ mm or s_{min}					
For M24:	$s_{design} \geq$	mm	greater of $[675 - (2.50 \times c_{design})]$ mm or s_{min}					

HSL-3 Heavy-duty Expansion Anchor 3.3.2

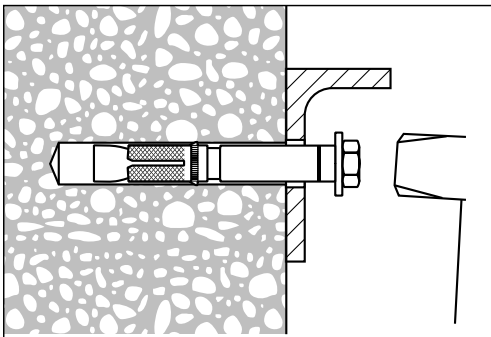
3.3.2.4 HSL-3 Installation Instructions



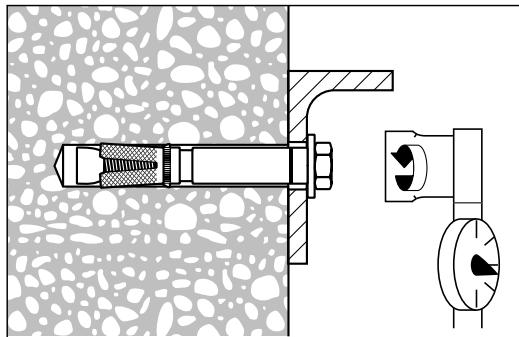
1. Using the correct diameter metric bit, drill hole to minimum required hole depth or deeper.



2. Remove drilling debris with a vacuum, blow out device or compressed air.



3. Using a hammer, tap the anchor through the part being fastened into the drilled hole until the washer is in contact with the fastened part. Do not expand anchor by hand prior to installation.



4. Using a torque wrench, apply the specified installation torque. HSL-3-B does not require use of a torque wrench. Tighten until torque cap shears off.

3.3.2.5 Ordering Information

HSL-3 Bolt Version

Description	Box Qty
HSL-3 M 8/20	40
HSL-3 M 8/40	40
HSL-3 M 10/20	20
HSL-3 M 10/40	20
HSL-3 M 12/25	20
HSL-3 M 12/50	20
HSL-3 M 16/25	10
HSL-3 M 16/50	10
HSL-3 M 20/30	6
HSL-3 M 20/60	6
HSL-3 M 24/30	4
HSL-3 M 24/60	4

HSL-3-B Torque Cap

Description	Box Qty
HSL-3-B M 12/5	20
HSL-3-B M 12/25	20
HSL-3-B M 12/50	10
HSL-3-B M 16/10	10
HSL-3-B M 16/25	10
HSL-3-B M 20/30	6
HSL-3-B M 24/30	4

HSL-3-G Stud Version

Description	Box Qty
HSL-3-G M 8/20	40
HSL-3-G M 10/20	20
HSL-3-G M 12/25	20
HSL-3-G M 12/50	10
HSL-3-G M 16/25	10
HSL-3-G M 16/50	10
HSL-3-G M 20/30	6
HSL-3-G M 20/60	6

Counter sunk HSL-3 available upon request as a special item.

3.3.3 HSL Heavy Duty Expansion Anchor

3.3.3.1 Product Description

3.3.3.2 Material Specifications

3.3.3.3 Technical Data

3.3.3.4 Installation Instructions

3.3.3.5 Ordering Information

3.3.3.1 Product Description

HSL-I M12 Flush Anchor with Torque Nut

Flush mount applications accommodated
by short removable stud

The Hilti HSL Heavy Duty Sleeve Anchor is a torque controlled expansion bolt designed for high performance in static and dynamic load applications. HSL anchors are available in metric sizes from 12 mm to 20 mm diameters.

Product Features

- High load capacity
- Spacer sleeve provides enhanced shear capacity
- Force controlled expansion
- Reliable pull-down of part fastened to overcome gaps
- Suitable for dynamic loading (fatigue, seismic, and shock loading)
- No spinning of anchor in hole when tightening bolt or nut
- Good performance in Hilti Matched Tolerance DD-B or DD-C Diamond Core Bit holes

HSLG-R Stainless Steel with Threaded Rod

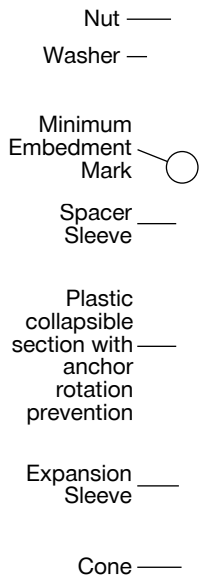
Guide Specifications

Expansion Anchors Carbon (Stainless) steel anchor consists of threaded rod, sleeve, expansion sleeve, expansion cone and collapsible plastic sleeve, (nut) and washer. Anchors shall be torque controlled expansion bolt as manufactured by Hilti.

Installation Refer to Section 3.3.3.4

Dynamic Loading

The HSL anchor has been tested under shock, seismic and fatigue (2×10^6 cycles) loading conditions. Contact your Hilti Field Engineer for additional information.



HSL Heavy Duty Expansion Anchor 3.3.3

3.3.3.2 Material Specifications

Carbon Steel Bolt or threaded rod conform to ISO 898-1, Class 8.8, $f_y \geq 93$ ksi, $f_u \geq 116$ ksi

Carbon Steel expansion sleeve conforms to DIN 2393, Grade ST-52-3

Carbon Steel nut conforms to DIN 934, Grade 8, $f_u \geq 116$ ksi

Stainless steel threaded rod conforms to DIN 267, Type A4-70, $f_y = 65$ ksi, $f_u \geq 102$ ksi

Stainless steel expansion sleeve conforms to DIN 17440, $f_u \geq 102$ ksi

Stainless Steel cone conforms to DIN 17440, $f_u \geq 102$ ksi

Stainless Steel washer conforms to DIN 17441, $74 \text{ ksi} \leq f_u \leq 103$ ksi

Stainless Steel nut conforms to DIN 934

Collapsible sleeve is made of Acetal resin plastic

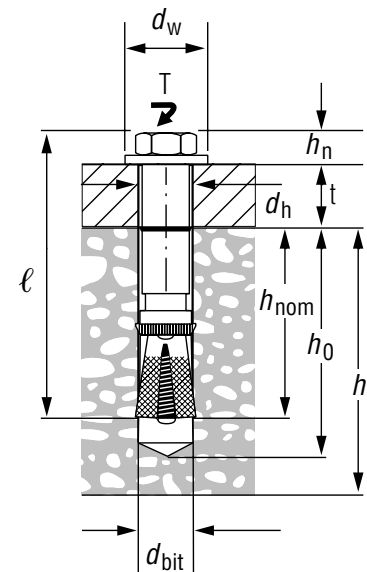
Carbon Steel cone conforms to DIN 1654, Type CQ35, $f_u \geq 87$ ksi

Carbon Steel washer conforms to DIN 1544, Grade ST37, $f_u \geq 91$ ksi

3.3.3.3 Technical Data

Table 1 - HSL Specifications

Details		HSL Anchor Thread Diameter (mm)					
		12	12	16	16	20	20
d_{bit} nominal bit dia.	mm	18		24		28	
h_o min. hole depth	mm	100		125		150	
	(in.)	(4)		(5)		(6)	
h_{nom} min. depth of embedment	mm	80		105		130	
	(mm)	(3-3/16)		(4-1/8)		(5-1/8)	
t Max. thickness fastened	mm	25	50	25	50	30	60
	(mm)	(1)	(2)	(1)	(2)	(1-1/8)	(2-1/4)
ℓ anchor length	mm	120	145	148	173	183	213
	(mm)	(4-3/4)	(5-3/4)	(5-3/4)	(6-3/4)	(7-1/4)	(8-3/8)
h_n head height + washer	mm	11		14		17	
	(in.)	(7/16)		(9/16)		(11/16)	
T_{inst} installation torque	Nm	80		200		400	
	(ft lb)	(60)		(150)		(300)	
wrench size (mm)	HSL/HSLG	19		24		30	
d_h min. dia. fixture hole	mm	22		28		33	
	(in.)	(13/16)		(1-1/8)		(1-5/16)	
d_w washer diameter	mm	30		40		45	
	(in.)	(1-3/16)		(1-9/16)		(1-3/4)	
h_{min} min. base material thickness	mm	160		180		220	
	(in.)	(6-1/4)		(7)		(8-3/4)	



3.3.3 HSL Heavy Duty Expansion Anchor

Table 2 - Stainless Steel HSLG-R Allowable Loads in Normal-Weight Concrete

Anchor Diameter	Embedment Depth mm (in.)	13.8 MPa (2000 psi)		20.7 MPa (3000 psi)		27.6 MPa (4000 psi)		41.4 MPa (6000 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 (1535)	13.7 (3090)	9.1 (2055)	14.8 (3325)	11.5 (2575)	15.8 (3560)	11.5 (2595)	16.4 (3690)
M12	80 (3-3/16)	8.7 (1960)	20.2 (4540)	11.3 (2530)	21.8 (4890)	13.8 (3105)	23.3 (5245)	17.5 (3925)	25.0 (5615)
M16	105 (4-1/8)	17.6 (3965)	34.7 (7805)	20.9 (4705)	39.9 (8965)	24.2 (5450)	45.0 (10125)	30.7 (6900)	46.9 (10550)
M20	130 (5-1/8)	25.1 (5650)	52.9 (11900)	30.7 (6910)	58.7 (13195)	36.4 (8175)	64.5 (14490)	44.5 (10005)	64.5 (14490)

Table 3 - Stainless Steel HSLG-R Ultimate Loads in Normal-Weight Concrete

Anchor Diameter	Embedment Depth mm (in.)	13.8 MPa (2000 psi)		20.7 MPa (3000 psi)		27.6 MPa (4000 psi)		41.4 MPa (6000 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 (5350)	47.8 (10785)	31.9 (7165)	51.6 (11595)	40.0 (8985)	55.2 (12410)	40.3 (9055)	57.3 (12880)
M12	80 (3-3/16)	30.4 (6830)	70.5 (15845)	39.3 (8830)	75.9 (17070)	48.2 (10835)	81.4 (18300)	60.9 (13700)	87.1 (19590)
M16	105 (4-1/8)	61.6 (13840)	121.1 (27220)	73.0 (16420)	139.1 (31270)	84.5 (19005)	157.1 (35320)	107.0 (24065)	163.7 (36800)
M20	130 (5-1/8)	87.7 (19715)	184.7 (41510)	107.3 (24115)	204.7 (46025)	126.9 (28520)	224.8 (50540)	155.3 (34910)	224.8 (50540)

Table 4 - HSL-I M12 Allowable Loads in 4000 psi Normal Weight Concrete¹

Description	Anchor Length	Embedment	Tension	Shear
	(mm)	(mm)	(lb)	(lb)
HSL - I M12 65/80	113	65	2,335	2,265
	130	80	3,150	2,350

¹ Allowable loads calculated using a 4:1 factor of safety.

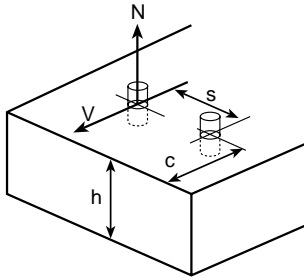
Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right)^{5/3} + \left(\frac{V_d}{V_{rec}} \right)^{5/3} \leq 1.0$$

Refer to Section 3.1.8.3

HSL Heavy Duty Expansion Anchor 3.3.3

Anchor Spacing and Edge Distance Guidelines

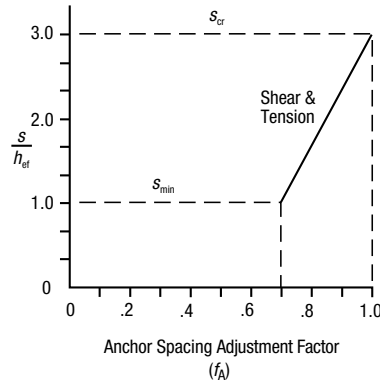


Anchor Spacing Adjustment Factors

$$s = \text{Actual Spacing}$$

$$s_{\min} = 1.0 h_{\text{nom}}$$

$$s_{\text{cr}} = 3.0 h_{\text{ef}}$$



Edge Distance Adjustment Factors

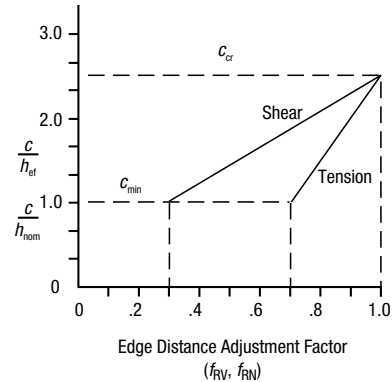
$$c = \text{Actual Edge Distance}$$

$$c_{\min} = 1.0 h_{\text{nom}} \quad \text{Tension}$$

$$c_{\text{cr}} = 2.5 h_{\text{ef}}$$

$$c_{\min} = 1.0 h_{\text{nom}} \quad \text{Shear}$$

$$c_{\text{cr}} = 2.5 h_{\text{nom}}$$



Anchor Size	in.	h_{nom} (mm)
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

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)		1.0	.92	.84		1.0	.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)			1.0	.92			1.0	.82
350	(13-3/4)				.95	300	(11-3/4)			1.0	.96			1.0	.91
395	(15-1/2)				1.0	325	(12-3/4)				1.0				1.0
430	(17)					350	(13-3/4)				1.0				1.0
470	(18-1/2)					390	(15-3/8)								

$$s_{\min} = 1.0 h_{\text{nom}} \quad s_{\text{cr}} = 3.0 h_{\text{ef}}$$

$$f_A = 0.15 \frac{s}{h_{\text{ef}}} + 0.55$$

$$\text{for } s_{\text{cr}} > s > s_{\min}$$

$$c_{\min} = 1.0 h_{\text{nom}} \quad c_{\text{cr}} = 2.5 h_{\text{ef}}$$

$$f_{\text{RN}} = (0.30) \left(\frac{c - 1.0 h_{\text{nom}}}{2.5 h_{\text{ef}} - 1.0 h_{\text{nom}}} \right) + 0.70$$

$$\text{for } c_{\text{cr}} > c > c_{\min}$$

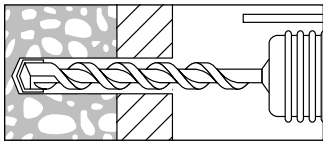
$$c_{\min} = 1.0 h_{\text{nom}} \quad c_{\text{cr}} = 2.5 h_{\text{nom}}$$

$$f_{\text{RV}} = 0.47 \frac{c}{h_{\text{nom}}} - 0.17$$

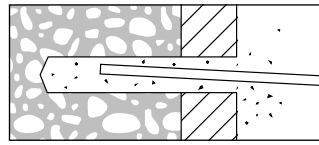
$$\text{for } c_{\text{cr}} > c > c_{\min}$$

3.3.3 HSL Heavy Duty Expansion Anchor

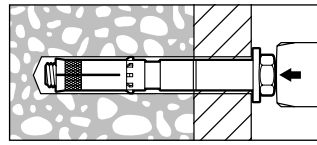
3.3.3.4 Installation Instructions



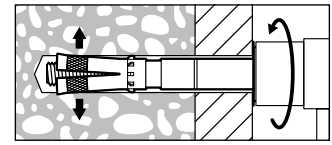
1. Drill a hole with the prescribed Hilti metric carbide or diamond core bit. **Note:** the HSL can be installed in a bottomless hole.



2. Clean the hole using compressed air.



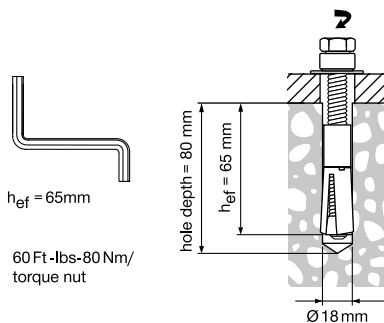
3. Using a hammer, tap the pre-assembled anchor through the object being anchored and into the hole. The anchor should be seated firmly against the base plate. **Note:** Do not expand the anchor by hand before tapping it into the hole.



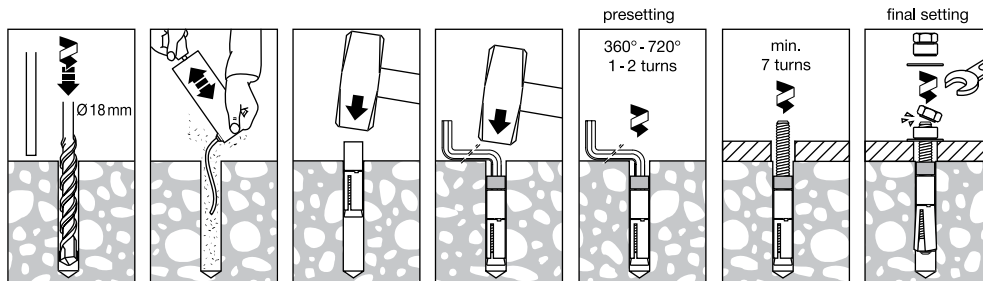
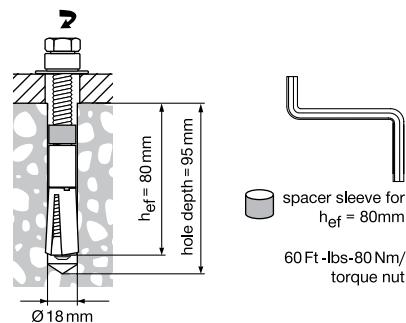
4. Tighten bolt or nut to the specified torque, using a torque wrench.

Setting Instructions for the HSL-I M12-0 65/80

HSL-I M12-0 65



HSL-I M12-0 80



3.3.3.5 Ordering Information

HSLG-R Stainless Steel Anchor

Material: Stainless Steel type 316

Description	Box Qty
HSLG-R M 10/20	20
HSLG-R M 12/25	20
HSLG-R M 16/25	10
HSLG-R M 20/30	6

HSL-I Flush Anchor

(Internally Threaded)

Description	Box Qty
HSL-I M12 65/80	20

KWIK Bolt TZ Expansion Anchor 3.3.4

3.3.4.1 KWIK Bolt TZ Product Description

The KWIK Bolt TZ (KB-TZ) is a torque controlled expansion anchor which is especially suited to seismic and cracked concrete applications. This anchor line is available in carbon steel, type 304 and type 316 stainless steel versions. The anchor diameters range from 3/8- and 3/4-inch in a variety of lengths. Applicable base materials include normal-weight concrete, structural lightweight concrete, and lightweight concrete over metal deck.

Guide Specifications

Torque controlled expansion anchors shall be KWIK Bolt TZ (KB-TZ) supplied by Hilti meeting the description in Federal Specification A-A 1923A, type 4. The anchor bears a length identification mark embossed into the impact section (dog point) of the anchor surrounded by four embossed notches identifying the anchor as a Hilti KWIK Bolt TZ in the installed condition. Anchors are manufactured to meet one of the following conditions:

- The carbon steel anchor body, nut, and washer have an electro-plated zinc coating conforming to ASTM B633 to a minimum thickness of 5 µm. The stainless steel expansion sleeve conforms to type 316.
- Stainless steel anchor body, nut and washer conform to type 304. Stainless steel expansion sleeve conforms to type 316.
- Stainless steel anchor body, nut, washer, and expansion sleeve conform to type 316 stainless steel.

Supplemental Design Provisions for ACI 318 Appendix D

Design strengths are determined in accordance with ACI 318 Appendix D and ICC Evaluation Service ESR-1917 Hilti KWIK Bolt TZ Carbon and Stainless Steel Anchors in Concrete. The relevant design parameters are reiterated in Tables 1, 2, and 3 of this document. Supplemental provisions required for the design of the KB-TZ are enumerated in Section 4.0 of ESR-1917 (DESIGN AND INSTALLATION). Note that these design parameters are supplemental to the design provisions of ACI 318.

Product Features

- Product and length identification marks facilitate quality control after installation.
- Through fixture installation and variable thread lengths improve productivity and accommodate various base plate thicknesses.
- Type 316 Stainless Steel wedges provide superior performance in cracked concrete.
- Ridges on expansion wedges provide increased reliability.
- Mechanical expansion allows immediate load application.
- Raised impact section (dog point) prevents thread damage during installation.
- Bolt meets ductility requirements of ACI 318 Section D1.

Installation

Drill hole in base material to the appropriate depth using a Hilti carbide tipped drill bit. Drive the anchor into the hole using a hammer. A minimum of four threads must be below the fastening surface prior to applying installation torque. Tighten the nut to the installation torque.

3.3.4.1 Product Description

3.3.4.2 Material Specifications

3.3.4.3 Technical Data

3.3.4.4 Installation Instructions

3.3.4.5 Ordering Information

Impact Section
(Dog Point)

Nut —

Washer —

Red
Mark —

Anchor —
Thread

Anchor —
Body

Stainless
Steel
Expansion —
Sleeve
(Wedges)

Expansion Cone

Listings/Approvals

ICC-ES (International Code Council)
ESR-1917

FM (Factory Mutual)

Pipe Hanger Components for Automatic Sprinkler Systems (3/8" - 3/4")

UL (Underwriters Laboratories)

Pipe Hanger Equipment for Fire Protection Services (3/8" - 3/4")

Independent Code Evaluation

IBC® / IRC® 2009 (AC 193 / ACI 355.2)

IBC® / IRC® 2006

3.3.4 KWIK Bolt TZ Expansion Anchor

3.3.4.2 Material Properties

Carbon steel with electroplated zinc

- Carbon steel KB-TZ anchors have the following minimum bolt fracture loads¹

Anchor Diameter (in.)	Shear (lb)	Tension (lb)
3/8	NA	6,744
1/2	7,419	11,240
5/8	11,465	17,535
3/4	17,535	25,853

- Carbon steel anchor components plated in accordance with ASTM B633 to a minimum thickness of 5µm.
- Nuts conform to the requirements of ASTM A 563, Grade A, Hex.
- Washers meet the requirements of ASTM F 844.
- Expansion sleeves (wedges) are manufactured from type 316 stainless steel.

Stainless steel

- Stainless steel KB-TZ anchors are made of type 304 or 316 material and have the following minimum bolt fracture loads¹

Anchor Diameter (in.)	Shear (lb)	Tension (lb)
3/8	5,058	6,519
1/2	8,543	12,364
5/8	13,938	19,109
3/4	22,481	24,729

- All nuts and washers are made from type 304 or type 316 stainless steel respectively.
- Nuts meet the dimensional requirements of ASTM F 594.
- Washers meet the dimensional requirements of ANSI B18.22.1, Type A, plain.
- Expansion Sleeve (wedges) are made from type 316 stainless steel.

¹ Bolt fracture loads are determined by testing in jig as part of product QC. These loads are not intended for design purposes. See Tables 2 and 3.

KWIK Bolt TZ Expansion Anchor 3.3.4

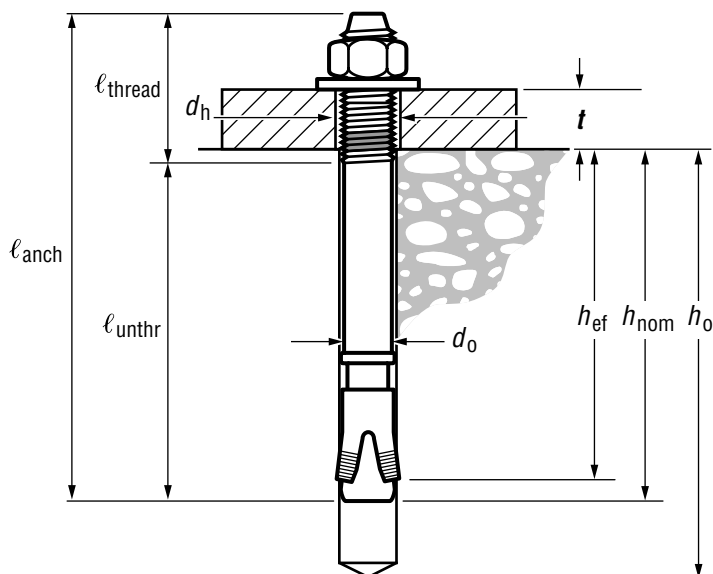
3.3.4.3 Technical Data

Table 1 — KWIK Bolt TZ Specification Table

Setting Information	Symbol	Units	Nominal anchor diameter (in.)													
			3/8			1/2			5/8			3/4				
Anchor O.D.	d _o	in. (mm)	0.375 (9.5)			0.5 (12.7)			0.625 (15.9)			0.75 (19.1)				
Nominal bit diameter	d _{bit}	in.	3/8			1/2			5/8			3/4				
Effective minimum embedment	h _{ef}	in. (mm)	2 (51)			2 (51)		3-1/4 (83)		3-1/8 (79)		4 (102)		3-3/4 (95)		4-3/4 (121)
Min. hole depth	h _o	in. (mm)	2-5/8 (67)			2-5/8 (67)		4 (102)		3-3/4 (95)		4-3/4 (121)		4-5/8 (117)		5-3/4 (146)
Min. thickness of fixture ¹	t _{min}	in. (mm)	1/4 (6)			3/4 (19)		1/4 (6)		3/8 (9)		3/4 (19)		1/8 (3)		1-5/8 (41)
Max. thickness of fixture	t _{max}	in. (mm)	2-1/4 (57)			4 (101)		2-3/4 (70)		5-5/8 (143)		4-3/4 (121)		4-5/8 (117)		3-5/8 (92)
Installation torque	T _{inst}	ft-lb (Nm)	25 (34)			40 (54)			60 (81)			110 (149)				
Minimum diameter of hole	d _h	in. (mm)	7/16 (11.1)			9/16 (14.3)			11/16 (17.5)			13/16 (20.6)				
Available anchor lengths	ℓ _{anch}	in. (mm)	3	3-3/4	5	3-3/4	4-1/2	5-1/2	7	4-3/4	6	8-1/2	10	5-1/2	8	10
			(76)	(95)	(127)	(95)	(114)	(140)	(178)	(121)	(152)	(216)	(254)	(140)	(203)	(254)
Threaded length including dog point	ℓ _{thread}	in. (mm)	7/8	1-5/8	2-7/8	1-5/8	2-3/8	3-3/8	4-7/8	1-1/2	2-3/4	5-1/4	6-3/4	1-1/2	4	6
			(22)	(41)	(73)	(41)	(60)	(86)	(178)	(38)	(70)	(133)	(171)	(38)	(102)	(152)
Unthreaded length	ℓ _{unthr}	in. (mm)	2-1/8 (54)			2-1/8 (54)			3-1/4 (83)			4 (102)				
Installation embedment	h _{nom}	in. (mm)	2-1/4 (57)			2-3/8 (60)		3-5/8 (92)		3-5/8 (92)		4-1/2 (114)		4-3/8 (111)		5-3/8 (137)

1 The minimum thickness of the fastened part is based on use of the anchor at minimum embedment and is controlled by the length of thread. If a thinner fastening thickness is required, increase the anchor embedment to suit.

Figure 1 — KWIK Bolt TZ Installed



3.3.4 KWIK Bolt TZ Expansion Anchor

Table 2 — Carbon Steel KWIK Bolt TZ Strength Design Information

Setting Information	Symbol	Units	Nominal anchor diameter											
			3/8		1/2				5/8			3/4		
Anchor O.D.	d _o	in. (mm)	0.375 (9.5)		0.5 (12.7)				0.625 (15.9)			0.75 (19.1)		
Effective minimum embedment ¹	h _{ef}	in. (mm)	2 (51)		2 (51)		3-1/4 (83)		3-1/8 (79)	4 (102)		3-3/4 (95)		4-3/4 (121)
Min. member thickness	h _{min}	in. (mm)	4 (102)	5 (127)	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)	4-3/8 (111)	4 (102)	5-1/2 (140)	4-1/2 (114)	7-1/2 (191)	6 (152)	6-1/2 (165)	8-3/4 (222)	6-3/4 (171)	10 (254)	8 (203)	9 (229)
Min. edge distance	c _{a,min}	in. (mm)	2-1/2 (64)		2-3/4 (70)		2-3/8 (60)		3-5/8 (92)	3-1/4 (83)		4-3/4 (121)		4-1/8 (105)
	for s ≥	in. (mm)	5 (127)		5-3/4 (146)		5-3/4 (146)		6-1/8 (156)	5-7/8 (149)		10-1/2 (267)		8-7/8 (225)
Min. anchor spacing	s _{min}	in. (mm)	2-1/2 (64)		2-3/4 (70)		2-3/8 (60)		3-1/2 (89)	3 (76)		5 (127)		4 (102)
	for c ≥	in. (mm)	3-5/8 (92)		4-1/8 (105)		3-1/2 (89)		4-3/4 (121)	4-1/4 (108)		9-1/2 (241)		7-3/4 (197)
Min. hole depth in concrete	h _o	in. (mm)	2-5/8 (67)		2-5/8 (67)		4 (102)		3-7/8 (98)	4-3/4 (121)		4-5/8 (117)		5-3/4 (146)
Min. specified yield strength	f _{ya}	lb/in ² (N/mm ²)	100,000 (690)		84,800 (585)				84,800 (585)			84,800 (585)		
Min. specified ult. strength	f _{uta}	lb/in ² (N/mm ²)	115,000 (793)		106,000 (731)				106,000 (731)			106,000 (731)		
Effective tensile stress area	A _{se}	in. ² (mm ²)	0.052 (33.6)		0.101 (65.0)				0.162 (104.6)			0.237 (152.8)		
Steel strength in tension	N _{sa}	lb (kN)	6,500 (28.9)		10,705 (47.6)				17,170 (76.4)			25,120 (111.8)		
Steel strength in shear	V _{sa}	lb (kN)	3,595 (16.0)		5,495 (24.4)				8,090 (36.0)			13,675 (60.8)		
Steel strength in shear, seismic	V _{eq}	lb (kN)	2,255 (10.0)		5,495 (24.4)				7,600 (33.8)			11,745 (52.2)		
Steel strength in shear, concrete on metal deck ²	V _{sa,deck}	lb (kN)	2,130 ¹⁰ (9.5)		3,000 (13.3)		4,945 (22)		4,600 ¹⁰ (20.5)	6,040 ¹⁰ (26.9)		NP		
Pullout strength uncracked concrete ³	N _{p,uncr}	lb (kN)	2515 (11.2)		NA		5,515 (24.5)		NA	9,145 (40.7)		8,280 (36.8)	10,680 (47.5)	
Pullout strength cracked concrete ³	N _{p,cr}	lb (kN)	2270 (10.1)		NA		4,915 (21.9)		NA			NA		
Pullout strength concrete on metal deck ⁴	N _{p,deck,cr}	lb (kN)	1,460 (6.5)		1,460 (6.5)		2,620 (11.7)		2,000 (8.9)	4,645 (20.7)		NP		
Anchor category ⁵			1											
Effectiveness factor k _{uncr} uncracked concrete			24											
Effectiveness factor k _{cr} cracked concrete ⁶			17											
Ψ _{c,N} = k _{uncr} /k _{cr} ⁷			1.41											
Coefficient for pryout strength, k _{cp}			1.0					2.0						
Strength reduction factor Φ for tension, steel failure modes ⁸			0.75											
Strength reduction factor Φ for shear, steel failure modes ⁸			0.65											
Strength reduction factor Φ for tension, concrete failure modes, Condition B ⁹			0.65											
Strength reduction factor Φ for shear, concrete failure modes			0.70											

1 See Fig. 1.

2 NP (not permitted) denotes that the condition is not supported.

3 NA (not applicable) denotes that this value does not control for design.

4 NP (not permitted) denotes that the condition is not supported. Values are for cracked concrete. Values are applicable to both static and seismic load combinations.

5 See ACI 318 D.4.4.

6 See ACI 318 D.5.2.2.

7 See ACI 318 D.5.2.6.

8 The KB-TZ is a ductile steel element as defined by ACI 318 D.1.

9 For use with the load combinations of ACI 318 Chapter 9 Section 9.2. Condition B applies where supplementary reinforcement in conformance with ACI 318 D.4.4 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.

10 For seismic applications, multiply the value of $V_{sa,deck}$ for the 3/8-inch-diameter by 0.63 and the 5/8-inch-diameter by 0.94.

KWIK Bolt TZ Expansion Anchor 3.3.4

Table 3 — Stainless Steel KWIK Bolt TZ Strength Design Information

Setting Information	Symbol	Units	Nominal anchor diameter											
			3/8		1/2				5/8			3/4		
Anchor O.D.	d _o	in. (mm)	0.375 (9.5)		0.5 (12.7)				0.625 (15.9)			0.75 (19.1)		
Effective minimum embedment ¹	h _{ef}	in. (mm)	2 (51)		2 (51)		3-1/4 (83)		3-1/8 (79)	4 (102)		3-3/4 (95)		4-3/4 (121)
Min. member thickness	h _{min}	in. (mm)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	6 (152)	8 (203)	
Critical edge distance	c _{ac}	in. (mm)	4-3/8 (111)	3-7/8 (98)	5-1/2 (140)	4-1/2 (114)	7-1/2 (191)	6 (152)	7 (178)	8-7/8 (225)	6 (152)	10 (254)	7 (178)	9 (229)
Min. edge distance	c _{a,min}	in. (mm)	2-1/2 (64)		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 (127)		5-3/4 (146)		5-1/4 (133)		5-1/2 (140)	5-1/2 (140)		10 (254)		8-1/2 (216)
Min. anchor spacing	s _{min}	in. (mm)	2-1/4 (57)		2-7/8 (73)		2 (51)		2-3/4 (70)	2-3/8 (60)		5 (127)		4 (102)
	for c ≥	in. (mm)	3-1/2 (89)		4-1/2 (114)		3-1/4 (83)		4-1/8 (105)	4-1/4 (108)		9-1/2 (241)		7 (178)
Min. hole depth in concrete	h _o	in. (mm)	2-5/8 (67)		2-5/8 (67)		4 (102)		3-3/4 (95)	4-3/4 (121)		4-5/8 (117)		5-3/4 (146)
Min. specified yield strength	f _{ya}	lb/in2 (N/mm2)	92,000 (634)		92,000 (634)				92,000 (634)			76,125 (525)		
Min. specified ult. strength	f _{uta}	lb/in2 (N/mm2)	115,000 (793)		115,000 (793)				115,000 (793)			101,500 (700)		
Effective tensile stress area	A _{se}	in2 (mm2)	0.052 (33.6)		0.101 (65.0)				0.162 (104.6)			0.237 (152.8)		
Steel strength in tension	N _{sa}	lb (kN)	5,980 (26.6)		11,615 (51.7)				18,630 (82.9)			24,055 (107.0)		
Steel strength in shear	V _{sa}	lb (kN)	4,870 (21.7)		6,880 (30.6)				9,350 (41.6)			12,890 (57.3)		
Steel strength in tension, seismic ²	N _{eq}	lb (kN)	NA		2,735 (12.2)		NA		NA			NA		
Steel strength in shear, seismic ²	V _{eq}	lb (kN)	2,825 (12.6)		6,880 (30.6)				11,835 (52.6)			14,615 (65.0)		
Pullout strength uncracked concrete ²	N _{p,uncr}	lb (kN)	2,630 (11.7)		NA			5,760 (25.6)		NA			NA	12,040 (53.6)
Pullout strength cracked concrete ²	N _{p,cr}	lb (kN)	2,340 (10.4)		3,180 (14.1)			NA		NA	5,840 (26.0)		8,110 (36.1)	NA
Anchor category ³			1		2		1							
Effectiveness factor k _{uncr} uncracked concrete			24											
Effectiveness factor k _{cr} cracked concrete ⁴			17		24		17		17	17		24		17
Ψ _{c,N} = k _{uncr} /k _{cr} ⁵			1.41		1.00		1.41		1.41	1.41		1.00		1.41
Coefficient for pryout strength, k _{cp}			1.0				2.0							
Strength reduction factor Φ for tension, steel failure modes ⁶			0.75											
Strength reduction factor Φ for shear, steel failure modes ⁶			0.65		0.55		0.65							
Strength reduction factor Φ for tension, concrete failure modes, Condition B ⁷			0.65											
Strength reduction factor Φ for shear, concrete failure modes			0.70											

1 See Fig. 1.

2 NA (not applicable) denotes that this value does not control for design.

3 See ACI 318 D.4.4.

4 See ACI 318 D.5.2.2.

5 See ACI 318 D.5.2.6.

6 The KB-TZ is a ductile steel element as defined by ACI 318 D.1.

7 For use with the load combinations of ACI 318 Chapter 9 Section 9.2. Condition B applies where supplementary reinforcement in conformance with ACI 318 D.4.4 is not provided, or where pullout or prout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.

3.3.4 KWIK Bolt TZ Expansion Anchor

Figure 2 — Interpolation of Minimum Edge Distance and Anchor Spacing

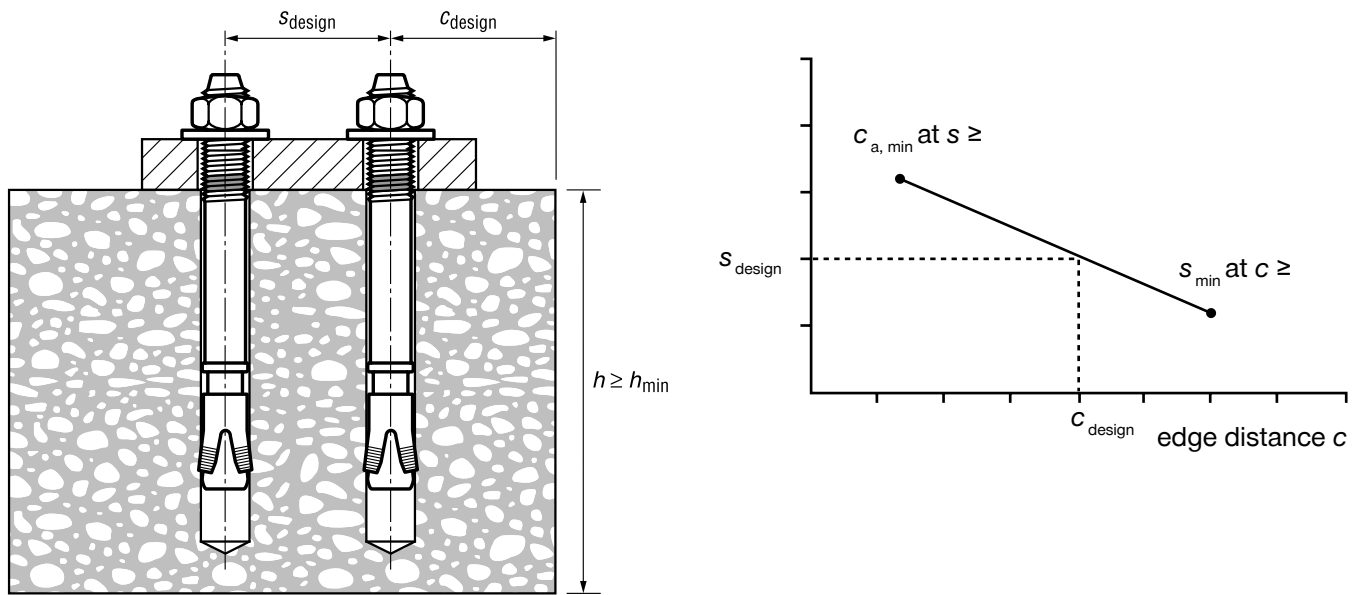
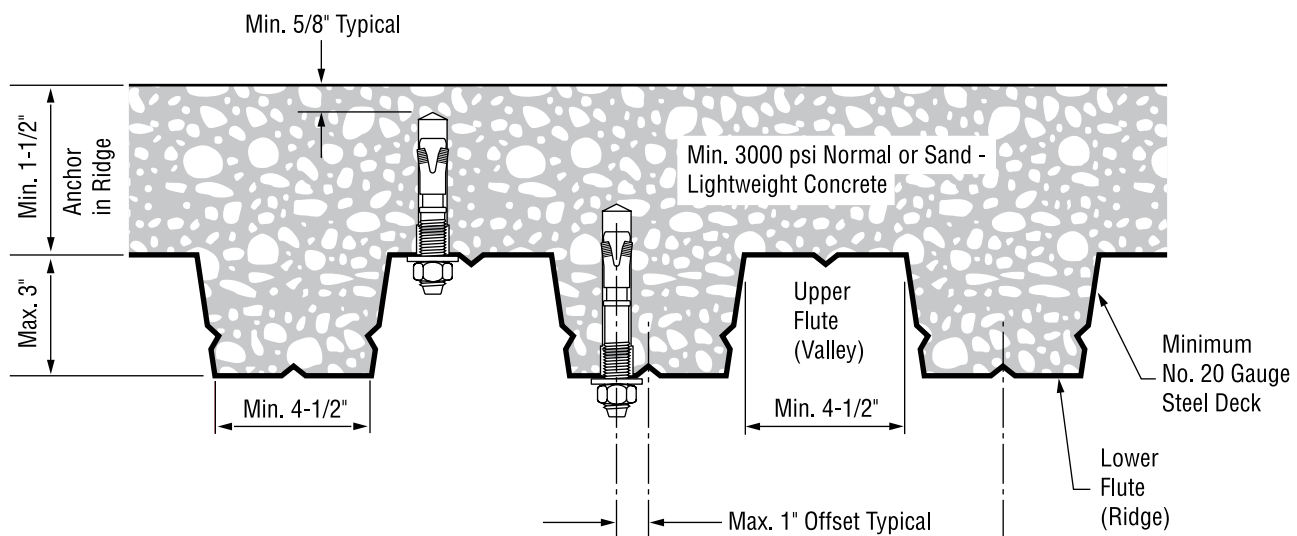


Table 4 — Mean Axial Stiffness Values (1,000 lb/in.) for KWIK Bolt TZ Carbon and Stainless Steel Anchors in Normal-Weight Concrete¹

Concrete condition	carbon steel KB-TZ, all diameters	stainless steel KB-TZ, all diameters
uncracked concrete	700	120
cracked concrete	500	90

¹ Mean values shown. Actual stiffness may vary considerably depending on concrete strength, loading and geometry of application.

Figure 3 — Installation in Concrete over Metal Deck Floor



KWIK Bolt TZ Expansion Anchor 3.3.4

Allowable Stress Design

Design values for use with allowable stress design (working stress design) shall be established as follows: $R_{allow,ASD} = \frac{R_d}{\alpha}$

where $R_d = \Phi R_k$ represents the limiting design strength in tension (ΦN_n) or shear (ΦV_n) as calculated according to ACI 318 D.4.1.1 and D.4.1.2

Table 5 - KWIK Bolt TZ Carbon and Stainless Steel Allowable Nonseismic Tension (ASD), Normal-Weight Uncracked Concrete (lb)^{1,2,3,4,5,6}

Diameter	h_{ef} (in.)	Concrete Compressive Strength							
		$f'_c = 2,500$ psi		$f'_c = 3,000$ psi		$f'_c = 4,000$ psi		$f'_c = 6,000$ psi	
		Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel
3/8	2	1,168	1,221	1,279	1,338	1,477	1,545	1,809	1,892
1/2	2	1,576	1,576	1,726	1,726	1,993	1,993	2,441	2,441
	3-1/4	2,561	2,674	2,805	2,930	3,239	3,383	3,967	4,143
5/8	3-1/8	3,078	3,078	3,372	3,372	3,893	3,893	4,768	4,768
	4	4,246	4,457	4,651	4,883	5,371	5,638	6,578	6,905
3/4	3-3/4	3,844	4,046	4,211	4,432	4,863	5,118	5,956	6,268
	4-3/4	4,959	5,590	5,432	6,124	6,272	7,071	7,682	8,660

- 1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- 2 Concrete determined to remain uncracked for the life of the anchorage.
- 3 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- 4 For strength design, the required strength = 1.6D + 1.2L. For ASD, the factored load = 1.0D + 1.0L. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- 5 Assuming a 50% dead and 50% live contributions, $\alpha = (1.6 \cdot 0.5 + 1.2 \cdot 0.5) / (1.0 \cdot 0.5 + 1.0 \cdot 0.5) = 1.4$
- 6 $ASD = \Phi_{concrete} \cdot N_{p,uncr} / \alpha = 0.65 \cdot N_{p,uncr} / 1.4$

Table 6 - KWIK Bolt TZ Carbon and Stainless Steel Allowable Nonseismic Tension (ASD), Normal-Weight Cracked Concrete (lb)^{1,2,3,4,5}

Diameter	h_{ef} (in.)	Concrete Compressive Strength							
		$f'_c = 2500$ psi		$f'_c = 3000$ psi		$f'_c = 4000$ psi		$f'_c = 6000$ psi	
		Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel
3/8	2	1,054	1,086	1,155	1,190	1,333	1,374	1,633	1,683
1/2	2	1,116	1,476	1,223	1,617	1,412	1,868	1,729	2,287
	3-1/4	2,282	2,312	2,500	2,533	2,886	2,886	3,535	3,582
5/8	3-1/8	2,180	2,180	2,388	2,388	2,758	2,925	3,377	3,377
	4	3,157	2,711	3,458	2,970	3,994	3,430	4,891	4,201
3/4	3-3/4	2,866	3,765	3,139	4,125	3,625	4,763	4,440	5,833
	4-3/4	4,085	4,085	4,475	4,475	5,168	5,168	6,329	6,329

- 1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- 2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- 3 For strength design, the required strength = 1.6D + 1.2L. For ASD, the factored load = 1.0D + 1.0L. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- 4 Assuming a 50% dead and 50% live contributions, $\alpha = (1.6 \cdot 0.5 + 1.2 \cdot 0.5) / (1.0 \cdot 0.5 + 1.0 \cdot 0.5) = 1.4$
- 5 $ASD = \Phi_{concrete} \cdot N_{p,cr} / \alpha = 0.65 \cdot N_{p,cr} / 1.4$

3.3.4 KWIK Bolt TZ Expansion Anchor

Table 7 - KWIK Bolt TZ Carbon and Stainless Steel Allowable Nonseismic Shear (ASD), Steel (lb)^{1,2,3,4,5,6}

Diameter (in.)	Allowable Steel Capacity, Shear	
	Carbon Steel	Stainless Steel
3/8	1,925	2,530
1/2	2,945	3,685
5/8	4,335	5,290
3/4	7,325	8,415

- 1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- 2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- 3 For strength design, the required strength = 1.6D + 1.2L. For ASD, the factored load = 1.0D + 1.0L. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- 4 $ASD = \Phi_{steel} \cdot V_{sa} / \alpha = 0.75 \cdot V_{sa} / 1.4$

Table 8 - KWIK Bolt TZ Carbon and Stainless Steel Allowable Seismic Tension (ASD), Normal-Weight Cracked Concrete (lb)^{1,2,3,4,5}

Diameter	h_{ef} (in.)	Concrete Compressive Strength ²							
		$f'_c = 2500$ psi		$f'_c = 3000$ psi		$f'_c = 4000$ psi		$f'_c = 6000$ psi	
		Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel	Carbon Steel	Stainless Steel
3/8	2	774	882	937	966	1,082	1,115	1,225	1,366
1/2	2	906	1,198	992	1,312	1,146	1,515	1,297	1,856
	3-1/4	1,852	1,876	2,028	2,055	2,342	2,373	2,651	2,907
5/8	3-1/8	1,769	1,769	1,938	1,938	2,238	2,238	2,533	2,741
	4	2,562	2,200	2,806	2,410	3,240	2,783	3,668	3,408
3/4	3-3/4	2,325	3,055	2,547	3,347	2,941	3,865	3,330	4,733
	4-3/4	3,315	3,315	3,632	3,632	4,193	4,193	4,747	5,136

- 1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- 2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- 3 For strength design, the required strength = 1.2D + 1.0E. For ASD, the factored load = 1.0D + 0.7E. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- 4 Assuming a 50% dead and 50% earthquake contributions, $\alpha = (1.2 \cdot 0.5 + 1.0 \cdot 0.5) / (1.0 \cdot 0.5 + 0.7 \cdot 0.5) = 1.294$
- 5 $ASD = \Phi_{concrete} \cdot \Phi_{seismic} \cdot N_{p,uncr} / \alpha = 0.65 \cdot 0.75 \cdot N_{p,uncr} / 1.294$

Table 9 - KWIK Bolt TZ Carbon and Stainless Steel Allowable Seismic Shear (ASD), Steel (lb)^{1,2,3,4,5}

Diameter (in.)	Allowable Steel Capacity, Shear	
	Carbon Steel	Stainless Steel
3/8	1,565	1,915
1/2	2,390	2,590
5/8	3,515	4,005
3/4	5,945	6,375

- 1 Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- 2 Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- 3 For strength design, the required strength = 1.2D + 1.0E. For ASD, the factored load = 1.0D + 0.7E. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- 4 Assuming a 50% dead and 50% earthquake contributions, $\alpha = (1.2 \cdot 0.5 + 1.0 \cdot 0.5) / (1.0 \cdot 0.5 + 0.7 \cdot 0.5) = 1.294$
- 5 $Seismic ASD = \Phi_{steel} \cdot \Phi_{seismic} \cdot V_{eq} / \alpha = 0.75 \cdot 0.75 \cdot V_{eq} / 1.294$

KWIK Bolt TZ Expansion Anchor 3.3.4

Table 10 - KWIK Bolt TZ Allowable Tension and Shear Loads (ASD), Installed into the Underside of Lightweight Concrete over Metal Deck Slab^{1,2}

Nominal Anchor Diameter	Embedment Depth h_{ef} (in.)	Tension Nonseismic ^{3,4,5} (lb)	Tension Seismic ^{7,8,9} (lb)	Shear Nonseismic ^{3,4,6} (lb)	Shear Seismic ^{7,8,10} (lb)
3/8	2	680	550	1,140	930
1/2	2	680	550	1,607	1,310
1/2	3 1/4	1,215	990	2,650	2,155
5/8	3 1/8	929	755	2,465	2,005
5/8	4	2,157	1,755	3,235	2,635

- Single anchors with no edge or anchor spacing reductions and no supplementary reinforcement (Condition B).
- Strength design load combinations from ACI 318 Section 9.2. ASD load combinations from ASCE 7-05, Section 2.
- For strength design, the required strength = $1.6D + 1.2L$. For ASD, the factored load = $1.0D + 1.0L$. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- Assuming a 50% dead and 50% live contributions, $\alpha = (1.6 \cdot 0.5 + 1.2 \cdot 0.5) / (1.0 \cdot 0.5 + 1.0 \cdot 0.5) = 1.4$
- $ASD = \phi_{concrete} \cdot N_{p,deck,cr} / \alpha = 0.65 \cdot N_{p,deck,cr} / 1.4$
- $ASD = \phi_{steel} \cdot V_{s,deck} / \alpha = 0.75 \cdot V_{s,deck} / 1.4$
- For strength design, the required strength = $1.2D + 1.0E$. For ASD, the factored load = $1.0D + 0.7E$. Conversion factor α is calculated by dividing the ACI 318 required strength by the ASCE 7 factored load.
- Assuming a 50% dead and 50% earthquake contributions, $\alpha = (1.2 \cdot 0.5 + 1.0 \cdot 0.5) / (1.0 \cdot 0.5 + 0.7 \cdot 0.5) = 1.294$
- $ASD = \phi_{concrete} \cdot \phi_{seismic} \cdot N_{p,deck,cr} / \alpha = 0.65 \cdot 0.75 \cdot N_{p,deck,cr} / 1.294$
- $10. \text{ Seismic ASD} = \phi_{concrete} \cdot \phi_{seismic} \cdot V_{s,deck} / \alpha = 0.75 \cdot 0.75 \cdot V_{s,deck} / 1.294$

Table 11 — KWIK Bolt TZ 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, ℓ_{anch} (in.)	From	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11	12	13	14	15
	Up to but not including	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11	12	13	14	15	16

Figure 4 — Bolt Head with Length Identification Mark and KWIK Bolt TZ Head Notch Embossment



3.3.4 KWIK Bolt TZ Expansion Anchor

TABLE 12 - KWIK Bolt TZ Design Information in accordance with CSA A23.3-04 Annex D¹

Design Parameter	Symbol	Units	Nominal anchor diameter												Ref.
			3/8		1/2				5/8			3/4			
Anchor O.D.	d _o	mm	9.5		12.7				15.9			19.1			
		(in.)	0.375		0.5				0.625			0.75			
Effective min. embedment depth	h _{ef, min}	mm	51		51		83		79	102		95		121	
		(in.)	2		2		3-1/4		3-1/8	4		3-3/4		4-3/4	
Min. member thickness	h _{min}	mm	102	127	102	152	152	203	127	152	203	152	203	203	
Critical edge distance	c _{ac}	mm	111	102	140	114	191	152	165	222	171	254	203	229	
Minimum edge distance	c _{ac}	mm	64		70		60		92	83		121		105	
	for s >	mm	127		146		146		156	149		267		225	
Minimum anchor spacing	s _{min}	mm	64		70		60		89	76		127		102	
	for c >	mm	92		105		89		121	108		241		197	
Minimum hole depth in concrete	h _o	mm	67		67		102		98	121		117		146	
Min. edge distance	1, 2 or 3		1												D.5.4c
Concrete material resistance factor for concrete	Φ _c		0.65												8.4.2
Steel embedment material resistance factor for reinforcement	Φ _s		0.85												8.4.3
Strength reduction factor for tension, steel failure modes	R		0.80												D.5.4a
Strength reduction factor for shear, steel failure modes	R		0.75												D.5.4a
Strength reduction factor for tension, concrete failure modes	R	Cond. A	1.15												D.5.4c
	R	Cond. B	1.00												D.5.4c
Strength reduction factor for shear, concrete failure modes	R	Cond. A	1.15												D.5.4c
	R	Cond. B	1.00												D.5.4c
Yield strength of anchor steel	f _y	MPa	690		585			585			585				
Ultimate strength of anchor steel	f _{ut}	MPa	862		731			731			731				
Effective cross-sectional area	A _{se}	mm ²	33.6		65.0			104.6			152.8				
Coefficient for factored concrete breakout resistance in tension	k		7												D.6.2.6
Modification factor for resistance in tension to account for uncracked concrete	ψ _{c,N}		1.4												D.6.2.6
Factored Steel Resistance in tension	N _{sr}	kN	19.7		32.3			52.0			76.0			D.6.1.2	
Factored Steel Resistance in shear	V _{sr}	kN	10.2		18.2			29.9			45.2			D.7.1.2c	
Factored Steel Resistance in shear, seismic	V _{sr, seismic}	kN	6.4		18.2			29.9			40.4				
Factored Steel Resistance in shear, concrete on metal deck	V _{sr, deck}	kN	6.0		8.5		14.0		13.0	17.1		Not Permitted			
Factored pullout resistance in 20 MPa uncracked concrete	N _{pr, uncr}	kN	7.8		N/A		17.1		N/A	28.4		25.7		33.2	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete	N _{pr, cr}	kN	7.1		N/A		15.3		N/A		N/A			D.6.3.2	
20 MPa cracked concrete	N _{pr, deck cr}	kN	4.5		4.5		8.1		6.2	14.4		Not Permitted		D.6.3.2	

1 For more information, please visit www.hilti.ca and navigate Service/Downloads, then Technical Downloads and open the Limit States Design Guide.

KWIK Bolt TZ Expansion Anchor 3.3.4

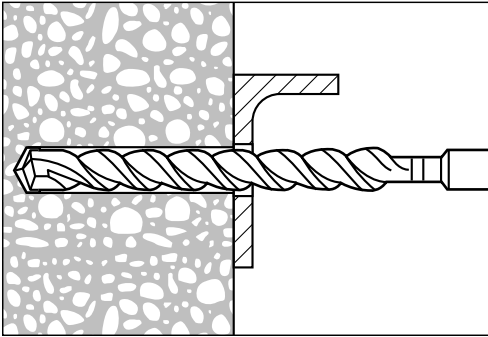
TABLE 13 - KWIK Bolt RTZ Design Information in accordance with CSA A23.3-04 Annex D¹


Design Parameter	Symbol	Units	Nominal anchor diameter												Ref.
			3/8		1/2				5/8			3/4			A23.3-04
Anchor O.D.	d _o	mm	9.5		12.7				15.9			19.1			
		(in.)	0.375		0.5				0.625			0.75			
Effective min. embedment depth	h _{ef, min}	mm	51		51		83		79	102		95		121	
		(in.)	2		2		3-1/4		3-1/8	4		3-3/4		4-3/4	
Min. member thickness	h _{min}	mm	102	127	102	152	152	203	127	152	203	152	203	203	
Critical edge distance	c _{ac}	mm	111	98	140	114	191	152	178	225	152	254	178	229	
Minimum edge distance	c _{ac}	mm	64		73		54		83	60		108		102	
	for s >	mm	127		146		133		140	140		254		216	
Minimum anchor spacing	s _{min}	mm	57		73		51		70	60		127		102	
	for c >	mm	89		114		83		105	108		241		178	
Minimum hole depth in concrete	h _o	mm	67		67		102		98	121		117		146	
Anchor category	1, 2 or 3		1												D.5.4c
Concrete material resis- tance factor for concrete	ϕ _c		0.65												8.4.2
Steel embedment mate- rial resistance factor for reinforcement	ϕ _s		0.85												8.4.3
Strength reduction factor for tension, steel failure modes	R		0.80												D.5.4a
Strength reduction factor for shear, steel failure modes	R		0.75												D.5.4a
Strength reduction factor for tension, concrete failure modes	R	Cond. A	1.15												D.5.4c
	R	Cond. B	1.00												D.5.4c
Strength reduction factor for shear, concrete failure modes	R	Cond. A	1.15												D.5.4c
	R	Cond. B	1.00												D.5.4c
Yield strength of anchor steel	f _y	MPa	634		634				634			525			
Ultimate strength of anchor steel	f _{ut}	MPa	793		793				793			700			
Effective cross-sectional area	A _{se}	mm ²	33.6		65.0				104.6			152.8			
Coefficient for factored concrete breakout resistance in tension	k		7		10		7		7			10		7	D.6.2.6
Modification factor for resistance in tension to account for uncracked concrete	ψ _{c,N}		1.40		1.00		1.40		1.40			1.00		1.40	D.6.2.6
Factored Steel Resistance in tension	N _{sr}	kN	18.1		35.1				56.4			72.7			D.6.1.2
Factored Steel Resistance in shear	V _{sr}	kN	13.8		19.5				33.6			56.9			D.7.1.2c
Factored Steel Resistance in shear, seismic	V _{sr, seismic}	kN	8.0		19.5				33.6			41.4			
Factored pullout resistance in 20 MPa uncracked concrete	N _{pr, cr}	kN	8.2		N/A		17.9		N/A			N/A		37.4	D.6.3.2
Factored pullout resistance in 20 MPa cracked concrete	N _{pr, cr}	kN	7.3		9.9		N/A		N/A	18.1		25.2	N/A		D.6.3.2

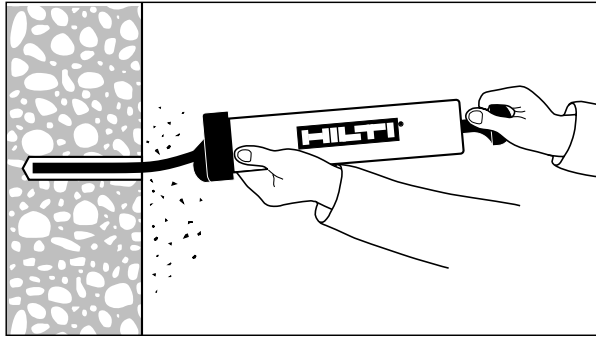
1 For more information, please visit www.hilti.ca and navigate Service/Downloads, then Technical Downloads and open the Limit States Design Guide.

3.3.4 KWIK Bolt TZ Expansion Anchor

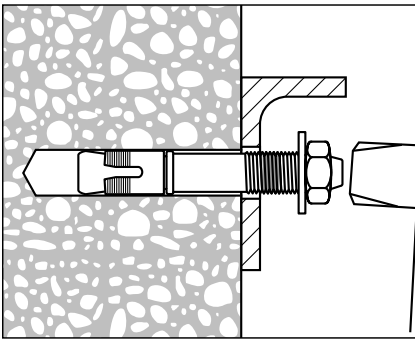
3.3.4.4 KWIK Bolt TZ Anchor Installation Instructions into normal-weight and lightweight concrete



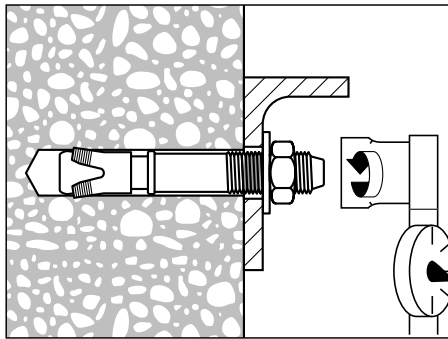
1. Hammer drill a hole to the same nominal diameter as the KWIK Bolt TZ. The minimum hole depth must conform with the instructions for use adhered to the packaging and the ICC-ES evaluation report, if applicable. The fixture may be used as a drilling template to ensure proper anchor location.



2. Clean hole.



3. Drive the KWIK Bolt TZ into the hole using a hammer. The anchor must be driven until at least 4 threads are below the surface of the fixture.



4. Tighten the nut to the installation torque.

KWIK Bolt TZ Expansion Anchor 3.3.4

3.3.4.5 KWIK Bolt TZ Anchor Ordering Information

Description	Length (in.)	Threaded Length (in.)	Box Quantity
KB-TZ 3/8x3	3	7/8	50
KB-TZ 3/8x3-3/4	3-3/4	1-5/8	50
KB-TZ 3/8x5	5	2-7/8	50
KB-TZ 1/2x3-3/4	3-3/4	1-5/8	20
KB-TZ 1/2x4-1/2	4-1/2	2-3/8	20
KB-TZ 1/2x5-1/2	5-1/2	3-3/8	20
KB-TZ 1/2x7	7	4-7/8	20
KB-TZ 5/8x4-3/4	4-3/4	1-1/2	15
KB-TZ 5/8x6	6	2-3/4	15
KB-TZ 5/8x8-1/2	8-1/2	5-1/4	15
KB-TZ 5/8x10	10	6-3/4	15
KB-TZ 3/4x5-1/2	5 1/2	1-1/2	10
KB-TZ 3/4x8	8	4	10
KB-TZ 3/4x10	10	6	10
KB-TZ SS304 3/8x3	3	7/8	50
KB-TZ SS304 3/8x3-3/4	3-3/4	1-5/8	50
KB-TZ SS304 3/8x5	5	2-7/8	50
KB-TZ SS304 1/2x3-3/4	3-3/4	1-5/8	20
KB-TZ SS304 1/2x4-1/2	4-1/2	2-3/8	20
KB-TZ SS304 1/2x5-1/2	5-1/2	3-3/8	20
KB-TZ SS304 1/2x7	7	4-7/8	20
KB-TZ SS304 5/8x4-3/4	4-3/4	1-1/2	15
KB-TZ SS304 5/8x6	6	2-3/4	15
KB-TZ SS304 5/8x8-1/2	8-1/2	5-1/4	15
KB-TZ SS304 5/8x10	10	6-3/4	15
KB-TZ SS304 3/4x5-1/2	5-1/2	1-1/2	10
KB-TZ SS304 3/4x8	8	4	10
KB-TZ SS304 3/4x10	10	6	10
KB-TZ SS316 3/8x3	3	7/8	50
KB-TZ SS316 3/8x3-3/4	3-3/4	1-5/8	50
KB-TZ SS316 1/2x3-3/4	3-3/4	1-5/8	20
KB-TZ SS316 1/2x4-1/2	4-1/2	2-3/8	20
KB-TZ SS316 1/2x5-1/2	5-1/2	3-3/8	20
KB-TZ SS316 5/8x4-3/4	4-3/4	1-1/2	15
KB-TZ SS316 5/8x6	6	2-3/4	15
KB-TZ SS316 3/4x5-1/2	5-1/2	1-1/2	10
KB-TZ SS316 3/4x10	10	6	10

3.3.5 KWIK HUS-EZ (KH-EZ) Carbon Steel Screw Anchor

3.3.5.1 Product Description

3.3.5.2 Material Specifications

3.3.5.3 Technical Data

3.3.5.4 Installation Instructions

3.3.5.5 Ordering Information

3.3.5.1 Product Description

Hilti KWIK HUS-EZ (KH-EZ) anchors are comprised of a body with hex washer head. The anchor is manufactured from carbon steel and is heat treated. It has a minimum 0.0003 inch (8 μ m) zinc coating in accordance with DIN EN ISO 4042. The KWIK HUS-EZ (KH-EZ) system is available in a variety of lengths with diameters of 1/4 inch, 3/8 inch, 1/2 inch, 5/8 inch and 3/4 inch (6.4mm, 9.5mm, 12.7mm, 15.9mm and 19.1mm). The hex head is larger than the diameter of the anchor and is formed with serrations on the underside. The anchor body is formed with threads running most of the length of the anchor body. The anchor is installed in a predrilled hole with a powered impact wrench or torque wrench. The anchor threads cut into the concrete on the sides of the hole and interlock with the base material during installation. Applicable base materials include normal-weight concrete, structural lightweight concrete, lightweight concrete over metal deck, and grout filled concrete masonry.

Guide Specifications

Screw anchors shall be KWIK HUS-EZ as supplied by Hilti, Inc. Anchors shall be manufactured from heat treated carbon steel material, zinc plated to a minimum thickness of 8 μ m. Anchor head shall display name of manufacturer, product name, diameter and length. Anchors shall be installed using a drill bit of same nominal diameter as anchor.

Product Features

- Suitable for cracked and uncracked normal weight and lightweight concrete, and grout filled concrete masonry.
- Suitable for seismic and nonseismic loads.
- Quick and easy to install.

- Length and diameter identification clearly stamped on head facilitates quality control and inspection after installation.
- Through fixture installation improves productivity and accurate installation.
- Thread design enables quality setting and exceptional load values in wide variety of base material strengths.
- Anchor is fully removable
- Anchor size is same as drill bit size and uses standard diameter drill bits.
- Suitable for reduced edge distances and spacing.

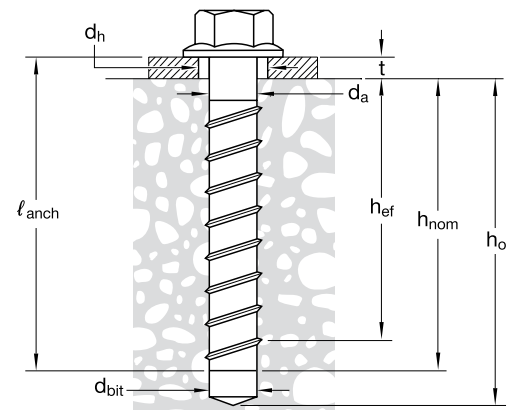
3.3.5.2 Material Specifications

Hilti KWIK HUS-EZ anchors are manufactured from carbon steel. The anchors are bright zinc plated to a minimum thickness of 8 μ m.

3.3.5.3 Technical Data

The data contained in Tables 1-5 of this section have been evaluated in accordance with AC 193. For more detail, see ICC-ES ESR 3027.

Figure 1 — KWIK HUS-EZ anchor installation details



Listings/Approvals

ICC-ES (International Code Council)
ESR-3027
(Cracked & Uncracked Concrete)
AC 106 ESR Pending
(Grout filled concrete masonry)
City of Los Angeles
Research Report No. 25897

Independent Code Evaluation

IBC® / IRC® 2009 (AC 193 / ACI 355.2)
IBC® / IRC® 2006 (AC 193 / ACI 355.2)
IBC® / IRC® 2003 (AC 193 / ACI 355.2)

KWIK HUS-EZ (KH-EZ) Carbon Steel Screw Anchor 3.3.5

Table 1 — KWIK HUS-EZ Specification Table^{1,2,3}

Characteristic	Symbol	Units	Nominal Anchor Diameter (inches)											
			1/4	3/8	1/2	5/8	3/4							
Nominal Diameter	d_a	in.	1/4	3/8	1/2	5/8	3/4							
Drill Bit Diameter	d_{bit}	in.	1/4	3/8	1/2	5/8	3/4							
Baseplate Clearance Hole Diameter	d_h	in.	3/8	1/2	5/8	3/4	7/8							
Installation Torque ⁴	T_{inst}	ft-lbf	18	40	45	85	115							
Impact Wrench Torque Rating ³	T_{impact}	ft-lbf	114	137	114	450	137	450	450	450				
Nominal Embedment depth	h_{nom}	in.	1-5/8	2-1/2	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 Depth	h_{ef}	in.	1.18	1.92	1.11	1.86	2.50	1.50	2.16	3.22	2.39	3.88	2.92	4.84
Minimum Hole Depth	h_o	in.	2	2-7/8	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 ²	c_{ac}	in.	2.00	2.78	2.10	2.92	3.75	2.75	3.75	5.25	3.63	5.81	4.41	7.28
Minimum Spacing at critical edge Distance	$s_{min,cac}$	in.	1.50	2.25	3	4								
Minimum Edge Distance ²	c_{min}	in.	1.50	1.75										
Minimum Spacing at Minimum Edge Distance	s_{min}	in.	3	4										
Minimum Concrete Thickness	h_{min}	in.	3.25	4.125	3.25	4	4.875	4.5	4.75	6.75	5	7	6	8.125
Wrench socket size	-	in.	7/16	9/16	3/4	15/16	1-1/8							
Head height	-	in.	0.24	0.35	0.49	0.57	0.70							
Effective tensile stress area	A_{se}	in. ²	0.045	0.086	0.161	0.268	0.392							
Minimum specified ultimate strength	f_{uta}	psi	134,000	106,225	120,300	112,540	90,180	81,600						

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 Pa, 1 in² = 645 mm², 1 lb/in = 0.175 N/mm

- The data presented in this table is to be used in conjunction with the design criteria of ACI 318 Appendix D.
- For installations through the soffit of steel deck into concrete (see Figure 2) anchors installed in the lower flute may be installed with a maximum 1 inch offset in either direction from the center of the flute.
- 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.
- $T_{inst,max}$ applies to installations using a calibrated torque wrench.

3.3.5 KWIK HUS-EZ (KH-EZ) Carbon Steel Screw Anchor

Table 2 — KWIK HUS EZ (KH EZ) Tension Strength Design Information^{1,2,3,4,5}

Characteristic	Symbol	Units	Nominal Anchor Diameter(inches)											
			1/4	3/8			1/2		5/8		3/4			
Anchor Category 1,2 or 3			1											
Nominal Embedment Depth	h_{nom}	in.	1-5/8	2-1/2	1-5/8	2-1/2	3-1/4	2-1/4	3	4-1/4	3-1/4	5	4	6-1/4
Steel Strength in Tension (ACI 318 D 5.1) ⁶														
Tension Resistance of Steel	N_{sa}	lb.	6070	9125	10335		18120			24210		32013		
Reduction Factor for Steel Strength ²	Φ_{sa}	-	0.65											
Concrete Breakout Strength in Tension (ACI 318 D.5.2)														
Effective Embedment Depth	h_{ef}	in.	1.18	1.92	1.11	1.86	2.50	1.52	2.16	3.22	2.39	3.88	2.92	4.84
Critical Edge Distance	c_{ac}	in.	2.00	2.78	2.10	2.92	3.74	2.75	3.67	5.25	3.63	5.82	4.81	7.28
Effectiveness Factor — Uncracked Concrete	k_{uncr}	-	24					27						
Effectiveness Factor — Cracked Concrete	k_{cr}	-	17											
Modification factor for cracked and uncracked concrete ⁵	$\Psi_{c,N}$	-	1.0											
Reduction Factor for Concrete Breakout Strength ²	Φ_{cb}	-	0.65 (Condition B)											
Pullout Strength in Tension (Non Seismic Applications) (ACI318 D.5.3)														
Characteristic pullout strength, uncracked concrete (2,500psi)	$N_{p,uncr}$	lb.	1305 ⁴	2348 ⁴	N/A									
Characteristic pullout strength, cracked concrete (2500 psi)	$N_{p,cr}$	lb.	632 ⁴	1166 ⁴	728 ⁴	N/A								
Reduction factor for pullout strength ²	Φ_p	-	0.65 (Condition B)											
Pullout Strength in Tension (Seismic Applications) (ACI 318 D.5.3)														
Characteristic Pullout Strength, Seismic (2,500 psi)	N_{eq}	lb.	632 ⁴	1166 ⁴	728 ⁴	N/A								
Reduction Factor for Pullout Strength ² (2,500 psi)	Φ_{eq}	-	0.65 (Condition B)											
Axial Stiffness in Service Load Range														
Uncracked Concrete	β_{uncr}	lb/in.	760,000											
Cracked Concrete	β_{cr}		293,000											

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 Pa, 1 in² = 645 mm², 1 lb/in = 0.175 N/mm

- 1 The data in this table is intended for use with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations the additional requirements of D.3.3 shall apply.
- 2 Values of Φ in this table apply when the load combinations for ACI 318 Section 9.2, IBC Section 1605.2.1 are used and the requirements of ACI 318 D.4.4 for Condition B are met. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be used. For situations where reinforcement meets the requirements of Condition A, ACI 318 Section D.4.4 provides the appropriate ϕ factor.
- 3 N/A denotes that pullout resistance does not govern and does not need to be considered.
- 4 The characteristic pullout resistance for concrete compressive strengths greater than 2500 psi may be increased by multiplying the value in the table by $(f'_c/2,500)^{1/2}$ for psi or $(f'_c/17.2)^{1/2}$ for MPa.
- 5 For sand-lightweight concrete, multiply concrete capacity values and pullout values by 0.60.

KWIK HUS-EZ (KH-EZ) Carbon Steel Screw Anchor 3.3.5

Table 3 — KWIK HUS EZ (KH EZ) Shear Strength Design Information^{1,2,3,4,5}

Characteristic	Symbol	Units	Nominal Anchor Diameter (inches)											
			1/4	3/8			1/2			5/8		3/4		
Anchor Category	1,2 or 3	1												
Embedment Depth	h_{nom}	in.	1-5/8	2-1/2	1-5/8	2-1/2	3-1/4	2-1/4	3	4-1/4	3-1/4	5	4	6-1/4
Steel Strength in Shear (ACI 318 D 6.1) ^{4, 5}														
Shear Resistance of Steel — Static	V_{sa}	lb.	1548		4057	5185			9245			11221		16662
Shear Resistance of Steel — Seismic	V_{eq}	lb.	1393		2524	3111			5547			6733		11556
Reduction Factor for Steel Strength	Φ_{sa}	-	0.60											
Concrete Breakout Strength in Shear (ACI 318 D.6.2)														
Nominal Diameter	d_a	in.	0.250		0.375			0.500			0.625		0.750	
Load Bearing Length of Anchor	ℓ_e	in.	1.18	1.92	1.11	1.86	2.50	1.52	2.16	3.22	2.39	3.88	2.92	4.84
Reduction Factor for Concrete Breakout Strength	Φ_{cb}	-	0.70											
Concrete Pryout Strength in Shear (ACI 318 D.6.3)														
Coefficient for Pryout Strength	k_{cp}	1.0					2.0	1.0		2.0	1.0	2.0		
Reduction Factor for Pryout Strength	Φ_{cp}	-	0.70											

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 Pa, 1 in² = 645 mm², 1 lb/in = 0.175 N/mm

- The data in this table is intended for use with the design provisions of ACI 318 Appendix D
- Values of Φ in this table apply when the load combinations for ACI 318 Section 9.2, IBC Section 1605.2.1 are used and the requirements of ACI 318 D.4.4 for Condition B are met. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be used. For situations where reinforcement meets the requirements of Condition A, ACI 318 D.4.4 provides the appropriate Φ factor.
- Reported values for steel strength in shear are based on test results per ACI 355.2, Section 9.4 and must be used for design in lieu of calculated results using equation D-20 of ACI 318.
- The KWIK HUS-EZ (KH-EZ) is considered a brittle steel element as defined by ACI 318 D.1.
- For sand-lightweight concrete, multiply concrete breakout and concrete pryout values by 0.60.

3.3.5 KWIK HUS-EZ (KH-EZ) Carbon Steel Screw Anchor

Table 4 – KWIK HUS-EZ (KH-EZ) Tension and Shear Design Data for Installation in the Underside of Concrete-Filled Profile Steel Deck Assemblies^{1,2,3,4,5}

Characteristic	Symbol	Units	Lower Flute											Upper Flute				
			Anchor Diameter															
			1/4		3/8			1/2			5/8		3/4	1/4		3/8		1/2
Embedment	h_{nom}	in.	1-5/8	2-1/2	1-5/8	2-1/2	3-1/4	2-1/4	3	4-1/4	3-1/4	5	4	1-5/8	2-1/2	1-5/8	2-1/2	2-1/4
Minimum Hole Depth	h_{hole}	in.	2	2-7/8	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	2	2-7/8	1-7/8	2-7/8	2-5/8
Effective Embedment Depth	h_{ef}	in.	1.18	1.92	1.11	1.86	2.50	1.52	2.16	3.22	2.39	3.88	2.92	1.18	1.92	1.11	1.86	1.52
Pullout Resistance, (uncracked concrete)	$N_{p,deck,uncr}$	lb.	1210	1875	1285	2240	3920	1305	3060	5360	4180	9495	4180	1490	1960	1015	2920	1395
Pullout Resistance (cracked concrete and seismic loads)	$N_{p,deck,cr}$	lb.	860	1330	1120	1965	3430	925	2170	3795	3070	7385	2630	1055	1390	885	2560	985
Steel Strength in Shear	$V_{sa,deck}$	lb.	1205	2210	1670	1511	3605	1605	2922	3590	3470	4190	3762	1205	3265	3935	6090	7850
Steel Strength in Shear, Seismic	$V_{sa,deck,eq}$	lb.	1080	1988	935	905	2163	963	1750	2154	2082	2514	2609	1080	2937	2203	3650	4710

1 Installation must comply with Figure 2.

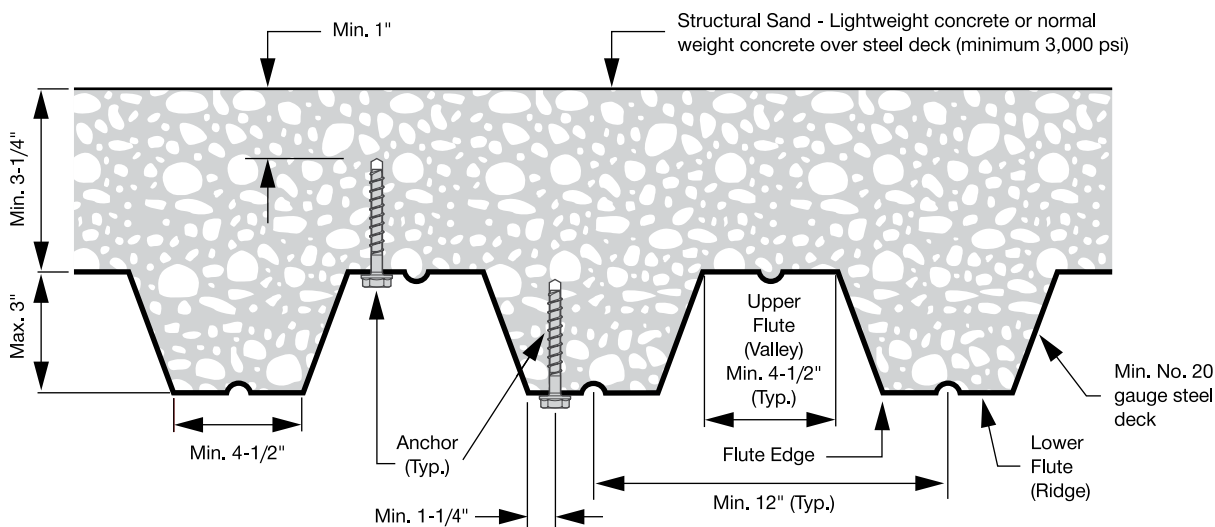
2 The values in this table are derived in accordance with ACI 318 Appendix D, Section D.5.3.2.

3 The values for ϕ_p in tension can be found in Table 2 of this report and the values for ϕ_{sa} in shear can be found in Table 3.

4 For installations through the soffit of steel deck into concrete (see Figure 2) anchors installed in the lower flute shall be installed with a maximum 1 inch offset in either direction from the centerline of the flute.

5 The characteristic pullout resistance for concrete compressive strengths greater than 3,000 psi may be increased by multiplying the value in the table by $(f'_c/3,000)^{1/2}$ for psi or $(f'_c/20.7)^{1/2}$ for MPa.

Figure 2 – Installation of KWIK HUS-EZ (KH-EZ) 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.

KWIK HUS-EZ (KH-EZ) Carbon Steel Screw Anchor 3.3.5

Table 5 – KWIK HUS-EZ (KH-EZ) Allowable Stress Design Values for Illustrative Purposes^{1,2,3,4,5,6,7,8,9,12}

Nominal Anchor Diameter [in.]	Embedment Depth, h_{nom} [in.]	Effective Embedment Depth, h_{ef} [in.]	Allowable Tension Load ¹⁰ [lbs]	Allowable Shear Load ¹¹ [lbs]
1/4	1 5/8	1.18	589	645
	2-1/2	1.92	1060	645
3/8	1-5/8	1.11	633	682
	2-1/2	1.86	1374	1480
	3-1/4	2.50	2141	2160
1/2	2-1/4	1.52	1142	1230
	3	2.16	1934	2083
	4-1/4	3.22	3521	3852
5/8	3-1/4	2.39	2252	2425
	5	3.88	4657	4675
3/4	4	2.92	3041	6549
	6-1/4	4.84	6489	6943

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N.

- 1 Single anchor with static tension or shear load only.
- 2 Concrete determined to remain uncracked for the life of the anchorage.
- 3 Load combinations are taken from ACI 318 Section 9.2 (no seismic loading).
- 4 40% dead load and 60% live load, controlling load combination $1.2D + 1.6L$.
- 5 Calculation of weighted average for conversion factor $\alpha = 1.2(0.4) + 1.6(0.6) = 1.44$.
- 6 $f'_c = 2,500$ psi (normal weight concrete).
- 7 $c_{a1} = c_{a2} \geq c_{ac}$, see Table 1.
- 8 $h \geq h_{min}$, see Table 1.
- 9 Values are for Condition B where supplementary reinforcement in accordance with ACI 318 D.4.4 is not provided.
- 10 Allowable Tension Load = factored Load (Lessor of N_p or Concrete Breakout from Table 2) $\div 1.44$
- 11 Allowable Shear Load = factored Load (Lessor of V_{sa} or Concrete Pryout from Table 3) $\div 1.44$
- 12 Values are for single anchors installed without influence of base material edge distance or adjacent anchors.

3.3.5 KWIK HUS-EZ (KH-EZ) Carbon Steel Screw Anchor

Table 6 – Allowable Tension Loads for KWIK HUS-EZ Installed in Grout-Filled Masonry Walls (lb)^{1,2,7,8}

Anchor Diameter (inches)	Embedment (inches) ³	Loads @ C _{cr} and S _{cr}	Spacing			Edge Distance		
			Critical - S _{cr} (inches) ⁴	Minimum - S _{min} (inches) ⁴	Load Reduction Factor at S _{min} ⁶	Critical - C _{cr} (inches) ⁵	Minimum C _{min} (inches) ⁵	Load Reduction Factor ⁶
1/4	1 5/8	530	4	2	0.70	4	4	1.00
	2 1/2	910		4	1.00			
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	1210						
1/2	2 1/4	710	4	2	0.60	4	4	1.00
	3	1110	8	4				
	4 1/4	1515						
5/8	3 1/4	1155	10	4	0.60	10	4	1.00
	5	1735						
3/4	4	1680	12	4	0.60	12	4	1.00
	6 1/4	2035						

Table 7 – Allowable Shear Loads for KWIK HUS-EZ Installed in Grout-Filled Masonry Walls (lb)^{1,2,7,8}

Anchor Diameter (inches)	Embedment (inches) ³	Load at C _{cr} and S _{cr}	Spacing			Edge Distance			
			Critical - S _{cr} (inches) ⁴	Minimum - S _{min} (inches) ⁴	Load Reduction Factor at S _{min} ⁶	Critical - C _{cr} (inches) ⁵	Minimum - C _{min} (inches) ⁵	Load Reduction Factor at C _{min}	
								Load Direction Perpendicular to Edge	Load Direction Parallel to Edge
1/4	1 5/8	675	4	4	1.00	4	4	1.00	1.00
	2 1/2	840						1.00	1.00
3/8	1 5/8	1140	6	4	0.94	6	4	0.61	1.00
	2 1/2	1165						0.70	1.00
	3 1/4	1190						0.70	1.00
1/2	2 1/4	1845	8	4	0.88	8	4	0.50	1.00
	3	2055						0.45	0.94
	4 1/4	2745						0.40	0.89
5/8	3 1/4	3040	10	4	0.36	10	4	0.36	0.82
	5	3485						0.34	0.92
3/4	4	3040	10	4	0.36	12	4	0.36	0.82
	6 1/4	3485						0.34	0.92

- All values are for anchors installed in fully grouted masonry with minimum masonry prism strength of 1500psi. Concrete masonry units shall be light-weight or normal-weight.
- Anchors may not be installed within one inch in any direction of a vertical joint.
- Embedment depth is measured from the outside face of the concrete masonry embedment.
- S_{cr} is anchor spacing where full load values in the Table may be used. 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.
- C_{cr} is the edge distance where full load values in the table may be used. 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.
- 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).
- 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.
- For combined loading: For 1/4" diameter - $\frac{T_{\text{applied}}}{T_{\text{allowable}}} + \frac{V_{\text{applied}}}{V_{\text{allowable}}} \leq 1$ For 3/8" - 3/4" diameter - $\left(\frac{T_{\text{applied}}}{T_{\text{allowable}}}\right)^{5/3} + \left(\frac{V_{\text{applied}}}{V_{\text{allowable}}}\right)^{5/3} \leq 1$

KWIK HUS-EZ (KH-EZ) Carbon Steel Screw Anchor 3.3.5

Table 8 – KWIK HUS-EZ Allowable Loads Installed In Top of Grout-Filled Concrete Masonry Construction (lb)

Anchor Diameter (inches)	Minimum Embedment Depth (inches) ²	Minimum Edge Distance (inches)	Minimum Spacing (inches)	Minimum End Distance (inches)	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	1110
5/8	5	1 3/4	10	5	1310	305	1165

1 All values are for anchors installed in fully grouted masonry with minimum masonry prism strength of 1500psi. Concrete masonry units shall be light-weight or normal-weight.

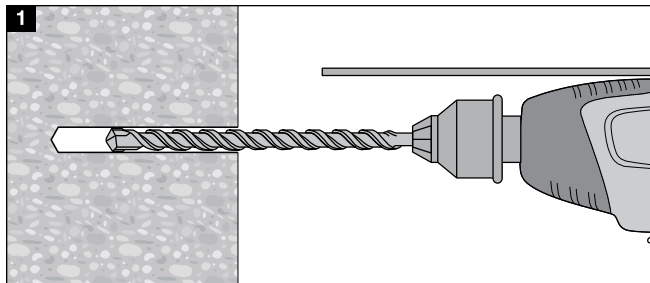
2 Embedment depth is measured from the top of the masonry construction.

3 For combined loading: For 1/4" diameter - $\frac{T_{\text{applied}}}{T_{\text{allowable}}} + \frac{V_{\text{applied}}}{V_{\text{allowable}}} \leq 1$ For 3/8" - 3/4" diameter - $\left(\frac{T_{\text{applied}}}{T_{\text{allowable}}}\right)^{5/3} + \left(\frac{V_{\text{applied}}}{V_{\text{allowable}}}\right)^{5/3} \leq 1$

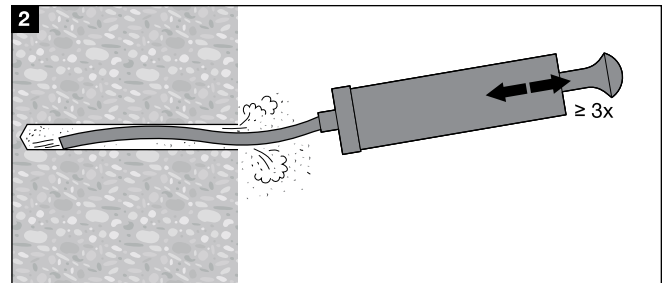
3.3.5.4 Installation Instructions

Drill holes in base material using carbide-tipped masonry drill bits complying with ANSI B212.15-1994. The nominal drill bit diameter must be equal to that of the anchor. The minimum drilled hole depth is given in Table 1. Prior to installation, dust and debris must be removed from the drilled hole using a hand pump, compressed air or a vacuum. The anchor must be installed into the predrilled hole using a powered impact wrench or installed with a torque wrench until the proper nominal embedment depth is obtained. The impact wrench

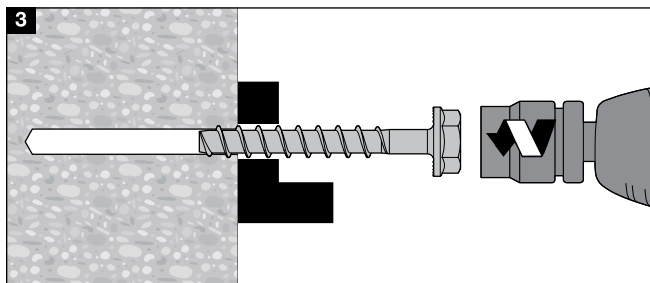
torque, T_{impact} and installation torque, T_{inst} for the manual torque wrench must be in accordance with Table 1. The KWIK HUS-EZ (KH-EZ) may be loosened by a maximum of one turn and reinstalled with a socket wrench or powered impact wrench to facilitate fixture attachment or realignment. For member thickness and edge distance restrictions for installations into the soffit of concrete on steel deck assemblies, see Figure 2.



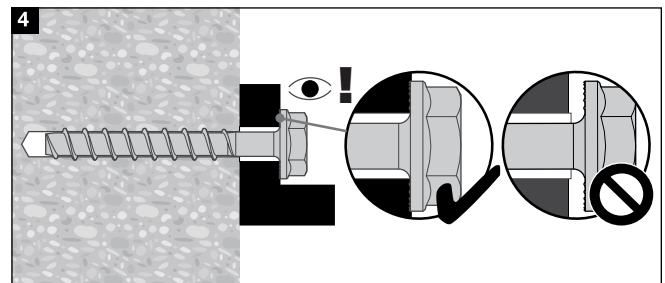
1 Drill hole in base material using proper diameter drill bit.



2 Clean drilled hole to remove debris.



3 Fasten anchor tightly against fastened part.



4 Install anchor using proper impact tool or torque wrench.

3.3.5.5 KWIK HUS-EZ (KH-EZ) Carbon Steel Screw Anchor

The data below is developed from testing performed in accordance with ACI 355.2. It is intended for applications designed according to CSA A23.3-04 Update No. 3 (August 2009) Design Of Concrete Structures Annex D and is generally suitable for the conditions described in the introduction of Annex D.

Table 9 — KWIK HUS-EZ Design Information (For use with CSA A23.3-04)



Characteristic	Symbol	Units	Nominal Anchor Diameter(inches)												Code Ref.	
			1/4		3/8			1/2			5/8		3/4			
Anchor Category 1,2 or 3			1													
Nominal Embedment Depth	h_{nom}	mm	41	64	41	64	83	57	76	108	83	127	102	159		
Concrete material resistance factor for concrete	Φ_c	-	0.65												8.4.2	
Steel material resistance factor	Φ_s	-	0.85												8.4.3	
Ultimate strength of anchor steel	f_{ut}	MPa	924		732		829		776			622		563		
Effective cross-sectional area of anchor	A_{se}	mm ²	29.0		55.5			103.9			172.9		252.9			
Minimum Edge Distance	c_{min}	mm	38						44							
Minimum Spacing	s_{min}	mm	76										102			
Minimum Concrete Thickness	h_{min}	mm	83	102	83	102	121	114	140	171	127	178	152	203		
Steel Strength in Tension (CSA A23.3 D.6.1) ²																
Factored Steel Resistance in tension	N_{sr}	kN	14.9		24.2		27.4		48.0			64.0		84.7		D.6.1.2
Reduction Factor for Steel Strength	R	-		0.70											D.5.4b	
Concrete Breakout Strength in Tension (CSA A23.3 D.6.2)																
Effective Embedment Depth	h_{ef}	mm	30	49	28	47	64	39	55	82	61	99	74	123		
Critical Edge Distance	c_{ac}	mm	51	71	53	74	95	70	93	133	92	148	112	185		
Effectiveness Factor — Uncracked Concrete	k_{unscr}	-	10												D.6.2.2	
Effectiveness Factor — Cracked Concrete	k_{cr}	-	7													
Modification factor for resistance in tension to account for uncracked concrete	$\Psi_{c,N}$	-	1.4												D.6.2.6	
Reduction Factor for Concrete Breakout Strength	R	-	1.15 (Condition A), 1.00 (Condition B)												D.5.4c	

KWIK HUS-EZ (KH-EZ) Carbon Steel Screw Anchor 3.3.5.5

Table 9 (Continued)



Characteristic	Symbol	Units	Nominal Anchor Diameter(inches)												Code Ref.
			1/4	3/8			1/2			5/8		3/4			
Anchor Category 1,2 or 3			1												
Nominal Embedment Depth	h_{nom}	mm	41	64	41	64	83	57	76	108	83	127	102	159	
Pullout Strength in Tension — Non Seismic Applications (CSA A23.3 D.6.3) ¹															
Factored Pullout Resistance, uncracked concrete (20 MPa)	$N_{pr,uncr}$	kN	4.1	7.3	N/A									D.6.3.2	
Factored Pullout Resistance, cracked concrete (20 MPa)	$N_{pr,cr}$	kN	2.0	3.6	2.3	N/A								D.6.3.2	
Reduction Factor for pullout strength	R	-	1.15 (Condition A), 1.00 (Condition B)												
Pullout Strength in Tension — Seismic Applications (CSA A23.3 D.6.3) ¹															
Factored Pullout Resistance, Seismic (20 MPa)	$N_{pr,seis}$	kN	2.0	3.6	2.3	N/A								D.6.3.2	
Reduction Factor for pullout strength	R	-	1.15 (Condition A), 1.00 (Condition B)												
Axial Stiffness in Service Load Range															
Uncracked Concrete	β_{uncr}	lb/in.	760000												
Cracked Concrete	β_{cr}	lb/in.	293000												
Steel Strength in Shear (CSA A23.3 D.7.1) ²															
Factored Shear Resistance of Steel – Static	V_{sr}	kN	3.8		11.1	12.7		22.7			27.6		40.9		D.7.1.2c
Factored Shear Resistance of Steel – Seismic	$V_{sr,seis}$	kN	3.4		6.2	7.6		13.6			16.5		28.4		D.7.1.2c
Reduction Factor for Steel Strength	R	-	0.65												D.5.4b
Concrete Breakout Strength in Shear (CSA A23.3 D.7.2)															
Nominal Diameter	d_o	mm	6.4		9.5			12.7			15.9		19.1		
Load Bearing Length of Anchor	ℓ_e	mm	49		28	47	64	39	55	82	61	99	74	123	
Reduction Factor for Concrete Breakout Strength	R			1.15 (Condition A), 1.00 (Condition B)											
Concrete Pryout Strength in Shear (CSA A23.3 D.7.3)															
Coefficient for Pryout Strength	k_{cp}		1.0				2.0	1.0		2.0	1.0	2.0			
Reduction Factor for Pryout Strength	R			1.15 (Condition A), 1.00 (Condition B)											

1 N/A denotes that pullout resistance does not govern and does not need to be considered.

2 The KWIK HUS-EZ (KH-EZ) is considered a brittle steel element as defined by CSA A23.3 D.2.

This table replaces Table 3 and Table 4 of this Supplement (and Table 3 and Table 4 of ESR-3027) for anchorage design in normal weight concrete in accordance with CSA A23.3-04.

3.3.5 KWIK HUS-EZ (KH-EZ) Carbon Steel Screw Anchor

3.3.5.6 Ordering Information

Order Information

Description	Hole Diameter	Total Length without Anchor Head	Minimum Embedment Depth	Qty (pcs) / Box
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"	2-1/2"	100
KH-EZ 1/4"x3"	1/4"	3"	2-1/2"	100
KH-EZ 1/4"x3-1/2"	1/4"	3-1/2"	2-1/2"	100
KH-EZ 1/4"x4"	1/4"	4"	2-1/2"	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 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 3/8"x4"	3/8"	4"	3-1/4"	50
KH-EZ 3/8"x5"	3/8"	5"	3-1/4"	30
KH-EZ 1/2"x2-1/2"	1/2"	2-1/2"	2-1/4"	30
KH-EZ 1/2"x3"	1/2"	3"	2-1/4"	30
KH-EZ 1/2"x3-1/2"	1/2"	3-1/2"	3"	25
KH-EZ 1/2"x4"	1/2"	4"	3"	25
KH-EZ 1/2"x4-1/2"	1/2"	4-1/2"	4 1/4"	25
KH-EZ 1/2"x5"	1/2"	5"	4 1/4"	25
KH-EZ 1/2"x6"	1/2"	6"	4-1/4"	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 5/8"x5-1/2"	5/8"	5-1/2"	3-1/4"	15
KH-EZ 5/8"x6-1/2"	5/8"	6-1/2"	3-1/4"	15
KH-EZ 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 3/4"x5-1/2"	3/4"	5-1/2"	4"	10
KH-EZ 3/4"x7"	3/4"	7"	4"	10
KH-EZ 3/4"x8"	3/4"	8"	4"	10
KH-EZ 3/4"x9"	3/4"	9"	4"	10

KWIK Bolt 3 Expansion Anchor 3.3.6

3.3.6.1 Product Description

The KWIK Bolt 3 (KB3) is a torque controlled expansion anchor, which provides consistent performance for a wide range of mechanical anchor applications. This anchor series is available in carbon steel with zinc electroplated coating, carbon steel with hot-dip galvanized coating, 304 stainless steel and 316 stainless steel versions. The threaded stud version of the anchor is available in a variety of diameters ranging from 1/4-in. to 1-in. depending on the steel and coating type. Applicable base materials include normal-weight concrete, structural lightweight concrete, lightweight concrete over metal deck, and grout filled concrete masonry.

Guide Specifications

Torque controlled expansion anchors shall be KWIK Bolt 3 supplied by Hilti meeting the description in Federal Specification A-A 1923A, Type 4. The anchor bears a length identification mark embossed into the impact section (dog point) of the anchor identifying the anchor as a Hilti KWIK Bolt 3 in the installed condition. Anchors are manufactured to meet one of the following conditions:

1. The carbon steel anchor body, nut and washer have an electroplated zinc coating conforming to ASTM B 633 to a minimum thickness of 5 µm.
2. The carbon steel hot-dip galvanized anchor body, nut, and washer conform to ASTM A 153. The stainless steel expansion elements conform to either type 304 or type 316.
3. The stainless steel anchor body, nut, and washer conform to type 304. The stainless steel expansion elements conform to either type 304 or type 316.
4. The stainless steel anchor body, nut, and washer conform to type 316. The stainless steel expansion elements conform to type 316.

Product Features

- Length identification code facilitates quality control and inspection after installation.
- Through fixture installation and variable thread lengths improve productivity and accommodate various base plate thicknesses.
- Raised impact section (Dog Point) prevents thread damage during installation.
- Anchor size is same as drill bit size for easy installation. For temporary applications anchors may be driven into drilled holes after usage.
- Mechanical expansion allows immediate load application.

Installation

Drill hole in concrete, structural lightweight concrete, or grout filled concrete masonry using a Hilti carbide tipped drill bit and a Hilti rotary hammer drill. Remove dust from the hole with oil free compressed air or vacuum. Alternately for 1/2-, 5/8-, 3/4- and 1-inch diameter KWIK Bolt 3 anchors, the hole may be drilled using a matched tolerance Hilti DD-C wet diamond core bit for anchoring applications. The slurry must be flushed from the diamond cored hole prior to anchor installation. The minimum hole depth must exceed the anchor embedment prior to torquing by at least by one hole diameter. Drive the anchor into the hole using a hammer. A minimum of six threads must be below the surface of the fixture. Tighten the nut to the installation torque.

3.3.6.1 Product Description

3.3.6.2 Material Specifications

3.3.6.3 Strength Design (LRFD)

3.3.6.4 Allowable Stress Design (ASD)

3.3.6.5 Installation Instructions

3.3.6.6 Ordering Information

Impact Section
(Dog Point)

Nut —

Washer —

Anchor
Thread —

Anchor
Body —

Expansion
Element —
(Wedges)

Expansion Cone

Listings/Approvals

ICC-ES (International Code Council)
ESR-2302

ICC-ES ESR-1385

Grout filled concrete masonry

City of Los Angeles

Research Report No. 25577

Research Report No. 25577M
for masonry

FM (Factory Mutual)

Pipe Hanger Components for
Automatic Sprinkler (3/8" - 3/4")

UL (Underwriters Laboratories)

UL 203 Pipe Hanger Equipment for Fire
Protection Services (3/8" - 3/4")

Miami-Dade County

NOA No. 06-0810.13

Qualified under an NQA-1 Nuclear
Quality Program



*Please refer to the reports to verify that the type and diameter specified is included

Independent Code Evaluation

IBC® / IRC® 2009

(AC 193 / ACI 355.2, AC 01)

IBC® / IRC® 2006

(AC 193 / ACI 355.2, AC 01)

IBC® / IRC® 2003

(AC 193 / ACI 355.2)

3.3.6 KWIK Bolt 3 Expansion Anchor

3.3.6.2 Material Properties

Carbon Steel with Electroplated Zinc

All Carbon Steel KWIK Bolt 3 and Rod Coupling Anchors, excluding the 3/4 x 12 and 1-inch diameter sizes, have the tensile bolt fracture loads shown in Table 5.

All carbon steel 3/4 x 12 and 1 inch diameter sizes and carbon steel countersunk KWIK Bolt 3 anchor bodies have mechanical properties as listed in Table 5.

Carbon steel anchor components plated in accordance with ASTM B633 to a minimum thickness of 5 µm.

Nuts conform to the requirements of ASTM A 563, Grade A, Hex.

Washers meet the requirements of ASTM F 844.

Expansion elements (wedges) are manufactured from carbon steel, except the following anchors have stainless steel wedges:

- All 1/4-inch diameter anchors
- KB3 3/4x12
- All 1-inch diameter anchors
- All countersunk KWIK Bolt 3

Carbon Steel with Hot-Dip Galvanized Coating

Anchor bodies manufactured from carbon steel have the tensile bolt fracture loads shown in Table 5.

Carbon steel anchor components hot-dip galvanized according to ASTM A 153, Class C (43 µm min.).

Nuts conform to the requirements of ASTM A 563, Grade A, Hex.

Washers meet the requirements of ASTM F 844.

Stainless steel expansion elements (wedges) are manufactured from either type 304 or type 316.

Stainless Steel

Anchor bodies smaller than 3/4-inch, excluding all Countersunk KWIK Bolt 3 anchors, are produced from type 304 or type 316 stainless steel having the bolt fracture loads shown in Table 5.

Anchor bodies 3/4-inch and larger, and all stainless steel Countersunk KWIK Bolt 3 anchor bodies, are produced from AISI 304 or 316 stainless steel having the mechanical properties shown in Table 5.

Nuts meet the dimensional requirements of ASTM F 594.

Washers meet the dimensional requirements of ANSI B18.22.1, Type A, plain.

Stainless steel expansion elements for type 304 anchors are made from either type 304 or type 316. Stainless steel expansion elements for type 316 anchors are made from type 316. All stainless steel nuts and washers for type 304 and type 316 anchors are manufactured from type 304 and type 316, respectively.

KWIK Bolt 3 Expansion Anchor 3.3.6

3.3.6.3 Strength Design (LRFD)

This section provides ACI 318 strength design information for the KWIK Bolt 3 used where the required post-installed anchor design must comply with the IBC 2003, IBC 2006 and IBC 2009. Testing was conducted in accordance with ACI 355.2 and ICC-ES AC193 in uncracked concrete. Engineering design based on this section is limited to uncracked concrete and seismic design categories A & B.

For more detailed information, please contact Hilti Technical Support. Note that the allowable load tables are not developed using the same safety factors as the allowable load Table 6 to 15 provided in the allowable load Section 4.3.5.4 of the 2008 Product Technical Guide and should not be interchanged. Edge distance and anchor spacing guidelines are specific for each design method. The installation torques for the 5/8-, 3/4- and 1-inch diameter anchors have been reduced in order to maintain reasonable spacing guidelines as developed in accordance with ACI 355.2.

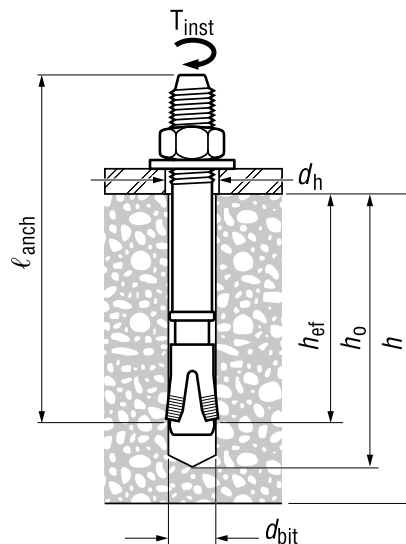


Figure 1 - KWIK Bolt 3 Installation

Table 1 - Installation Information Strength Design

Setting Information	Symbol	Units	Nominal anchor diameter							
			1/4	3/8	1/2	5/8	3/4	1		
Anchor O.D.	d_o	in. (mm)	0.25 (6.4)	0.375 (9.5)	0.5 (12.7)	0.625 (15.9)	0.75 (19.1)	1 (25.4)		
ANSI drill bit diameter	d_{bit}	in.	1/4	3/8	1/2	5/8	3/4	1		
Effective minimum embedment	h_{ef}	in. (mm)	1-1/2 (38)	2 (51)	2 (51)	3-1/4 (83)	3-1/8 (79)	4 (102)	3-3/4 (95)	5 (127)
Min hole depth	h_o	in. (mm)	2 (51)	2-5/8 (67)	2-5/8 (67)	4 (102)	3-7/8 (98)	4-3/4 (121)	4-1/2 (114)	5-3/4 (146)
Installation torque	T_{inst}	ft-lb (Nm)	4 (5)	20 (27)	40 (54)	60 (81)	110 (149)	150 (203)		
Expansion element clearance hole	d_h	in. (mm)	5/16 (7.9)	7/16 (11.1)	9/16 (14.3)	11/16 (17.5)	13/16 (20.6)	1-1/8 (28.6)		

3.3.6 KWIK Bolt 3 Expansion Anchor

Table 2 - Carbon Steel KB3 Strength Design

Design Information	Symbol	Units	Nominal anchor diameter												
			1/4	3/8		1/2			5/8			3/4			
Anchor O.D.	d _o	in. (mm)	0.25 (6.4)	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)		3-1/8 (79)	4 (102)		3-3/4 (95)		5 (127)
Min. member thickness	h _{min}	in. (mm)	4 (102)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	6 (152)	8 (203)	8 (203)
Critical edge distance	c _{cr}	in. (mm)	2-3/4 (70)	4-1/2 (114)	3-7/8 (98)	4-7/8 (124)	3-5/8 (92)	6-3/4 (171)	5-5/8 (143)	7-1/2 (191)	9-1/2 (241)	7-1/2 (191)	9-3/4 (248)	7-1/2 (191)	9-1/2 (241)
Min. edge distance	c _{min}	in. (mm)	1-3/8 (35)	2 (51)	1-1/2 (38)	2-1/8 (54)	2 (51)	1-5/8 (41)	1-5/8 (41)	2-1/4 (57)	1-3/4 (44)	1-3/4 (44)	2-3/4 (70)	2-5/8 (67)	2-1/2 (64)
	for s ≥	in. (mm)	1-3/4 (44)	2-7/8 (73)	3-1/2 (89)	4-7/8 (124)	4-3/4 (121)	4-1/4 (108)	4 (102)	5-1/4 (133)	4-3/4 (121)	4 (102)	6-7/8 (175)	6-1/2 (165)	6-3/8 (162)
Min. anchor spacing	s _{min}	in. (mm)	1-1/4 (32)	1-3/4 (44)	1-3/4 (44)	2-1/2 (64)	2-1/4 (57)	2 (51)	1-7/8 (48)	2-3/8 (60)	2-1/8 (54)	2-1/8 (54)	3-3/4 (95)	3-3/8 (86)	3-1/4 (83)
	for c ≥	in. (mm)	1-5/8 (41)	2-3/8 (60)	2-3/8 (60)	2-5/8 (67)	2-3/8 (60)	2-1/4 (57)	2 (51)	3-1/8 (79)	2-3/8 (60)	2-1/4 (57)	3-3/4 (95)	3-3/8 (86)	3-3/8 (86)
Min. hole depth in concrete	h ₀	in. (mm)	2 (51)	2-5/8 (67)		2-5/8 (67)		4 (102)		3-7/8 (98)	4-3/4 (121)		4-1/2 (114)		5-3/4 (146)
Min. specified yield strength	f _y	psi (N/mm ²)	84,800 (585)	84,800 (585)		84,800 (585)			84,800 (585)			84,800 (585)			
Min. specified ultimate strength	f _{ut}	psi (N/mm ²)	106,000 (731)	106,000 (731)		106,000 (731)			106,000 (731)			106,000 (731)			
Effective tensile stress area	A _{se}	in ² (mm ²)	0.02 (12.9)	0.06 (38.7)		0.11 (71.0)			0.17 (109.7)			0.24 (154.8)			
Steel strength in tension	N _s	lb (kN)	2,120 (9.4)	6,360 (28.3)		11,660 (51.9)			18,020 (80.2)			25,440 (113.2)			
Steel strength in shear	V _s	lb (kN)	1,640 (7.3)	4,470 (19.9)		6,635 (29.5)		6,750 (30.0)		12,230 (54.4)			15,660 (69.7)		16,594 (73.8)
Steel strength in shear, concrete on metal deck ³	V _{sa,deck}	lb (kN)		1,930 (8.6)		2,840 (12.6)		3,155 (14.0)		6,585 (29.3)			NP		
Pullout strength uncracked concrete ⁴	N _{p,uncr}	lb (kN)	1,575 (7.0)	NA		NA		6,800 (30.2)		NA			NA		10,585
Pullout strength concrete on metal deck ⁵	N _{p,deck,uncr}	lb (kN)	1,750 (7.8)	2,245 (10.0)		2,730 (12.1)			4,765 (21.2)			NP			
Anchor category ⁶	1, 2 or 3	-	1												
Effectiveness factor k _{uncr} uncracked concrete ⁷	k _{uncr}	-	24												
Installation torque	T _{inst}	ft-lb (Nm)	4 (5)	20 (27)		40 (54)			60 (81)			110 (149)			
Axial stiffness in service load range	β	(lb/in)	116,150	162,850		203,500		191,100		222,150	170,700		207,400		164,000
COV β _{uncr}	β	%	60	42		29		29		25	21		19		24
Strength reduction factor Φ for tension, steel failure modes ⁸											0.75				
Strength reduction factor Φ for shear, steel failure modes ⁸											0.65				
Strength reduction factor Φ for tension, concrete failure modes, Condition B ⁹											0.65				
Strength reduction factor Φ for shear concrete, failure modes, Condition B ⁹											0.70				

For **SI**: 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 MPa. For pound-in units: 1 mm = 0.03937 inches

1 For KB3 into the soffit of sand lightweight or normal-weight concrete on metal deck floor and roof assemblies, see Fig. 5.

2 See Figure 2.

3 NP (not permitted) denoted that the condition is not supported.

4 NA (not applicable) denotes that the condition does not govern for design.

5 NP (not permitted) denoted that the condition is not supported.

6 See ACI 318 Section D.4.4.

7 See ACI 318 Section D.5.2.2.

8 The carbon Steel KB3 is a ductile steel element as defined by ACI 318 Section D.1.

9 For use with the load combinations of ACI 318 Section 9.2 or IBC Section 1605.2.1. Condition B applies where supplementary reinforcement in conformance with ACI 318 Section D.4.4 is not provided, or where pull-out or pry out strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.

KWIK Bolt 3 Expansion Anchor 3.3.6

Table 3 - Stainless Steel KB3 Strength Design Information

Design Information	Symbol	Units	Nominal anchor diameter													
			1/4	3/8		1/2			5/8			3/4		1		
Anchor O.D.	d _o	in. (mm)	0.25 (6.4)	0.375 (9.5)		0.5 (12.7)			0.625 (15.9)			0.75 (19.1)		1 (25.4)		
Effective min. embedment ¹	h _{ef}	in. (mm)	1.5 (38)	2 (51)		2 (51)		3.25 (83)	3.125 (79)	4 (102)		3.75 (95)		5 (127)	4 (102)	5.75 (146)
Min. member thickness	h _{min}	in. (mm)	4 (102)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	6 (152)	8 (203)	8 (203)	10 (254)
Critical edge distance ²	c _{cr}	in. (mm)	3 (76)	4.375 (111)	3.875 (98)	4.875 (124)	4 (102)	6.75 (171)	5.75 (146)	7.375 (187)	9.5 (241)	7.5 (191)	10.5 (267)	9.25 (235)	9.75 (248)	11 (279)
Min. edge distance ²	c _{min}	in. (mm)	1.375 (35)	2 (51)	1.625 (41)	2.5 (64)	1.875 (48)	1.625 (41)	1.625 (41)	3.25 (83)	2.5 (64)	2.5 (64)	3.25 (83)	3 (76)	2.875 (73)	3.5 (89)
	for s ≥	in. (mm)	1.75 (44)	4 (102)	3.625 (92)	5 (127)	4.625 (117)	4.5 (114)	4.25 (108)	5.625 (143)	5.25 (133)	5 (127)	7 (178)	6.875 (175)	6.625 (168)	6.75 (172)
Min. anchor spacing	s _{min}	in. (mm)	1.25 (32)	2 (51)	1.75 (44)	2.5 (64)	2.25 (57)	2.125 (54)	1.875 (48)	3.125 (79)	2.125 (54)	2.125 (54)	4 (102)	3.5 (89)	3.5 (89)	5 (127)
	for c ≥	in. (mm)	1.625 (41)	3.25 (83)	2.5 (64)	2.875 (73)	2.375 (60)	2.375 (60)	2.125 (54)	3.875 (98)	3 (76)	2.75 (70)	4.125 (105)	3.75 (95)	3.75 (95)	4.25 (108)
Min. hole depth in concrete	h ₀	in. (mm)	2 (51)	2.625 (67)		2.625 (67)			4 (102)	3.875 (98)	4.75 (121)		4.5 (114)		5.75 (146)	5 (127)
Min. specified yield strength	f _y	psi (N/mm ²)	92000 (634)	92,000 (634)		92,000 (634)			92,000 (634)			76,000 (524)		76,000 (524)		
Min. specified ult. strength	f _{ut}	psi (N/mm ²)	115000 (793)	115,000 (793)		115,000 (793)			115,000 (793)			90,000 (621)		90,000 (621)		
Effective tensile stress area	A _{se}	in ² (mm ²)	0.02 (12.9)	0.06 (38.7)		0.11 (71.0)			0.17 (109.7)			0.24 (154.8)		0.47 (303.2)		
Steel strength in tension	N _{sa}	lb (kN)	2300 (10.2)	6,900 (30.7)		12,650 (56.3)			19,550 (87.0)			21,600 (96.1)		42,311 (188.2)		
Steel strength in shear	V _{sa}	lb (kN)	1680 (7.5)	4,980 (22.2)		4,195 (18.7)		6,940 (30.9)		8,955 (39.8)	14,300 (63.6)		11,900 (52.9)	23,545 (104.7)	12,510 (55.6)	30,000 (133.5)
Steel strength in shear, concrete on metal deck	V _{sa,deck}	lb (kN)	2,020 (9.0)	2,580 (11.5)		1,745 (7.8)			5,690 (25.3)			NP		NP		
Pullout strength uncracked concrete	N _{p,uncr}	lb (kN)	1325 (5.9)	3,120 (13.9)		3,310 (14.7)		6,340 (28.2)		6,230 (27.7)	7,830 (34.8)		8,555 (38.1)	10,830 (48.2)	NA	15,550 (69.2)
Pullout strength concrete on metal deck ⁵	N _{p,deck,uncr}	lb (kN)	1805 (8.0)	2,580 (11.5)		1,945 (8.7)			4,430 (19.7)			NP		NP		
Anchor category ⁶	1, 2 or 3	–	2	1												
Effectiveness factor uncracked concrete ⁷	k _{uncr}	–	24													
Installation torque	T _{inst}	ft-lb (Nm)	4 (5)	20 (27)		40 (54)			60 (81)			110 (149)		150 (203)		
Axial stiffness in service load range	β	(lb/in)	57,400	158,300		154,150		77,625		227,600	189,200		275,600	187,000	126,400	174,800
COV	β	%	40	34		36		17		31	22		35	21	38	22
Strength reduction factor Φ for tension, steel failure modes													0.75			
Strength reduction factor Φ for shear, steel failure modes ⁸													0.65			
Strength reduction factor Φ for tension concrete failure modes, Condition B ⁹													0.65			
Strength reduction factor Φ for shear concrete failure modes, Condition B ⁹													0.70			

1 See Figure 1.

2 For KB3 into the soffit of sand lightweight or normal-weight concrete on metal deck floor and roof assemblies, see Figure 3.

3 NP (not permitted) denoted that the condition is not supported.

4 NA (not applicable) denotes that the condition does not govern for design.

5 NP (not permitted) denoted that the condition is not supported.

6 See ACI 318 Section D.4.4.

7 See ACI 318 Section D.5.2.2.

8 The KB3 is a ductile steel element as defined by ACI 318 Section D.1.

9 For use with the load combinations of ACI 318 Section 9.2. Condition B applies where supplementary reinforcement in conformance with ACI 318 Section D.4.4 is not provided, or where pull-out or pry out strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.

3.3.6 KWIK Bolt 3 Expansion Anchor

Table 4 - Hot-Dip Galvanized KB3 Strength Design Information

Design Information	Symbol	Units	Nominal anchor Diameter									
			1/2			5/8			3/4			
Anchor O.D.	d _o	in. (mm)	0.5 (12.)			0.625 (15.9)			0.75 (19.1)			
Effective min. embedment ²	h _{ef}	in. (mm)	2 (51)		3.25 (83)		3.125 (79)	4 (102)		3.75 (95)		5 (127)
Min. member 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 _{cr}	in. (mm)	4.875 (124)	3.625 (92)	6.75 (171)	5.625 (143)	7.5 (191)	9.5 (241)	7.5 (191)	9.75 (248)	7.5 (191)	9.5 (241)
Min. edge distance	c _{min}	in. (mm)	3.25 (83)	2.625 (67)	2 (51)		2.25 (57)	2 (51)	1.875 (48)	3.5 (89)		3.625 (92)
	for s ≥	in. (mm)	6.25 (159)	5.5 (140)	4.875 (124)		5.25 (133)	5 (127)	4.75 (121)	7.5 (191)		7.375 (187)
Min. anchor spacing	s _{min}	in. (mm)	3.125 (79)	2.75 (70)	2.375 (60)	2.125 (54)	2.5 (64)	2.125 (54)	2.125 (54)	4 (102)		3.875 (98)
	for c ≥	in. (mm)	3.75 (95)	2.75 (70)	2.625 (67)	2.25 (57)	3.5 (89)	2.5 (64)	2.25 (57)	6.5 (165)		4.75 (121)
Min. hole depth in concrete	h ₀	in. (mm)	2.625 (67)			4 (102)		3.875 (98)	4.75 (121)		4.5 (114)	5.75 (146)
Min. specified yield strength	f _y	psi (N/mm ²)	84,800 (585)				84,800 (585)			84,800 (585)		
Min. specified ult. strength	f _{ut}	psi (N/mm ²)	106,000 (731)				106,000 (731)			106,000 (731)		
Effective tensile stress area	A _{se}	in ² (mm ²)	0.11 (71.0)				0.17 (109.7)			0.24 (154.8)		
Steel strength in tension	N _{sa}	lb (kN)	11,660 (51.9)				18,020 (80.2)			25,440 (113.2)		
Steel strength in shear	V _{sa}	lb (kN)	4,200 (18.7)		5,870 (26.1)		11,635 (51.8)			17,000 (75.6)		
Pullout strength uncracked concrete ⁴	N _{p,uncr}	lb (kN)	NA		6,540 (29.1)		6,465 (28.8)		9,375 (41.7)	NA		10,175 (45.3)
Anchor category ⁷	1, 2 or 3	–	1									
Effectiveness factor uncracked concrete ⁷	k _{uncr}	–	24									
Installation torque	T _{inst}	ft-lb (Nm)	40 (54)				60 (81)			110 (149)		
Axial stiffness in service load range	β	(lb/in)	177,000		332,850		347,750	190,130		364,725		314,650
COV	β	%	42		18		37	36		27		21
Strength reduction factor f for tension, steel failure modes ⁵								0.75				
Strength reduction factor f for shear, steel failure modes ⁵								0.65				
Strength reduction factor f for tension concrete failure modes, Condition B ⁶								0.65				
Strength reduction factor f for shear concrete failure modes, Condition B ⁶								0.70				

1 See Table 16 and the associated figure.

2 NA (not applicable) denotes that this value does not govern for design.

3 See ACI 318 Section D.4.4.

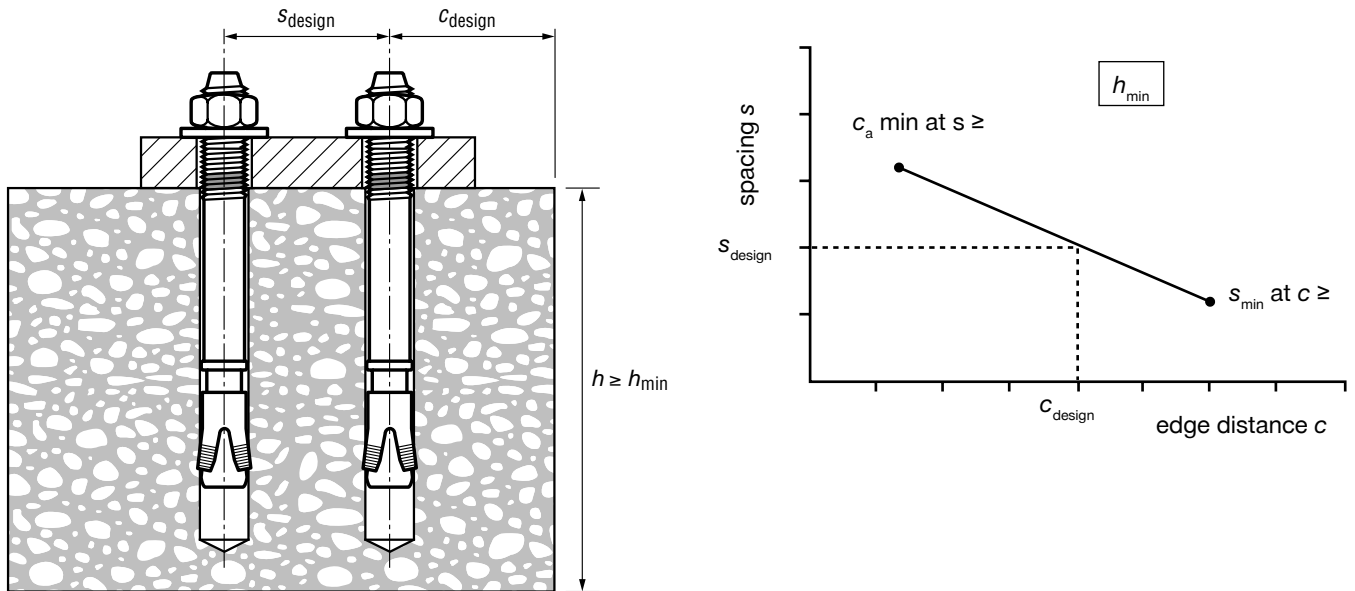
4 See ACI 318 Section D.5.2.2.

5 The KB3 is a ductile steel element as defined by ACI 318 Section D.1

6 For use with the load combinations of ACI 318 Section 9.2. Condition B applies where supplementary reinforcement in conformance with ACI 318 Section D.4.4 is not provided, or where pull-out or pry out strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.

KWIK Bolt 3 Expansion Anchor 3.3.6

Figure 2 - Interpolation of Minimum Edge Distance and Anchor Spacing



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
Length of anchor, (in.)	From 1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2	7	7-1/2	8	8-1/2	9	9-1/2	10	11	12
Up to but not including	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2	7	7-1/2	8	8-1/2	9	9-1/2	10	11	12	13

← Length Identification Mark

3.3.6 KWIK Bolt 3 Expansion Anchor

3.3.6.4 Allowable Stress Design

Table 5 - KWIK Bolt 3 Specifications and Properties¹

Bolt Size			in.	1/4			3/8			1/2		
Details			(mm)	(6.4)			(9.5)			(12.7)		
d _{bit}	nominal bit diameter ²		in.	1/4			3/8			1/2		
h _{min} /h _{nom} /h _{deep}	depth of embedment		in. (mm)	1-1/8 (29)	2 (51)	3 (76)	1-5/8 (41)	2-1/2 (64)	3-1/2 (89)	2-1/4 (57)	3-1/2 (89)	4-3/4 (121)
h _o	minimum/standard/deep hole depth		in. (mm)	1-3/8 (35)	2-1/4 (57)	3-1/4 (83)	2 (51)	2-7/8 (73)	3-7/8 (89)	2-3/4 (70)	4 (102)	5-1/4 (133)
d _h	fixture hole		in. (mm)	5/16 (8)			7/16 (11)			9/16 (14)		
T _{inst} Installation Torque	Normal weight & Light weight Concrete	Carbon Steel	ft-lb	4			20			40		
		HDG	(Nm)	(5)			(27)			(54)		
		Stainless Steel	ft-lb (Nm)	6 (8)			20 (27)			40 (54)		
	Grout Filled Block	Carbon Steel	ft-lb (Nm)	4 (5)			15 (20)			25 (34)		
h	min. base material thickness		in.	3 inch (76 mm) or 1.3 times embedment, whichever number is greater								
Bolt Fracture Load	Carbon Steel			2900 lb ^{4,6}			7200 lb ^{4,6}			12400 lb ⁴		
	HDG			no offering			no offering			12400 lb ⁴		
	Stainless Steel			2900 lb ^{4,7}			7200 lb ^{4,7}			12400 lb ⁴		

Bolt Size			in.	5/8			3/4			1		
Details			(mm)	(15.9)			(19.1)			(25.4)		
d _{bit}	nominal bit diameter ²		in.	5/8			3/4			1		
h _{min} /h _{nom} /h _{deep}	depth of embedment		in.	2-3/4	4	5-1/2	3-1/4	4-3/4	6-1/2 ³	4-1/2	6	9
			(mm)	(70)	(102)	(140)	(83)	(121)	(165)	(114)	(152)	(229)
h _o	minimum/standard/deep hole depth		in.	3-3/8	4-5/8	6-1/8	4	5-1/2	7	5-1/2	7	10
			(mm)	(86)	(117)	(156)	(102)	(140)	(178)	(140)	(178)	(254)
d _h	fixture hole		in.	11/16			13/16			1-1/8		
			(mm)	(17)			(21)			(29)		
T _{inst} Installation Torque	Normal weight & Light weight Concrete	Carbon Steel	ft-lb	60			110			150		
		HDG	(Nm)	(81)			(149)			(203)		
		Stainless Steel	ft-lb	60			110			150		
			(Nm)	(81)			(149)			(203)		
	Grout Filled Block	Carbon Steel	ft-lb	65			120			-		
			(Nm)	(88)			(163)					
h	min. base material thickness		in.	3 inch (76 mm) or 1.3 times embedment, whichever number is greater								
Bolt Fracture Load	Carbon Steel			19600 lb ⁴			28700 lb ^{4,8}			f _{ut} ≥ 88 ksi, f _y ≥ 75 ksi ⁵		
	HDG			19600 lb ⁴			28700 lb ⁴			no offering		
	Stainless Steel			21900 lb ⁴			f _{ut} ≥ 76 ksi, f _y ≥ 64 ksi ⁵			f _{ut} ≥ 76 ksi, f _y ≥ 64 ksi ⁵		

1 See KWIK Bolt 3 Product Line Table in Section 3.3.6.6 for a full list and anchor length and thread length configurations.

2 Loads for KWIK Bolt 3 are applicable for both carbide drill bits and matched tolerance Hilti DD-B or DD-C diamond core bits in sizes ranging from 1/2 inch to 1 inch.

3 The deep embedment depth for stainless steel KWIK Bolt 3 anchors is 8 inch (203 mm).

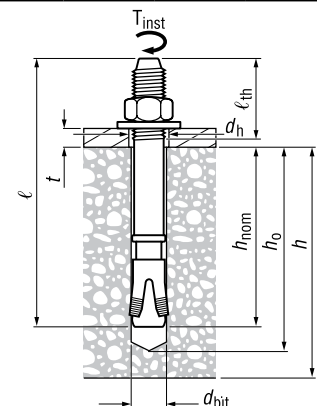
4 Bolt fracture loads are determined by testing in a jig as part of product quality control. These values are not intended for design purposes.

5 Bolt strength specified by minimum tensile and yield strength. Bolt fracture load not applicable.

6 Bolt fracture load not applicable to carbon steel Countersunk KWIK Bolt 3. The tensile and yield strengths are $f_{ut} \geq 105$ ksi and $f_y \geq 90$ ksi.

7 Bolt fracture load not applicable to stainless steel Countersunk KWIK Bolt 3. The tensile and yield strengths are $f_{ut} \geq 90$ ksi and $f_y \geq 76$ ksi.

8 For 3/4 x 12, $f_{ut} \geq 88$ ksi and $f_y \geq 75$ ksi. Bolt fracture load not applicable.



KWIK Bolt 3 Expansion Anchor 3.3.6

Table 6 - Carbon Steel KWIK Bolt 3 Allowable Loads in Normal-Weight Concrete¹

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	$f'_c = 2000$ psi (13.8 MPa)		$f'_c = 3000$ psi (20.7 MPa)		$f'_c = 4000$ psi (27.6 MPa)		$f'_c = 6000$ psi (41.4 MPa)	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
1/4 (6.4)	1-1/8 (29)	300 (1.3)	530 (2.4)	365 (1.6)	530 (2.4)	430 (1.9)	530 (2.4)	550 (2.4)	530 (2.4)
	2 (51)	635 (2.8)		715 (3.2)		800 (3.6)		845 (3.8)	
	3 (76)	755 (3.4)		795 (3.5)		840 (3.7)			
3/8 (9.5)	1-5/8 (41)	730 (3.2)	1135 (5.0)	910 (4.0)	1275 (5.7)	1095 (4.9)	1315 (5.8)	1090 (4.8)	1315 (5.8)
	2-1/2 (64)	1260 (5.6)	1315 (5.8)	1555 (6.9)	1315 (5.8)	1850 (8.2)		2060 (9.2)	
	3-1/2 (89)	1580 (7.0)		1770 (7.9)		1965 (8.7)		2150 (9.6)	
1/2 (12.7)	2-1/4 (57)	1235 (5.5)	1865 (8.3)	1430 (6.4)	2300 (10.2)	1620 (7.2)	2405 (10.7)	1975 (8.8)	2415 (10.7)
	3-1/2 (89)	1930 (8.6)	2415 (10.7)	2185 (9.7)	2415 (10.7)	2440 (10.9)	2415 (10.7)	3240 (14.4)	
	4-3/4 (121)	2135 (9.5)		2355 (10.5)		2575 (11.5)		3620 (16.1)	
5/8 (15.9)	2-3/4 (70)	1920 (8.5)	2750 (12.2)	2065 (9.2)	3410 (15.2)	2210 (9.8)	3785 (16.8)	2830 (12.6)	3910 (17.4)
	4 (102)	2660 (11.8)	3910 (17.4)	3020 (13.4)	3910 (17.4)	3385 (15.1)	3910 (17.4)	4770 (21.2)	
	5-1/2 (140)	3285 (14.6)		3695 (16.4)		4100 (18.2)		5325 (23.7)	
3/4 (19.1)	3-1/4 (83)	2120 (9.4)	4090 (18.2)	2425 (10.8)	4900 (21.8)	2730 (12.1)	5310 (23.6)	3785 (16.8)	5310 (23.6)
	4-3/4 (121)	3240 (14.4)	5340 (23.8)	4260 (18.9)	5340 (23.8)	5285 (23.5)	5495 (24.4)	6155 (27.4)	6225 (27.7)
	6-1/2 (165)	4535 (20.2)		5860 (26.1)		7185 (32)		7005 (31.2)	
1 (25.4)	4-1/2 (114)	3330 (14.8)	7070 (31.4)	4050 (18.0)	7600 (33.8)	4670 (20.8)	8140 (36.2)	5070 (22.6)	9200 (40.9)
	6 (152)	4930 (21.9)	9200 (40.9)	6000 (26.7)	9200 (40.9)	7070 (31.4)	9200 (40.9)	8400 (37.4)	
	9 (229)	6670 (29.7)		7670 (34.1)		8670 (38.6)		10670 (47.5)	

¹ Intermediate load values for other concrete strengths and embedments can be calculated by linear interpolation.

3.3.6 KWIK Bolt 3 Expansion Anchor

Table 7 - Carbon Steel KWIK Bolt 3 Ultimate Loads in Normal-Weight Concrete¹

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	$f'_c = 2000$ psi (13.8 MPa)		$f'_c = 3000$ psi (20.7 MPa)		$f'_c = 4000$ psi (27.6 MPa)		$f'_c = 6000$ psi (41.4 MPa)	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
1/4 (6.4)	1-1/8 (29)	1120 (5.0)	1995 (8.9)	1370 (6.1)	1995 (8.9)	1615 (7.2)	1995 (8.9)	2060 (9.2)	1995 (8.9)
	2 (51)	2375 (10.5)		2690 (12.0)		3000 (13.3)		3165 (14.1)	
	3 (76)	2830 (12.6)		2990 (13.3)		3150 (14.0)			
3/8 (9.5)	1-5/8 (41)	2740 (12.2)	4250 (18.9)	3420 (15.2)	4790 (21.3)	4100 (18.2)	4930 (21.9)	4095 (18.2)	4930 (21.9)
	2-1/2 (64)	4720 (21.0)	4930 (21.9)	5830 (25.9)	4930 (21.9)	6935 (30.8)		7730 (34.4)	
	3-1/2 (89)	5925 (26.4)		6645 (29.6)		7365 (32.8)		8055 (35.8)	
1/2 (12.7)	2-1/4 (57)	4635 (20.6)	7000 (31.1)	5355 (23.8)	8630 (38.4)	6075 (27.0)	9030 (40.2)	7410 (33.0)	9065 (40.3)
	3-1/2 (89)	7240 (32.2)	9065 (40.3)	8195 (36.5)	9065 (40.3)	9145 (40.7)	9065 (40.3)	12140 (54.0)	
	4-3/4 (121)	8000 (35.6)		8830 (39.3)		9655 (42.9)		13585 (60.4)	
5/8 (15.9)	2-3/4 (70)	7210 (32.1)	10315 (45.9)	7750 (34.5)	12790 (56.9)	8285 (36.9)	14195 (63.1)	10615 (47.2)	14650 (65.2)
	4 (102)	9975 (44.4)	14650 (65.2)	11335 (50.4)	14650 (65.2)	12690 (56.4)	14650 (65.2)	17890 (79.6)	
	5-1/2 (140)	12315 (54.8)		13850 (61.6)		15385 (68.4)		19970 (88.8)	
3/4 (19.1)	3-1/4 (83)	7955 (35.4)	15335 (68.2)	9100 (40.5)	18375 (81.7)	10245 (45.6)	19910 (88.6)	14185 (63.1)	19910 (88.6)
	4-3/4 (121)	12150 (54.0)	20030 (89.1)	15985 (71.1)	20030 (89.1)	19820 (86.2)	20605 (91.7)	23085 (102.7)	23355 (103.9)
	6-1/2 (165)	17000 (75.6)		21970 (97.7)		26935 (119.8)		26260 (116.8)	
1 (25.4)	4-1/2 (114)	12500 (55.6)	26500 (117.9)	15200 (67.6)	28500 (126.8)	17500 (77.8)	30500 (135.7)	19000 (84.5)	34500 (153.5)
	6 (152)	18500 (82.3)	34500 (153.5)	22500 (100.1)	34500 (153.5)	26500 (117.9)	34500 (153.5)	31500 (140.1)	
	9 (229)	25000 (111.2)		28750 (127.9)		32500 (144.6)		40000 (177.9)	

¹ Intermediate load values for other concrete strengths and embedments can be calculated by linear interpolation.

KWIK Bolt 3 Expansion Anchor 3.3.6

Table 8 - Stainless Steel KWIK Bolt 3 Allowable Loads in Normal-Weight Concrete¹

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	$f'_c = 2000$ psi (13.8 MPa)		$f'_c = 3000$ psi (20.7 MPa)		$f'_c = 4000$ psi (27.6 MPa)		$f'_c = 6000$ psi (41.4 MPa)	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
1/4 (6.4)	1-1/8 (29)	260 (1.2)	595 (2.6)	320 (1.4)	675 (3.0)	380 (1.7)	725 (3.2)	470 (2.1)	805 (3.6)
	2 (51)	540 (2.4)	675 (3.0)	625 (2.8)		705 (3.1)	805 (3.6)	910 (4.0)	
	3 (76)	685 (3)		750 (3.3)		810 (3.6)			
3/8 (9.5)	1-5/8 (41)	605 (2.7)	880 (3.9)	670 (3.0)	1110 (4.9)	730 (3.2)	1345 (6.0)	950 (4.2)	1690 (7.5)
	2-1/2 (64)	1285 (5.7)	1570 (7.0)	1430 (6.4)	1570 (7.0)	1575 (7.0)	1590 (7.1)	1940 (8.6)	1590 (7.1)
	3-1/2 (89)	1620 (7.2)		1755 (7.8)		1885 (8.4)		2035 (9.1)	
1/2 (12.7)	2-1/4 (57)	1015 (4.5)	1875 (8.3)	1230 (5.5)	2130 (9.5)	1450 (6.4)	2380 (10.6)	1620 (7.2)	2740 (12.2)
	3-1/2 (89)	1445 (6.4)	3010 (13.4)	1975 (8.8)	3010 (13.4)	2510 (11.2)	3045 (13.5)	2655 (11.8)	3045 (13.5)
	4-3/4 (121)	1990 (8.9)		2250 (10.0)				2985 (13.3)	
5/8 (15.9)	2-3/4 (70)	1650 (7.3)	2875 (12.8)	1755 (7.8)	3485 (15.5)	1860 (8.3)	4095 (18.2)	2335 (10.4)	4625 (20.6)
	4 (102)	2455 (10.9)	4625 (20.6)	2900 (12.9)	4625 (20.6)	3340 (14.9)	4625 (20.6)	4395 (19.5)	
	5-1/2 (140)	3480 (15.5)		3885 (17.3)		4290 (19.1)		6260 (27.8)	
3/4 (19.1)	3-1/4 (83)	1550 (6.9)	3945 (17.5)	1950 (8.7)	4260 (18.9)	2350 (10.5)	5645 (25.1)	2610 (11.6)	5645 (25.1)
	4-3/4 (121)	2510 (11.2)	5535 (24.6)	3250 (14.5)	5535 (24.6)	3870 (17.2)		4670 (20.8)	
	8 (203)	2930 (13.0)		3735 (16.6)		4530 (20.2)		5120 (22.8)	
1 (25.4)	4-1/2 (114)	3120 (13.9)	6080 (27.0)	3870 (17.2)	6770 (30.1)	4610 (20.5)	7470 (33.2)	4800 (21.4)	7470 (33.2)
	6 (152)	4400 (19.6)	7470 (33.2)	6400 (28.5)	7470 (33.2)	7200 (32.0)		7330 (32.6)	
	9 (229)	5600 (24.9)		8000 (35.6)		9390 (41.8)		9390 (41.8)	

¹ Intermediate load values for other concrete strengths and embedments can be calculated by linear interpolation.

3.3.6 KWIK Bolt 3 Expansion Anchor

Table 9 - Stainless Steel KWIK Bolt 3 Ultimate Loads in Normal-Weight Concrete¹

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	$f'_c = 2000$ psi (13.8 MPa)		$f'_c = 3000$ psi (20.7 MPa)		$f'_c = 4000$ psi (27.6 MPa)		$f'_c = 6000$ psi (41.4 MPa)	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
1/4 (6.4)	1-1/8 (29)	980 (4.4)	2240 (10.0)	1205 (5.4)	2530 (11.3)	1430 (6.4)	2725 (12.1)	1755 (7.8)	3020 (13.4)
	2 (51)	2035 (9.1)	2530 (11.3)	2340 (10.4)		2640 (11.7)	3020 (13.4)	3415 (15.2)	
	3 (76)	2580 (11.5)		2810 (12.5)		3040 (13.5)			
3/8 (9.5)	1-5/8 (41)	2275 (10.1)	3300 (14.7)	2505 (11.1)	4175 (18.6)	2735 (12.2)	5045 (22.4)	3560 (15.8)	6015 (26.8)
	2-1/2 (64)	4825 (21.5)	5900 (26.2)	5365 (23.9)	5900 (26.2)	5905 (26.3)	5954 (26.5)	7270 (32.3)	5954 (26.5)
	3-1/2 (89)	6075 (27.0)		6575 (29.2)		7075 (31.5)		7625 (33.9)	
1/2 (12.7)	2-1/4 (57)	3805 (16.9)	7030 (31.3)	4620 (20.6)	7980 (35.5)	5435 (24.2)	8930 (39.7)	6080 (27.0)	10285 (45.7)
	3-1/2 (89)	5415 (24.1)	11290 (50.2)	7410 (33.0)	11290 (50.2)	9405 (41.8)	11410 (50.8)	9950 (44.3)	11410 (50.8)
	4-3/4 (121)	7460 (33.2)		8435 (37.5)				11200 (49.8)	
5/8 (15.9)	2-3/4 (70)	6185 (27.5)	10790 (48.0)	6580 (29.3)	13075 (58.2)	6975 (31.0)	15360 (68.3)	8760 (39.0)	17355 (77.2)
	4 (102)	9205 (40.9)	17355 (77.2)	10870 (48.4)	17355 (77.2)	12530 (55.7)	17355 (77.2)	16490 (73.4)	
	5-1/2 (140)	13040 (58.0)		14560 (64.8)		16080 (71.5)		23475 (104.4)	
3/4 (19.1)	3-1/4 (83)	5800 (25.8)	14790 (65.8)	7300 (32.5)	15980 (71.1)	8800 (39.1)	21160 (94.1)	9800 (43.6)	21160 (94.1)
	4-3/4 (121)	9400 (41.8)	20750 (92.3)	11950 (53.2)	20750 (92.3)	14500 (64.5)		17500 (77.8)	
	8 (203)	11000 (48.9)		14000 (62.3)		17000 (75.6)		19200 (85.4)	
1 (25.4)	4-1/2 (114)	11700 (52.0)	22800 (101.4)	14500 (64.5)	25400 (113.0)	17300 (77.0)	28000 (124.6)	18000 (80.1)	28000 (124.6)
	6 (152)	16500 (73.4)	28000 (124.6)	21750 (96.7)	28000 (124.6)	27000 (120.1)		27500 (122.3)	
	9 (229)	21000 (93.4)		28100 (125.0)		35200 (156.6)		35200 (156.6)	

¹ Intermediate load values for other concrete strengths and embedments can be calculated by linear interpolation.

KWIK Bolt 3 Expansion Anchor 3.3.6

Table 10 - Hot-Dip Galvanized KWIK Bolt 3 Allowable Loads in Normal-Weight Concrete¹

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	$f'_c = 2000$ psi (13.8 MPa)		$f'_c = 3000$ psi (20.7 MPa)		$f'_c = 4000$ psi (27.6 MPa)		$f'_c = 6000$ psi (41.4 MPa)	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
1/2 (12.7)	2-1/4 (57)	1125 (5.0)	1785 (7.9)	1265 (5.6)	1785 (7.9)	1400 (6.2)	2190 (9.7)	1655 (7.4)	2190 (9.7)
	3-1/2 (89)	1895 (8.4)	2190 (9.7)	2115 (9.4)	2190 (9.7)	2335 (10.4)		3105 (13.8)	
	4-3/4 (121)	2215 (9.9)		2530 (11.3)		2845 (12.7)		3740 (16.6)	
5/8 (15.9)	2-3/4 (70)	1785 (7.9)	3780 (16.8)	1965 (8.7)	3780 (16.8)	2140 (9.5)	3780 (16.8)	2745 (12.2)	3790 (16.8)
	4 (102)	2545 (11.3)		3155 (14.0)		3765 (16.7)		5280 (23.5)	
	5-1/2 (140)	3375 (15.0)		4030 (17.9)		4030 (17.9)		6055 (26.9)	
3/4 (19.1)	3-1/4 (83)	2355 (10.5)	4240 (18.9)	2545 (11.3)	4240 (18.9)	2735 (12.2)	5340 (23.8)	2825 (12.6)	5340 (23.8)
	4-3/4 (121)	3730 (16.6)	5340 (23.8)	4350 (19.3)	5340 (23.8)	4970 (22.1)		5805 (25.8)	
	8 (203)	5115 (22.8)		5805 (25.8)		6495 (28.9)		7520 (33.5)	

¹ Intermediate load values for other concrete strengths and embedments can be calculated by linear interpolation.

Table 11 - Hot-Dip Galvanized KWIK Bolt 3 Ultimate Loads in Normal-Weight Concrete¹

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	$f'_c = 2000$ psi (13.8 MPa)		$f'_c = 3000$ psi (20.7 MPa)		$f'_c = 4000$ psi (27.6 MPa)		$f'_c = 6000$ psi (41.4 MPa)	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
1/2 (12.7)	2-1/4 (57)	4220 (18.8)	6695 (29.8)	4740 (21.1)	6695 (29.8)	5255 (23.4)	8210 (36.5)	6210 (27.6)	8210 (36.5)
	3-1/2 (89)	7100 (31.6)	8210 (36.5)	7935 (35.3)	8210 (36.5)	8765 (39.0)		11645 (51.8)	
	4-3/4 (121)	8310 (37.0)		9495 (42.2)		10675 (47.5)		14030 (62.4)	
5/8 (15.9)	2-3/4 (70)	6690 (29.8)	14170 (63.0)	7360 (32.7)	14170 (63.0)	8030 (35.7)	14170 (63.0)	10295 (45.8)	14170 (63.0)
	4 (102)	9550 (42.5)		11835 (52.6)		14120 (62.8)		19800 (88.1)	
	5-1/2 (140)	12650 (56.3)		15115 (67.2)		17575 (78.2)		22705 (101.0)	
3/4 (19.1)	3-1/4 (83)	8825 (39.3)	15900 (70.7)	9545 (42.5)	15900 (70.7)	10260 (45.6)	20030 (89.1)	10600 (47.2)	20030 (89.1)
	4-3/4 (121)	13995 (62.3)	20030 (89.1)	16315 (72.6)	20030 (89.1)	18635 (82.9)		21765 (96.8)	
	6-1/2 (165)	19180 (85.3)		21770 (96.8)		24355 (108.3)		28210 (125.5)	

¹ Intermediate load values for other concrete strengths and embedments can be calculated by linear interpolation.

3.3.6 KWIK Bolt 3 Expansion Anchor

Table 12 - Carbon Steel KWIK Bolt 3 Allowable Loads in Lightweight Concrete^{1,2}

Anchor Diameter in. (mm)	Anchor Depth in. (mm)		Tension $f'_c = 2000$ psi (13.8 MPa) lb (kN)		Tension $f'_c = 3000$ psi (20.7 MPa) lb (kN)		Tension $f'_c = 4000$ psi (27.6 MPa) lb (kN)		Shear $f'_c = 2000$ psi (13.8 MPa) lb (kN)	
1/4 (6.4)	1-1/8	(29)	275	(1.2)	335	(1.5)	400	(1.8)	400	(1.8)
	2	(51)	595	(2.6)	675	(3.0)	750	(3.3)	400	(1.8)
3/8 (9.5)	1-5/8	(41)	585	(2.6)	685	(3.0)	785	(3.5)	890	(4.0)
	2-1/2	(64)	1120	(5.0)	1340	(6.0)	1560	(6.9)	1345	(5.9)
1/2 (12.7)	2-1/4	(57)	1160	(5.2)	1340	(6.0)	1520	(6.8)	1750	(7.8)
	3-1/2	(89)	1810	(8.1)	2050	(9.1)	2285	(10.2)	2835	(12.6)
5/8 (15.9)	2-3/4	(70)	1560	(6.9)	1815	(8.1)	2070	(9.2)	2580	(11.5)
	4	(102)	2485	(11.1)	2830	(12.6)	3170	(14.1)	3360	(14.9)
3/4 (19.1)	3-1/4	(83)	1920	(8.5)	2240	(10.0)	2560	(11.4)	3835	(17.1)
	4-3/4	(121)	3035	(13.5)	3995	(17.8)	4955	(22)	5010	(22.3)

1 Allowable loads based on safety factor of 4.0.

2 Intermediate load values for other concrete strengths and embedments can be calculated by linear interpolation.

Table 13 - Stainless Steel KWIK Bolt 3 Allowable Loads in Lightweight Concrete^{1,2}

Anchor Diameter in. (mm)	Anchor Depth in. (mm)		Tension $f'_c = 2000$ psi (13.8 MPa) lb (kN)		Tension $f'_c = 3000$ psi (20.7 MPa) lb (kN)		Tension $f'_c = 4000$ psi (27.6 MPa) lb (kN)		Shear $f'_c = 2000$ psi (13.8 MPa) lb (kN)	
1/4 (6.4)	1-1/8	(29)	245	(1.1)	300	(1.3)	355	(1.6)	545	(2.4)
	2	(51)	510	(2.3)	585	(2.6)	660	(2.9)	630	(2.8)
3/8 (9.5)	1-5/8	(41)	560	(2.5)	625	(2.8)	685	(3.0)	825	(3.7)
	2-1/2	(64)	920	(4.1)	1200	(5.3)	1475	(6.6)	1345	(6.0)
1/2 (12.7)	2-1/4	(57)	950	(4.2)	1155	(5.1)	1360	(6.0)	1755	(7.8)
	3-1/2	(89)	1355	(6.0)	1855	(8.3)	2350	(10.5)	2955	(13.1)
5/8 (15.9)	2-3/4	(70)	1470	(6.5)	1605	(7.1)	1745	(7.8)	2695	(12.0)
	4	(102)	2300	(10.2)	2715	(12.1)	3130	(13.9)	4500	(20.0)

1 Allowable loads based on safety factor of 4.0.

2 Intermediate load values for other concrete strengths and embedments can be calculated by linear interpolation.

Table 14 - Carbon Steel KWIK Bolt 3 Allowable Loads for Anchor installed at 1-3/4 in. Edge Distance in Normal-Weight Concrete¹

Anchor Diameter in. (mm)		Minimum Depth Embedment in. (mm)		$f'_c = 2000$ psi (13.8 MPa)					
				Tension in. (mm)		Shear			
						Perpendicular to Edge in. (mm)		Parallel to Edge in. (mm)	
3/8 (9.5)	(9.5)	3	(76)	955	(4.2)	410	(1.8)	915	(4.1)
		3	(76)	930	(4.1)	375	(1.7)	1000	(4.4)
1/2 (12.7)	(12.7)	4-1/2	(114)	1285	(5.7)	445	(2.0)	1415	(6.3)

1 Allowable loads based on safety factor of 4.0. Intermediate load values for other concrete strengths and embedments can be calculated by linear interpolation.

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Table 15 - KWIK Bolt 3 Carbon Steel and Stainless Steel KWIK Bolt 3 Allowable Loads, installed into the Underside of Lightweight Concrete on Metal Profile Deck¹

Anchor Material	Anchor Diameter in. (mm)	Embedment Depth in. (mm)	$f'_c = 3000 \text{ psi (20.7 MPa)}$			
			Tension lb (kN)		Shear lb (kN)	
Carbon Steel	1/4 (6.4)	2 (51)	620	(2.8)	713	(3.2)
	3/8 (9.5)	2-1/2 (64)	1035	(4.6)	1370	(6.1)
	1/2 (12.7)	3-1/2 (89)	1725	(7.7)	2435	(10.8)
	5/8 (15.9)	4 (102)	2220	(9.9)	3160	(14.1)
Stainless Steel	1/4 (6.4)	2 (51)	615	(2.7)	650	(2.9)
	3/8 (9.5)	2-1/2 (64)	1015	(4.5)	1450	(6.4)
	1/2 (12.7)	3-1/2 (89)	1475	(6.6)	2200	(9.8)
	5/8 (15.9)	4 (102)	2220	(9.8)	3355	(14.9)

¹ Allowable loads based on using a safety factor of 4.0.

Figure 3 - Installation in Concrete over Metal Deck

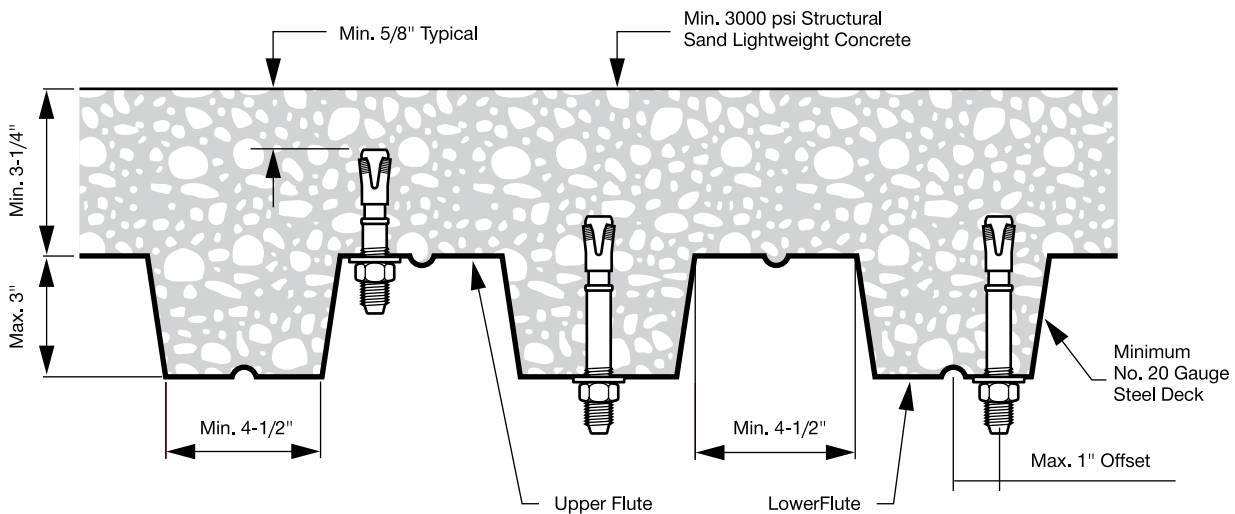


Table 16 - Countersunk KWIK Bolt Allowable Loads in Normal-Weight Concrete¹

Anchor Material	Anchor Diameter in. (mm)	Embedment Depth in. (mm)	$f'_c = 3000 \text{ psi (20.7 MPa)}$			
			Tension lb (kN)		Shear ² lb (kN)	
Carbon Steel	1/4 (6.4)	1-1/8 (29)	365	(1.6)	350	(1.6)
	3/8 (9.5)	1-5/8 (41)	810	(3.6)	750	(3.3)
Stainless Steel	1/4 (6.4)	1-1/8 (29)	320	(1.4)	500	(2.2)
	3/8 (9.5)	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%.

3.3.6 KWIK Bolt 3 Expansion Anchor

Table 17 - Carbon Steel KWIK Bolt 3 Allowable Loads for Anchors Installed in Top of Grout-Filled Concrete Masonry Wall¹

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Tension lb (kN)	Shear	
			V ₁ lb (kN)	V ₂ lb (kN)
1/2 (12.7)	3 (76)	645 (2.9)	310 (1.4)	615 (2.7)
5/8 (15.9)	3-1/2 (89)	850 (3.8)	310 (1.4)	615 (2.7)

¹ Masonry prism strength must be at least 1500 psi at the time of installation in accordance with UBC Standard 21-17.

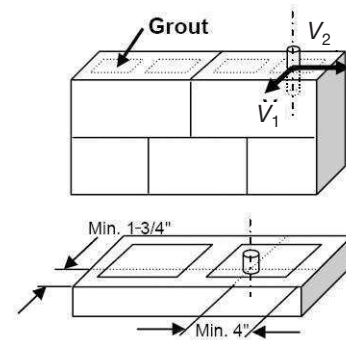


Table 18 - HHDCA Ceiling Hanger Allowable Loads¹

Anchor Diameter in. (mm)	Minimum Embedment in. (mm)	Normal Weight Concrete ²		Lightweight Concrete ³	Lightweight Concrete ³
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
1/4 (6.4)	1-1/4 (32)	410 (1.8)	425 (1.9)	260 (1.2)	294 (1.3)

¹ Allowable loads based on using a safety factor of 4.0.

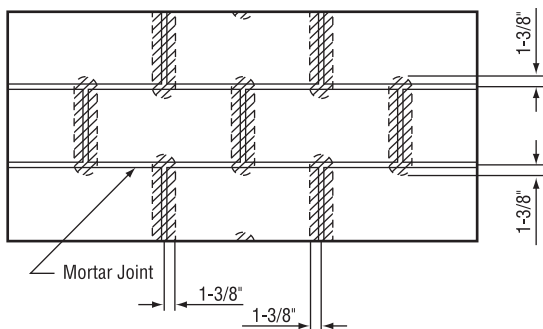
² Allowable loads are for anchors installed into normal-weight concrete having a minimum compressive strength of 3500 psi at the time of installation.

³ Allowable loads are for anchors installed into lightweight concrete having a minimum compressive strength of 3000 psi at the time of installation.

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right)^{5/3} + \left(\frac{V_d}{V_{rec}} \right)^{5/3} \leq 1.0 \text{ (Ref. Section 3.1.8.3)}$$

Figure 4 - Installation in Grout-filled Concrete Masonry Unit



¹ Anchor installation is allowed in all non-shaded areas.

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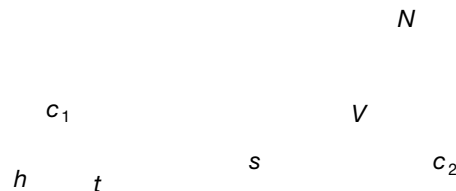
Table 19 - Carbon Steel KWIK Bolt 3 Allowable Loads in Grout-Filled Concrete Masonry Units^{1, 2, 3, 4, 5, 6}

Anchor Diameter in. (mm)	Anchor Depth in. (mm)	Minimum Distance from Edge of Block in. (mm)	Tension lb (kN)	Shear lb (kN)
1/4 (6.4)	1-1/8 (29)	4 (102)	150 (0.7)	380 (1.7)
		12 (305)		
	2 (51)	4 (102)	540 (2.4)	445 (2.0)
		12 (305)		
3/8 (9.5)	1-5/8 (41)	4 (102)	320 (1.4)	735 (3.3)
		12 (305)	340 (1.5)	940 (4.2)
	2-1/2 (64)	4 (102)	780 (3.5)	1010 (4.5)
		12 (305)		1395 (6.2)
1/2 (12.7)	2-1/4 (57)	4 (102)	630 (2.8)	830 (3.7)
		12 (305)	665 (3.0)	1465 (6.5)
	3-1/2 (89)	4 (102)	905 (4.0)	1080 (4.8)
		12 (305)		2375 (10.6)
5/8 (15.9)	2-3/4 (70)	4 (102)	815 (3.6)	890 (4.0)
		12 (305)	865 (3.8)	2165 (9.6)
	4 (102)	4 (102)	1240 (5.5)	970 (4.3)
		12 (305)	1295 (5.8)	2770 (12.3)
3/4 (19.1)	3-1/4 (83)	4 (102)	1035 (4.6)	785 (3.5)
		12 (305)		3135 (13.8)
	4-3/4 (121)	4 (102)	1645 (7.3)	825 (3.7)
		12 (305)	1710 (7.6)	3305 (14.7)

- Values are for anchors installed in Type 1 Grade N, lightweight, medium-weight, or normal-weight concrete masonry units conforming to UBC Standard 21-4. The masonry units must be fully grouted with coarse grout conforming to UBC Standard 21-15, Type S, N, or M. Masonry prism compressive strength must be at least 1500 psi at the time of installation when tested in accordance with UBC Standard 21-17.
- Anchors must be installed a minimum of 1-3/8 inch from any vertical mortar joint (see figure).
- Anchor locations are limited to one per masonry cell.
- Embedment depth is measured from the outside face of the concrete masonry unit.
- Linear interpolation to determine load values at intermediate edge distances is permitted.
- All allowable loads based on safety factor of 4.0

Anchor Spacing and Edge Distance Guidelines

- s = on-center fastening spacing
c = edge distance from center of bolt.
- Apply appropriate load reduction factors for tension and shear if anchor spacing and/or edge distance is less than the critical spacing (s_{cr}) or edge distance (c_{cr}).
- See Section 3.1.8 for determining compounded spacing and edge distance reduction as well as intermediate load values for concrete strengths and embedments.



3.3.6 KWIK Bolt 3 Expansion Anchor

Edge Distance Adjustment Factors

Edge Reduction Factor
Tension

c/h_c

Adjustment Conditions	Critical Edge Distance	Minimum Edge Distance
Emb Ratio	$c/h_c = 1.75$	$c/h_c = 1.00$
Reduction	$f_{RN} = 1.00$	$f_{RN} = 0.80$
$h_c = h_{act}$ for $h_{min} \leq h_{act} \leq h_{nom}$ $h_c = h_{nom}$ for $h_{act} > h_{nom}$		
h_{act} = Actual Embedment c = Actual Edge Distance f_{RN} = Edge Distance Reduction Factor for Tension Loading		

f_{RN}

Edge Reduction Factor
Shear

c/h_{min}

Shear Plane Correlation	Shear Conditions	f_{RV} Reduction factor at Min. Edge Distance
f_{RV1}	Shear towards edge	$f_{RV1} = 0.50$
f_{RV2}	Shear parallel edge	$f_{RV2} = 0.60$
f_{RV3}	Shear away from edge	$f_{RV3} = 0.83$
embedment to edge distance ratio at critical edge distance		$c/h_{min} = 3.00$
embedment to edge distance ratio at minimum edge distance		$c/h_{min} = 1.50$
c = Actual Edge Distance h_{min} = Min Embedment for Specific Anchor Diamete		

f_{RV}

Anchor Spacing Adjustment Factors

Anchor Spacing Reduction Factor
Tension

s/h_c

Adjustment Conditions	Critical Anchor Spacing	Minimum Anchor Spacing
Emb Ratio	$s/h_c = 2.25$	$s/h_c = 1.00$
Reduction	$f_{AN} = 1.00$	$f_{AN} = 0.60$
$h_c = h_{act}$ for $h_{min} \leq h_{act} \leq h_{nom}$ $h_c = h_{nom}$ for $h_{act} > h_{nom}$		
h_{act} = Actual Embedment c = Actual Anchor Spacing Distance f_{AN} = Anchor Spacing Reduction Factor for Tension Loading		

f_{AN}

Anchor Spacing Reduction Factor
Shear

s/h_c

Adjustment Conditions	Critical Anchor Spacing	Minimum Anchor Spacing
Emb Ratio	$s/h_c = 2.25$	$s/h_c = 1.00$
Reduction	$f_{AV} = 1.00$	$f_{AV} = 0.60$
$h_c = h_{act}$ for $h_{min} \leq h_{act} \leq h_{nom}$ $h_c = h_{nom}$ for $h_{act} > h_{nom}$		
h_{act} = Actual Embedment c = Actual Anchor Spacing Distance f_{AV} = Anchor Spacing Reduction Factor for Shear Loading		

f_{AV}

KWIK Bolt 3 Expansion Anchor 3.3.6

Influence of Edge Distance and Anchor Spacing on Anchor Performance

Load Adjustment Factors for 1/4" Diameter Anchors									
Adjustment Factor 1/4 in.	Spacing Tension f_{AN}		Edge Distance Tension f_{RN}		Spacing Shear f_{AV}		Edge Distance Shear		
							⊥ Toward Edge f_{RV1}	Toward Edge f_{RV1}	⊥ Away from Edge f_{RV3}
Embedment Depth, in.	1-1/8	≥ 2	1-1/8	≥ 2	1-1/8	≥ 2	≥ 1-1/8	≥ 1-1/8	≥ 1-1/8
Spacing/Edge Distance, in.									
1-1/8	0.60		0.80		0.90				
1-11/16	0.75		0.93		0.94		0.50	0.60	0.83
1-3/4	0.78		0.95		0.94		0.52	0.61	0.84
2	0.85	0.60	1.00	0.80	0.96	0.90	0.59	0.67	0.86
2-1/4	0.92	0.64		0.83	0.98	0.91	0.67	0.73	0.89
2-1/2	0.99	0.68		0.87	1.00	0.92	0.74	0.79	0.91
3	1.00	0.76		0.93		0.94	0.89	0.91	0.96
3-3/8		0.82		0.98		0.96	1.00	1.00	1.00
3-1/2		0.84		1.00		0.96	1.00	1.00	1.00
4		0.92				0.98			
4-1/2		1.00				1.00			
4-3/4									
5									

Standard Anchor Embedments (in.)		
1/4	h_{min}	1-1/8
	h_{nom}	2
	h_{deep}	3
3/8	h_{min}	1-5/8
	h_{nom}	2-1/2
	h_{deep}	3-1/2
1/2	h_{min}	2-1/4
	h_{nom}	3-1/2
	h_{deep}	4-3/4

Note: Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Load Adjustment Factors for 3/8" Diameter Anchors									
Adjustment Factor 3/8 in.	Spacing Tension f_{AN}		Edge Distance Tension f_{RN}		Spacing Shear f_{AV}		Edge Distance Shear		
							⊥ Toward Edge f_{RV1}	Toward Edge f_{RV1}	⊥ Away from Edge f_{RV3}
Embedment Depth, in.	1-5/8	≥ 2-1/2	1-5/8	≥ 2-1/2	1-5/8	≥ 2-1/2	≥ 1-5/8	≥ 1-5/8	≥ 1-5/8
Spacing/Edge Distance, in.									
1-5/8	0.60		0.80		0.90				
2	0.67		0.86		0.92				
2-1/4	0.72		0.90		0.93				
2-1/2	0.77	0.60	0.94	0.80	0.94	0.90	0.51	0.61	0.83
3	0.87	0.66	1.00	0.85	0.97	0.92	0.62	0.69	0.87
3-1/4	0.92	0.70		0.88	0.98	0.92	0.67	0.73	0.89
3-1/2	0.97	0.73		0.91	0.99	0.93	0.72	0.77	0.90
3-3/4	1.00	0.76		0.93	1.00	0.94	0.77	0.82	0.92
4		0.79		0.96		0.95	0.82	0.86	0.94
4-1/2		0.86		1.00		0.96	0.92	0.94	0.97
5		0.92				0.98	1.00	1.00	1.00
5-5/8		1.00				1.00			
5-3/4									

Spacing — Tension	
$h_{min} \leq h_{act} \leq h_{nom}$	$f_{AN} = \frac{s/h_{act} + 0.88}{3.13}$
$h_{act} \geq h_{nom}$	$f_{AN} = \frac{s/h_{nom} + 0.88}{3.13}$

Edge Distance — Tension	
$h_{min} \leq h_{act} \leq h_{nom}$	$f_{RN} = \frac{c/h_{act} + 2}{3.75}$
$h_{act} \geq h_{nom}$	$f_{RN} = \frac{c/h_{nom} + 2}{3.75}$

Spacing — Shear	
$h_{min} \leq h_{act} \leq h_{nom}$	$f_{AV} = \frac{s/h_{act} + 10.25}{12.5}$
$h_{act} \geq h_{nom}$	$f_{AV} = \frac{s/h_{nom} + 10.25}{12.5}$

Edge Distance — Shear	
$h_{act} \geq h_{min}$	
perpendicular toward edge	$f_{RV1} = \frac{c}{3h_{min}}$
parallel to edge	$f_{RV2} = \frac{c/h_{min} + 0.75}{3.75}$
perpendicular away from edge	$f_{RV3} = \frac{c/h_{min} + 5.82}{8.82}$

Note: Edge distance and anchor spacing for all lightweight and sand-lightweight concrete are obtained by dividing the normal-weight dimensions by 0.75 and 0.85, respectively.

Load Adjustment Factors for 1/2" Diameter Anchors									
Adjustment Factor 1/2 in.	Spacing Tension f_{AN}		Edge Distance Tension f_{RN}		Spacing Shear f_{AV}		Edge Distance Shear		
							⊥ Toward Edge f_{RV1}	Toward Edge f_{RV1}	⊥ Away from Edge f_{RV3}
Embedment Depth, in.	2-1/4	≥ 3-1/2	2-1/4	≥ 3-1/2	2-1/4	≥ 3-1/2	≥ 2-1/4	≥ 2-1/4	≥ 2-1/4
Spacing/Edge Distance, in.									
2-1/4	0.60		0.80		0.90				
2-1/2	0.64		0.83		0.91				
3	0.71		0.89		0.93				
3-3/8	0.76		0.93		0.94		0.50	0.60	0.83
3-3/4	0.81	0.62	0.98	0.82	0.95	0.91	0.56	0.64	0.85
4-1/4	0.88	0.67	1.00	0.86	0.97	0.92	0.63	0.70	0.87
4-3/4	0.96	0.71		0.90	0.99	0.93	0.70	0.76	0.90
5	1.00	0.74		0.91	1.00	0.93	0.74	0.79	0.91
5-3/4		0.81		0.97		0.95	0.85	0.88	0.95
6		0.83		1.00		0.96	0.89	0.91	0.96
6-1/2		0.87				0.97	0.96	0.97	0.99
7-1/4		0.94				0.99	1.00	1.00	1.00
7-3/4		1.00				1.00			

3.3.6 KWIK Bolt 3 Expansion Anchor

Influence of Edge Distance and Anchor Spacing on Anchor Performance

Load Adjustment Factors for 5/8" Diameter Anchors									
Adjustment Factor 5/8 in.	Spacing Tension f_{AN}		Edge Distance Tension f_{RN}		Spacing Shear f_{AV}		Edge Distance Shear		
							⊥ Toward Edge f_{RV1}	Toward Edge f_{RV1}	⊥ Away from Edge f_{RV3}
Embedment Depth, in.	2-3/4	≥ 4	2-3/4	≥ 4	2-3/4	≥ 4	≥ 2-3/4	≥ 2-3/4	≥ 2-3/4
Spacing/Edge Distance, in.	2-3/4	0.60		0.80		0.90			
	3-1/2	0.69		0.87		0.92			
	4	0.75	0.60	0.92	0.80	0.94	0.90		
	4-1/4	0.77	0.62	0.95	0.82	0.94	0.91	0.52	0.61
	4-3/4	0.83	0.66	1.00	0.85	0.96	0.92	0.58	0.66
	5-1/2	0.92	0.72		0.90	0.98	0.93	0.67	0.73
	6	0.98	0.76		0.93	0.99	0.94	0.73	0.78
	6-1/4	1.00	0.78		0.95	1.00	0.95	0.76	0.81
	7		0.84		1.00		0.96	0.85	0.88
	7-1/2		0.88				0.97	0.91	0.93
	7-3/4		0.90				0.98	0.94	0.95
	8-1/2		0.96				0.99	1.00	1.00
	9		1.00						

Load Adjustment Factors for 3/4" Diameter Anchors									
Adjustment Factor 3/4 in.	Spacing Tension f_{AN}		Edge Distance Tension f_{RN}		Spacing Shear f_{AV}		Edge Distance Shear		
							⊥ Toward Edge f_{RV1}	Toward Edge f_{RV1}	⊥ Away from Edge f_{RV3}
Embedment Depth, in.	3-1/4	≥ 4-3/4	3-1/4	≥ 4-3/4	3-1/4	≥ 4-3/4	≥ 3-1/4	≥ 3-1/4	≥ 3-1/4
Spacing/Edge Distance, in.	3-3/8	0.61		0.81		0.90			
	4	0.67		0.86		0.92			
	5	0.77	0.62	0.94	0.81	0.94	0.90	0.51	0.61
	5-3/4	0.85	0.67	1.00	0.86	0.96	0.92	0.59	0.67
	6-1/4	0.90	0.70		0.88	0.97	0.93	0.64	0.71
	6-1/2	0.92	0.72		0.90	0.98	0.93	0.67	0.73
	7	0.97	0.75		0.93	0.99	0.94	0.72	0.77
	7-1/2	1.00	0.79		0.95	1.00	0.95	0.77	0.82
	8-1/4		0.84		1.00		0.96	0.85	0.88
	9		0.89				0.97	0.92	0.94
	9-3/4		0.94				0.98	1.00	1.00
	10-1/4		0.97				0.99		
	10-3/4		1.00				1.00		

Load Adjustment Factors for 1" Diameter Anchors									
Adjustment Factor 1 in.	Spacing Tension f_{AN}		Edge Distance Tension f_{RN}		Spacing Shear f_{AV}		Edge Distance Shear		
							⊥ Toward Edge f_{RV1}	Toward Edge f_{RV1}	⊥ Away from Edge f_{RV3}
Embedment Depth, in.	4-1/2	≥ 6	4-1/2	≥ 6	4-1/2	≥ 6	≥ 4-1/2	≥ 4-1/2	≥ 4-1/2
Spacing/Edge Distance, in.	4-1/2	0.60		0.80		0.90			
	6	0.71	0.60	0.89	0.80	0.93	0.90		
	7	0.78	0.65	0.95	0.84	0.94	0.91	0.52	0.61
	8	0.85	0.71	1.00	0.89	0.96	0.93	0.59	0.67
	9	0.92	0.76		0.93	0.98	0.94	0.67	0.73
	9-3/4	0.97	0.80		0.97	0.99	0.95	0.72	0.78
	10-1/4	1.00	0.83		0.99	1.00	0.96	0.76	0.81
	11-1/4		0.88		1.00		0.97	0.83	0.87
	11-5/8		0.90				0.98	0.86	0.89
	12-1/2		0.95				0.99	0.93	0.94
	13		0.97				0.99	0.96	0.97
	13-1/2		1.00				1.00	1.00	1.00
	14-3/4								

Standard Anchor Embedments (in.)		
5/8	h_{min}	2-3/4
	h_{nom}	4
	h_{deep}	5-1/2
3/4	h_{min}	3-1/4
	h_{nom}	4-3/4
	h_{deep}	6-1/2 ¹
1	h_{min}	4-1/2
	h_{nom}	6
	h_{deep}	9

1. Embedment depth shown reflects embedment for carbon steel anchor, deep embedment depth for stainless steel anchor is 8 inch.

Note: Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing — Tension	
$h_{min} \leq h_{act} \leq h_{nom}$	$h_{act} \geq h_{nom}$
$f_{AN} = \frac{s/h_{act} + 0.88}{3.13}$	$f_{AN} = \frac{s/h_{nom} + 0.88}{3.13}$

Edge Distance — Tension	
$h_{min} \leq h_{act} \leq h_{nom}$	$h_{act} \geq h_{nom}$
$f_{RN} = \frac{c/h_{act} + 2}{3.75}$	$f_{RN} = \frac{c/h_{nom} + 2}{3.75}$

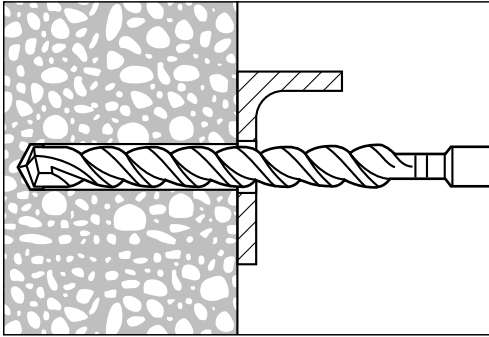
Spacing — Shear	
$h_{min} \leq h_{act} \leq h_{nom}$	$h_{act} \geq h_{nom}$
$f_{AV} = \frac{s/h_{act} + 10.25}{12.5}$	$f_{AV} = \frac{s/h_{nom} + 10.25}{12.5}$

Edge Distance — Shear	
$h_{act} \geq h_{min}$	
perpendicular toward edge	
$f_{RV1} = \frac{c}{3h_{min}}$	
parallel to edge	
$f_{RV2} = \frac{c/h_{min} + 0.75}{3.75}$	
perpendicular away from edge	
$f_{RV3} = \frac{c/h_{min} + 5.82}{8.82}$	

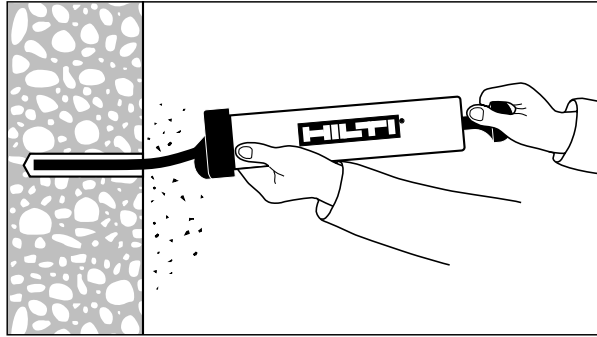
Note: Edge distance and anchor spacing for all lightweight and sand-lightweight concrete are obtained by dividing the normal-weight dimensions by 0.75 and 0.85, respectively.

KWIK Bolt 3 Expansion Anchor 3.3.6

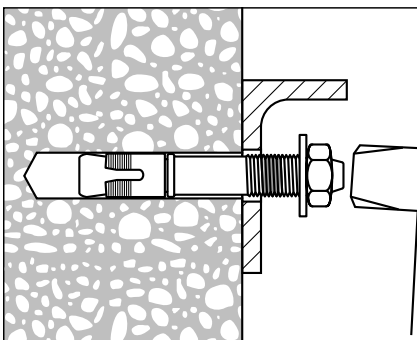
3.3.6.5 Installation Instructions



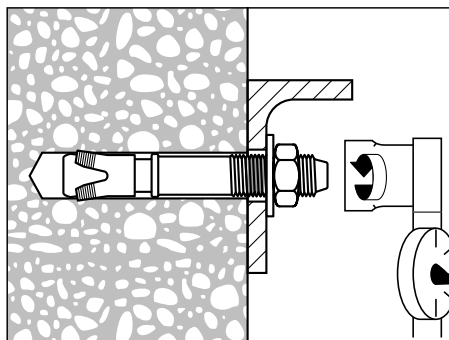
1. Hammer drill a hole to the same nominal diameter as the KWIK Bolt 3. The hole depth must exceed the anchor embedment by at least one diameter. The fixture may be used as a drilling template to ensure proper anchor location.



2. Clean hole.



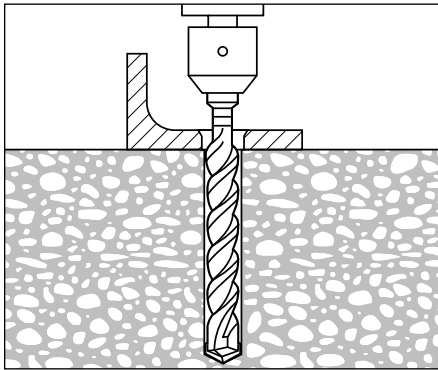
3. Drive the KWIK Bolt 3 into the hole using a hammer. The anchor must be driven until at least 6 threads are below the surface of the fixture.



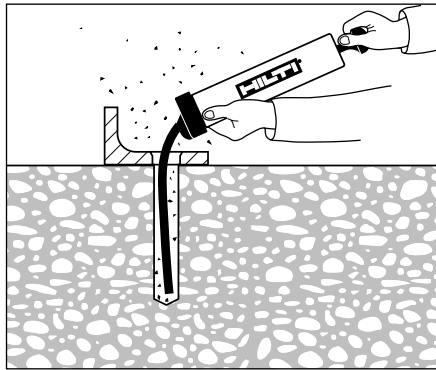
4. Tighten the nut to the installation torque.

3.3.6 KWIK Bolt 3 Expansion Anchor

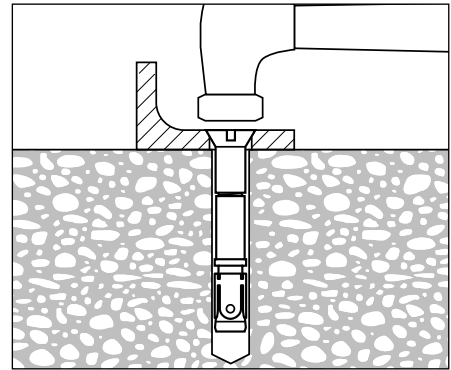
Countersunk KWIK Bolt 3 Anchor Installation Instructions



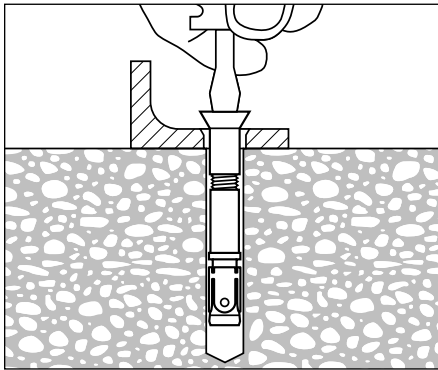
1. Drill.



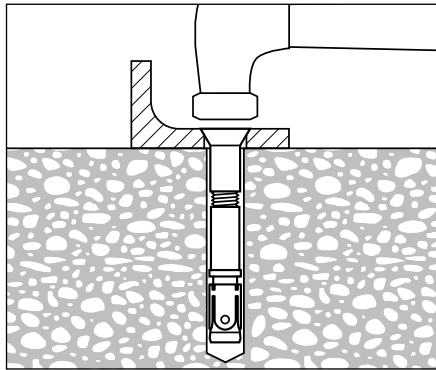
2. Clean.



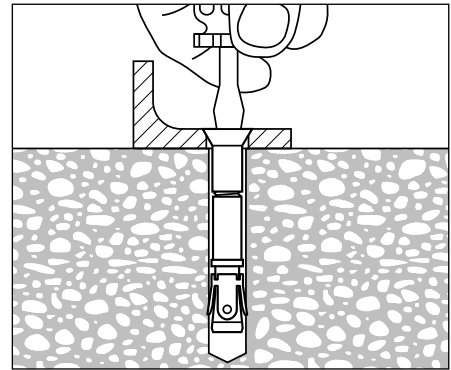
3. Thread post nut completely onto anchor. Tap into hole.



4. Loosen screw two full turns.

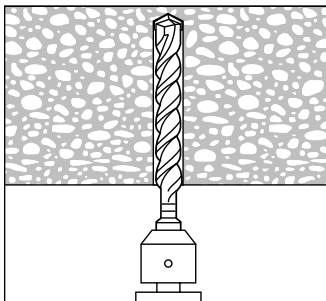


5. Tap-in again.

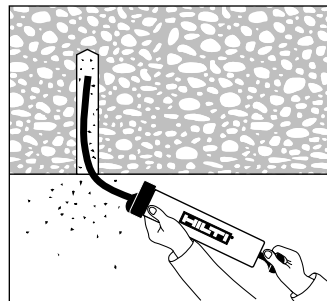


6. Tighten.

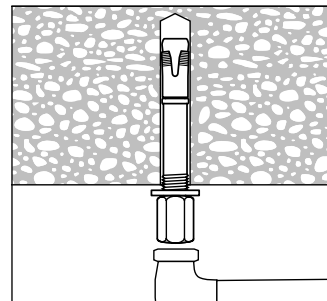
Rod Coupling KWIK Bolt 3 Anchor Installation Instructions



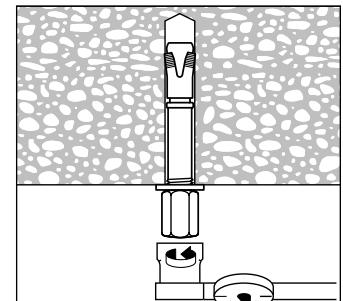
1. Drill.



2. Clean.

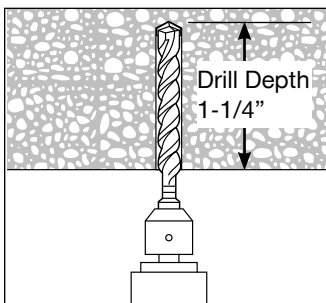


3. Tap-in.

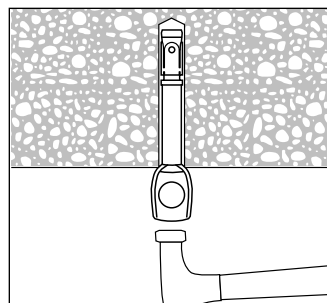


4. Tighten.

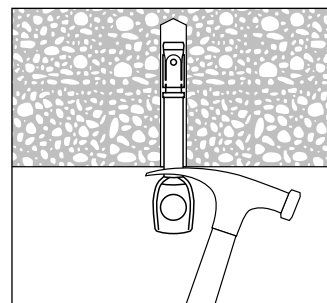
Hilti Ceiling KWIK Bolt (HHDCA) Anchor Installation Instructions



1. Drill hole using 1/4" bit.



2. Tap in.



3. Pry downward.

KWIK Bolt 3 Expansion Anchor 3.3.6

3.3.6.6 Ordering Information

KWIK Bolt 3 Anchor Product Line

Size	Length (ℓ) in. (mm)		Thread Length (ℓ _{th}) in. (mm)		ID Stamp	Box	Carbon Steel	304 SS	316 SS	HDG
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)	1-1/2	(41)	L	10		●		
			4-5/8	(119)			●			
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		●	●		

3.3.6 KWIK Bolt 3 Expansion Anchor

Countersunk KWIK Bolt Anchor Product Line

Size	Length in. (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. (mm)	Thread Length in. (mm)	ID Stamp	Box Quantity
3/8 x 2-1/4	2-1/4 (57)	7/8 (22)	B	100

HHDCa Ceiling Anchor Product Line

Size	Length in. (mm)	Eyelet Size in.	Box Quantity
1/4 x 2	2-1/32 (52)	5/16	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" only)

HHDCa Ceiling Hanger (1/4" x 2" only)

KWIK HUS (KH) Carbon Steel Screw Anchor 3.3.7

3.3.7.1 Product Description

Hilti KWIK HUS (KH) anchors are comprised of a body with hex washer head. The anchor is manufactured from carbon steel and is heat treated. It has a minimum 0.0003 inch (8 µm) zinc coating in accordance with DIN EN ISO 4042. The anchoring system is available in a variety of lengths with diameters of 3/8 inch, 1/2 inch, 5/8 inch and 3/4 inch (9.5mm, 12.7mm, 15.9mm and 19.1mm). The hex head is larger than the diameter of the anchor and is formed with serrations on the underside. The anchor body is formed with threads running most of the length of the anchor body. The anchor is installed in a predrilled hole with a powered impact wrench or torque wrench. The anchor threads cut into the base material on the sides of the hole and interlock with the base material during installation. Applicable base materials include normal-weight concrete, structural lightweight concrete, lightweight concrete over metal deck, and grout filled concrete masonry.

Guide Specifications

Screw anchors shall be KWIK HUS as supplied by Hilti, Inc. Anchors shall be manufactured from heat treated carbon steel material, zinc plated to a minimum thickness of 8µm. Anchor head shall display product name, (KH) diameter and length. Anchors shall be installed using a drill bit of same nominal diameter as anchor.

Product Features

- Quick and easy to install.
- Length and diameter identification clearly stamped on head facilitates quality control and inspection after installation.
- Through fixture installation improves productivity and accurate installation.
- Thread design enables quality setting and exceptional load values in wide variety of base material strengths.
- Anchor is fully removable
- Anchor size is same as drill bit size and uses standard diameter drill bits.
- Suitable for reduced edge distances and spacing.
- Suitable for uncracked normal weight concrete, lightweight concrete and grout filled concrete masonry.

3.3.7.2 Material Specifications

Hilti KWIK HUS anchors are manufactured from carbon steel. The anchors are dull zinc plated to a minimum thickness of 8µm.

3.3.7.1 Product Description

3.3.7.2 Material Specifications

3.3.7.3 Technical Data

3.3.7.4 Installation Instructions

3.3.7.5 Ordering Information



Listings/Approvals

ICC-ES (International Code Council)
AC 106 ESR Pending
(Grout filled concrete masonry)

3.3.7 KWIK HUS (KH) Carbon Steel Screw Anchor

3.3.7.3 Technical Data

Figure 1 — KWIK HUS (KH) Anchor Installation Details

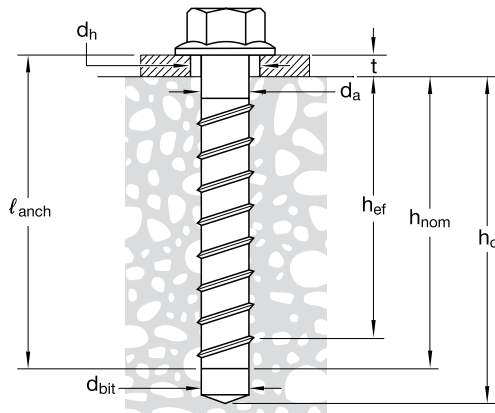


Table 1 – KWIK HUS (KH) Specification Table^{1,2,3}

Characteristic	Symbol	Units	Nominal Anchor Diameter (inches)										
			3/8			1/2			5/8		3/4		
Nominal Diameter	d _a	in.	3/8			1/2			5/8		3/4		
Drill Bit Diameter	d _{bit}	in.	3/8			1/2			5/8		3/4		
Baseplate Clearance Hole Diameter	d _h	in.	1/2			5/8			3/4		7/8		
Installation Torque ⁴	T _{inst}	ft-lbf	40			45			85		115		
Impact Wrench Torque Rating ³	T _{impact}	ft-lbf	114	450		137	450		450		450		
Minimum Nominal Embedment Depth	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 Depth	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 ²	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 ²	c _{min}	in.	1.50			1.75							
Minimum Spacing at Minimum Edge Distance	s _{min}	in.	3									4	
Minimum Concrete Thickness	h _{min}	in.	3.25	4	4.875	3.75	4.75	6.75	5	7	6	8.125	
Wrench Socket Size	-	in.	9/16			3/4			15/16		1-1/8		
Head Height	-	in.	0.35			0.49			0.57		0.70		
Effective tensile stress area	A _{se}	in. ²	0.086			0.161			0.268		0.392		
Minimum specified ultimate strength	f _{ut}	psi	107,120			97,140			90,180		81,600		

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 Pa, 1 in² = 645 mm², 1 lb/in = 0.175 N/mm

1 The data presented in this table is to be used in conjunction with the design criteria of ACI 318 Appendix D.

2 For installations through the soffit of steel deck into concrete (see figure 2) anchors installed in the lower flute may be installed with a maximum 1 inch offset in either direction from the center of the flute.

3 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.

4 T_{inst} applies to installations using a calibrated torque wrench.

KWIK HUS (KH) Carbon Steel Screw Anchor 3.3.7

Table 2 – KWIK HUS (KH) Tension and Shear Strength Design Information^{1,2,3,4,5}

Characteristic	Symbol	Units	Nominal Anchor Diameter (inches)									
			3/8		1/2			5/8		3/4		
Anchor Category 1,2 or 3			1									
Nominal Embedment Depth	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
Steel Strength in Tension (ACI 318 D.5.1)												
Tension Resistance of Steel	N_{sa}	lb.	9,213			15,640			24,210		32,013	
Reduction Factor for Steel Strength	Φ_{sa}	-	0.65									
Concrete Breakout Strength in Tension (ACI 318 D.5.2)												
Effective Embedment Depth	h_{ef}	in.	1.11	1.86	2.20	1.52	2.16	3.22	2.39	3.88	2.92	4.84
Critical Edge Distance	c_{ac}	in.	2.10	2.92	3.30	2.75	3.88	5.25	3.63	5.82	4.41	7.28
Effectiveness Factor – Uncracked Concrete	k_{uncr}	-	24						27			
Reduction Factor for Concrete Breakout Strength – Tension	Φ_{cb}	-	0.65 (Condition B)									
Characteristic Pullout Strength, Uncracked Concrete (2,500psi)	$N_{p,uncr}$	lb.	N/A									
Steel Strength in Shear (ACI 318 D.6.1)												
Shear Resistance of Steel – Static	V_{sa}	lb.	5,155			8,186			11,221		16,662	
Reduction Factor for Steel Strength	Φ_{sa}	-	0.60									
Concrete Breakout in Shear (ACI 318 D.6.2)												
Nominal Diameter	d_a	in.	0.375			0.500			0.625		0.750	
Load Bearing Length of Anchor	ℓ_e	in.	1.11	1.86	2.20	1.52	2.16	3.22	2.39	3.88	2.92	4.84
Reduction Factor for Concrete Breakout Strength — Shear	Φ_{cb}	-	0.70									
Concrete Pryout Strength in Shear (ACI 318 D.6.3)												
Coefficient for Pryout Strength	k_{cp}	-	1.0	1.0	1.0	1.0	1.0	2.0	1.0	2.0	2.0	2.0
Reduction Factor for Pryout Strength	Φ_{cp}	-	0.70									

For SI: 1 inch = 25.4 mm, 1 ft-lb = 1.356 N-m, 1 psi = 6.89 Pa, 1 in² = 645 mm²

- The data in this table is intended for use with the design provisions of ACI 318 Appendix D.
- Values of Φ in this table applies when the load combinations for ACI 318 Section 9.2, IBC Section 1605.2.1 are used and the requirements of ACI 318 D.4.4 for Condition B are met. If the load combinations of ACI 318 Appendix C are used, the appropriate value of Φ must be used. For situations where reinforcement meets the requirements of Condition A, ACI 318 Section D.4.4 provides the appropriate Φ factor.
- N/A denotes that pullout resistance does not govern and does not need to be considered.
- The characteristic pullout resistance for concrete compressive strengths greater than 2500 psi may be increased by multiplying the value in the table by $(f'_c/2,500)^{1/2}$ for psi or $(f'_c/17.2)^{1/2}$ for MPa.
- For sand-lightweight concrete, multiply concrete capacity values and pullout values by 0.60.

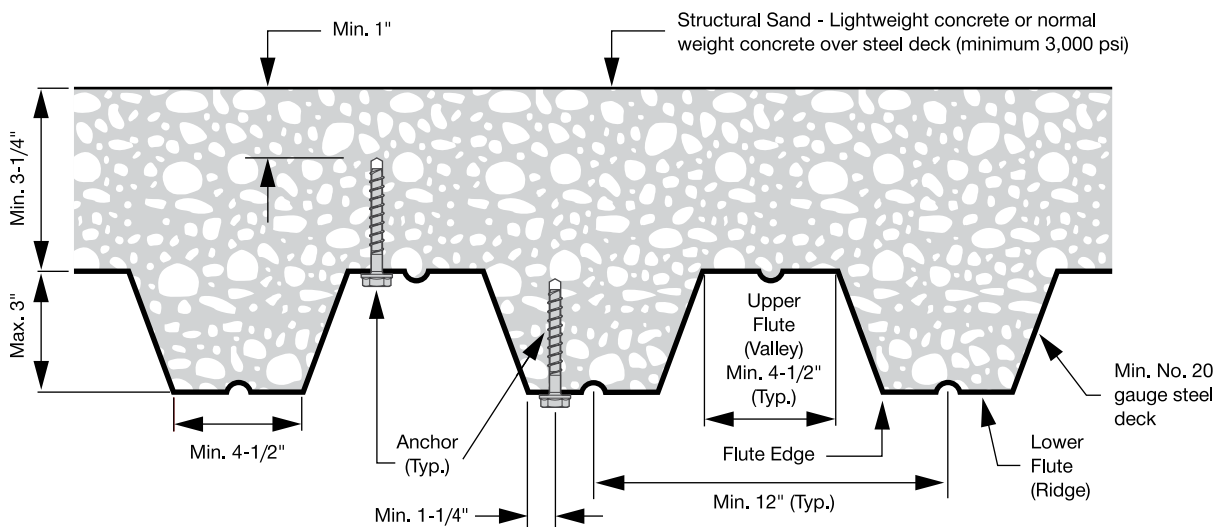
3.3.7 KWIK HUS (KH) Carbon Steel Screw Anchor

Table 3 – KWIK HUS (KH) Tension and Shear Design Data for installation in the Underside of Concrete-filled Profile Steel Deck Assemblies^{1,2,3,4,5}

Characteristic	Symbol	Units										Upper Flute				
			3/8			1/2			5/8		3/4	1/4		3/8		1/2
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	1-5/8	2-1/2	1-5/8	2-1/2	2-1/4
Minimum Hole Depth	h_{hole}	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	2	2-7/8	1-7/8	2-7/8	2-5/8
Effective Embedment Depth	h_{ef}	in.	1.11	1.86	2.20	1.52	2.16	3.22	2.39	3.88	2.92	1.18	1.92	1.11	1.86	1.52
Pullout Resistance, (uncracked concrete)	$N_{p,deck,uncr}$	lb.	1285	2240	3920	1305	3060	5360	4180	9495	4180	1490	1960	1015	2920	1395
Steel Strength in Shear	$V_{sa,deck}$	lb.	1670	1511	3605	1605	2922	3590	3470	4190	3762	1205	3265	3935	6090	7850

- 1 Installation must comply with Figure 2.
- 2 The values in this table shall be used with the appropriate equal in ACI 318 Appendix D, equations D.5.3.1 and D.5.3.2.
- 3 The values for Φ_p in tension can be found in Table 2 of this report and the values for Φ_{sa} in shear can be found in Table 3.
- 4 For installations through the soffit of steel deck into concrete (see Figure 2) anchors installed in the lower flute shall be installed with a maximum 1 inch offset in either direction from the centerline of the flute.
- 5 The characteristic pullout resistance for concrete compressive strengths greater than 2,500 psi may be increased by multiplying the value in the table by $(f'_c / 3,000)^{1/2}$ for psi or $(f'_c / 20.7)^{1/2}$ for MPa.

Figure 2 – Installation of KWIK HUS (KH) 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.

KWIK HUS (KH) Carbon Steel Screw Anchor 3.3.7

Table 4 – KWIK HUS (KH) Allowable Stress Design Values for Illustrative Purposes^{1,2,3,4,5,6,7,8,9,12}

Nominal Anchor Diameter [in.]	Embedment Depth, h_{nom} [in.]	Effective Embedment Depth, h_{ef} [in.]	Allowable Tension Load ¹⁰ [lbs]	Allowable Shear Load ¹¹ [lbs]
3/8	1-5/8	1.11	633	682
	2-1/2	1.86	1374	1480
	3-1/4	2.20	1768	1903
1/2	2-1/4	1.52	1142	1093
	3	2.16	1934	1852
	4-1/4	3.22	3521	3411
5/8	3-1/4	2.39	2252	2425
	5	3.88	4657	4675
3/4	4	2.92	3041	6549
	6-1/4	4.84	6489	6943

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N.

- 1 Single anchor with static tension or shear load only.
- 2 Concrete determined to remain uncracked for the life of the anchorage.
- 3 Load combinations are taken from ACI 318 Section 9.2 (no seismic loading).
- 4 40% dead load and 60% live load, controlling load combination $1.2D + 1.6L$.
- 5 Calculation of weighted average for conversion factor $\alpha = 1.2(0.4) + 1.6(0.6) = 1.44$.
- 6 $f'_c = 2,500$ psi (normal weight concrete).
- 7 $c_{a1} = c_{a2} \geq c_{ac}$.
- 8 $h \geq h_{min}$.
- 9 Values are for Condition B where supplementary reinforcement in accordance with ACI 318 D.4.4 is not provided.
- 10 Allowable tension load = factored load (Concrete Breakout from Table 2) $\div 1.44$
- 11 Allowable Shear Load = factored Load (Lessor of V_{sa} or Concrete Pryout from Table 2) $\div 1.44$
- 12 Values are for single anchors installed without influence of base material edge distance or adjacent anchors.

3.3.7 KWIK HUS (KH) Carbon Steel Screw Anchor

Table 5 – Allowable Tension Loads for KWIK HUS installed in Grout-filled Masonry Walls (lb)^{1,2,7,8}

Anchor Diameter (inches)	Embedment (inches) ³	Loads @ C _{cr} and S _{cr}	Spacing			Edge Distance		
			Critical - S _{cr} (inches) ⁴	Minimum - S _{min} (inches) ⁴	Load Reduction Factor at S _{min} ⁶	Critical - C _{cr} (inches) ⁵	Minimum C _{min} (inches) ⁵	Load Reduction Factor ⁶
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	1210						
1/2	2 1/4	710	4	2	0.60	4	4	1.00
	3	1110	8	4				
	4 1/4	1515						
5/8	3 1/4	1155	10	4	0.60	10	4	1.00
	5	1735						
3/4	4	1680	12	4	0.60	12	4	1.00
	6 1/4	2035						

Table 6 – Allowable Shear Loads for KWIK HUS installed in Grout-filled Masonry Walls (lb)^{1,2,3,7,8}

Anchor Diameter (inches)	Embedment (inches) ³	Load at C _{cr} and S _{cr}	Spacing			Edge Distance			
			Critical - S _{cr} (inches) ⁴	Minimum - S _{min} (inches) ⁴	Load Reduction Factor at S _{min} ⁶	Critical - C _{cr} (inches) ⁵	Minimum - C _{min} (inches) ⁵	Load Reduction Factor at C _{min}	
								Load Direction Perpendicular to Edge	Load Direction Parallel to Edge
3/8	1 5/8	1140	6	4	0.94	6	4	0.61	1.00
	2 1/2	1165						0.70	1.00
	3 1/4	1190						0.70	1.00
1/2	2 1/4	1845	8	4	0.88	8	4	0.50	1.00
	3	2055						0.45	0.94
	4 1/4	2745						0.40	0.89
5/8	3 1/4	3040	10	4	0.36	10	4	0.36	0.82
	5	3485						0.34	0.92
3/4	4	3040	10	4	0.36	12	4	0.36	0.82
	6 1/4	3485						0.34	0.92

1 All values are for anchors installed in fully grouted masonry with minimum masonry prism strength of 1500psi. Concrete masonry units shall be light-weight or normal-weight.

2 Anchors may not be installed within one inch in any direction of a vertical joint.

3 Embedment depth is measured from the outside face of the concrete masonry embedment.

4 S_{cr} is anchor spacing where full load values in the Table may be used. 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.

5 C_{cr} is the edge distance where full load values in the table may be used. 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.

6 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).

7 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.

8 For combined loading:
$$\left(\frac{T_{\text{applied}}}{T_{\text{allowable}}} \right)^{5/3} + \left(\frac{V_{\text{applied}}}{V_{\text{allowable}}} \right)^{5/3} \leq 1$$

KWIK HUS (KH) Carbon Steel Screw Anchor 3.3.7

Table 7 – KWIK HUS Allowable Loads installed in Top of Grout-Filled Concrete Masonry Construction (lb)

Anchor Diameter (inches)	Minimum Embedment Depth (inches) ²	Minimum Edge Distance (inches)	Minimum Spacing (inches)	Minimum End Distance (inches)	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	1110
5/8	5	1 3/4	10	5	1310	305	1165

1 All values are for anchors installed in fully grouted masonry with minimum masonry prism strength of 1500psi. Concrete masonry units shall be light-weight or normal-weight.

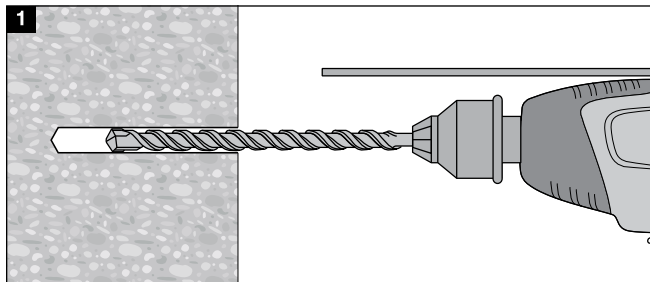
2 Embedment depth is measured from the top of the masonry construction.

3 For combined loading: $\left(\frac{T_{\text{applied}}}{T_{\text{allowable}}}\right)^{5/3} + \left(\frac{V_{\text{applied}}}{V_{\text{allowable}}}\right)^{5/3} \leq 1$

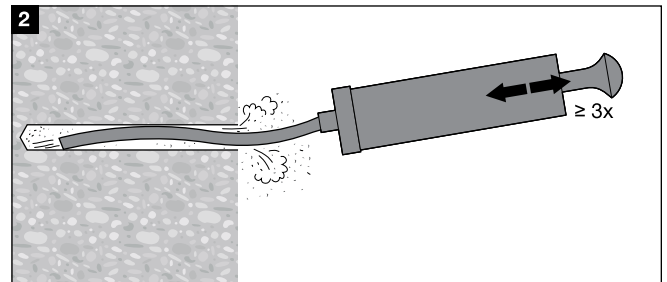
3.3.7.4 Installation Instructions

Drill holes in base material using carbide-tipped masonry drill bits complying with ANSI B212.15-1994. The nominal drill bit diameter must be equal to that of the anchor. The minimum drilled hole depth is given in Table 1. Prior to installation, dust and debris must be removed from the drilled hole using a hand pump, compressed air or a vacuum. The anchor must be installed into the predrilled hole using a powered impact wrench or installed with a torque wrench until the proper

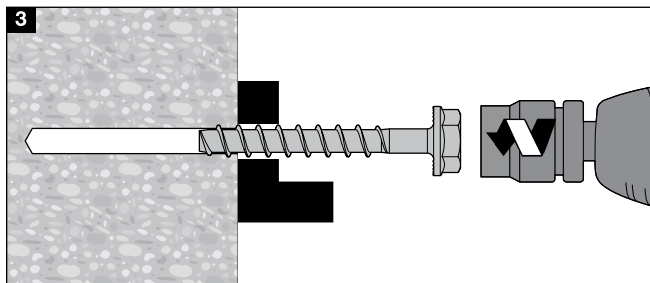
nominal embedment depth is obtained. The impact wrench torque, T_{impact} and installation torque, T_{inst} for the manual torque wrench must be in accordance with Table 1. The KWIK HUS (KH) may be loosened by a maximum of one turn and reinstalled with a socket wrench or powered impact wrench to facilitate fixture attachment or realignment. For member thickness and edge distance restrictions for installations into the soffit of concrete on steel deck assemblies, see Figure 2.



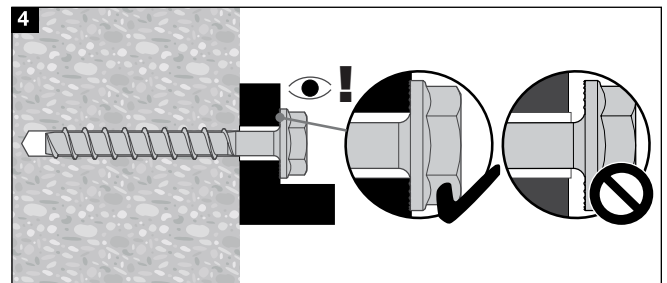
1 Drill hole in base material using proper diameter drill bit.



2 Clean drilled hole to remove debris.



3 Fasten anchor tightly against fastened part.



4 Install anchor using proper impact tool or torque wrench.

3.3.7.5 KWIK HUS (KH) Carbon Steel Screw Anchor

The data below is developed from testing performed in accordance with ACI 355.2. It is intended for applications designed according to CSA A23.3-04 Update No. 3 (August 2009) Design of Concrete Structures Annex D and is generally suitable for the conditions described in the introduction of Annex D.

Table 8 – Design Information for use with CSA A23.3-04



Characteristic	Symbol	Units	Nominal Anchor Diameter (inches)											Code Ref.
			3/8		1/2			5/8		3/4				
Anchor Category (1, 2 or 3)			1											
Nominal Embedment Depth	h_{nom}	mm	41	64	83	57	76	108	83	127	102	159		
Concrete material resistance factor for concrete	ϕ_c	-	0.65											8.4.2
Steel material resistance factor	ϕ_s	-	0.85											8.4.3
Ultimate strength of anchor steel	f_{ut}	MPa	739			670			622		563			
Effective cross-sectional area of anchor	A_{se}	mm ²	55.5			103.9			172.9		252.9			
Minimum Edge Distance	c_{min}	mm	44											
Minimum Spacing	s_{min}	mm	76						102					
Minimum Concrete Thickness	h_{min}	mm	83	102	121	95	127	152	127	178	152	203		
Steel Strength in Tension (CSA A23.3 D.6.1) ²														
Factored Steel Resistance in tension	N_{sr}	kN	24.4			41.4			64.0		84.7		D.6.1.2	
Reduction Factor for Steel Strength	R	-	0.70											D.5.4b
Concrete Breakout Strength in Tension (CSA A23.3 D.6.2)														
Effective Embedment Depth	h_{ef}	mm	28	47	56	39	55	82	61	99	74	123		
Critical Edge Distance	c_{ac}	mm	64	79	95	70	99	133	92	148	112	185		
Effectiveness Factor — Uncracked Concrete	k_{uncr}	-	10											D.6.2.2
Modification factor for uncracked concrete	$\Psi_{c,N}$	-	1.4											D.6.2.6
Reduction Factor for Concrete Breakout Strength	R	-	1.15 (Condition A), 1.00 (Condition B)											D.5.4c
Pullout Strength in Tension (CSA A23.3 D.6.3) ¹														
Factored Pullout Resistance, uncracked concrete (20 MPa)	$N_{pr,uncr}$	kN	N/A											D.6.3.2
Reduction Factor for pullout strength	R		1.15 (Condition A), 1.00 (Condition B)											
Steel Strength in Shear (CSA A23.3 D.7.1) ²														
Factored Shear Resistance of Steel - Static	V_{sr}	kN	12.7			20.1			27.6		40.9		D.7.1.2c	
Reduction Factor for Steel Strength	R		0.65											D.5.4b
Concrete Breakout Strength in Shear (CSA A23.3 D.7.2)														
Nominal Diameter	d_o	mm	9.5			12.7			15.9		19.1			
Load Bearing Length of Anchor	ℓ_e	mm	28	47	56	39	55	82	61	99	74	123		
Reduction Factor for Concrete Breakout Strength	R	-	1.15 (Condition A), 1.00 (Condition B)											
Concrete Pryout Strength in Shear (CSA A23.3 D.7.3)														
Coefficient for Pryout Strength	k_{cp}		1.0	1.0	1.0	1.0	1.0	2.0	1.0	2.0	2.0	2.0		
Reduction Factor for Pryout Strength	R		1.15 (Condition A), 1.00 (Condition B)											

1 N/A denotes that pullout resistance does not govern and does not need to be considered.

2 The KWIK HUS (KH) is considered a brittle steel element as defined by CSA A23.3 D.2.

3 The KWIK HUS (KH) is suitable for uncracked concrete applications only. For cracked concrete applications (i.e. tension zone anchorages), consider the KWIK HUS (KH) anchor

This table replaces Table 2 of this Supplement for anchorage design in normal weight concrete in accordance with CSA A23.3-04.

KWIK HUS (KH) Carbon Steel Screw Anchor 3.3.7

3.3.7.6 Ordering Information

Description	Hole Diameter	Total Length without Anchor Head	Minimum Embedment Depth	Qty (pcs) 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

3.3.8 HCA Coil Anchor

3.3.8.1 Product Description

3.3.8.2 Material Specifications

3.3.8.3 Technical Data

3.3.8.4 Installation Instructions

3.3.8.5 Ordering Information



3.3.8.1 Product Description

The Hilti HCA Coil Anchor is a bolt type expansion anchor for use in concrete.

Product Features

- Reusable type anchors, providing major cost savings*
- Bolt type anchor enables low profile fastenings
- Preassembled units allow quick production fastening
- Utilizes a disposable, low cost expansion coil which minimizes reuse costs
- Heat treated to Grade 5 specification, which provides high shear load capacity

* Test results when reused four uses: maximum 20% reduction in tensile capacity; no reduction in shear.

Guide Specifications

Expansion Anchor – Expansion anchors shall be bolt style which meet the mechanical properties of a Grade 5 bolt. Anchors are to be zinc plated in accordance with ASTM B633, SC1, Type III. Anchors shall be Hilti HCA designation as supplied by Hilti.

Installation – Install bolt type anchors in holes drilled with Hilti carbide tipped drill bits or DD-B or DD-C diamond core bits. Install anchors as per manufacturer's recommendation.

3.3.8.2 Material Specifications

1/4" HCA Carbon Steel meets the requirements of case of hardened AISI 1018

3/8"– 3/4" HCA Carbon Steel meets the chemical requirements of AISI 1035 and heat treated to Grade 5 specification

Coil meets the requirements of plain carbon steel

Carbon Steel HCA and coil are plated in accordance with ASTM B633, SC1, Type III

Mechanical Properties

min. f_u
ksi (MPa)

100 (690)

120 (830)

Table 2 - HCA Lengths²

Diameter	Length ℓ in. (mm)
1/4	1-3/4 (44)
	2-1/2 (64)
	3-1/2 (89)
3/8	2-1/4 (57)
	3 (76)
	5 (127)
1/2	3 (76)
	4 (102)
	5-1/2 (140)
	7 (178)
3/8	3-1/2 (89)
	5 (127)
	8 (203)
3/4	4-1/2 (114)
	6 (152)
	10 (254)

3.3.8.3 Technical Data

Table 1 - HCA Specification Table

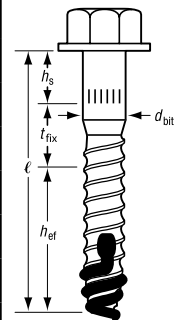
Details	Bolt Size					
	in.	1/4	3/8	1/2	5/8	3/4
d_{bit} nominal bit diameter ¹	in.	1/4	3/8	1/2	5/8	3/4
h_s depth set mark	in.	3/8	5/8	5/8	3/4	1
ℓ anchor length min./max. (other lengths available)	in.	1-3/4	2-1/4	3	3-1/2	4-1/2
	in.	3-1/2	5	7	8	10
d_h coil clearance hole in plate	in.	5/16	7/16	9/16	11/16	13/16
T_{inst} installation torque	ft-lb	10	40	80	130	180
h min. base material thickness	in.	3" or 1.3 h_{ef} whichever is greater				

1 Hilti carbide-tipped drill bit or matched tolerance Hilti DD-B or DD-C diamond core bits

2 Maximum thickness to be fastened $t = \ell - (h_{ef} + h_s)$

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right)^1 + \left(\frac{V_d}{V_{rec}} \right)^1 \leq 1.0 \text{ (Ref. Section 4.1.8.3)}$$



HCA Coil Anchor 3.3.8

Table 3 - Carbon Steel HCA Allowable Concrete/Steel Capacity in Concrete¹

Anchor Diameter in.	Embedment Depth in.	Allowable Concrete Capacity ^{3,4} , lb						Allowable Steel Strength ² , lb	
		2000 psi		4000 psi		6000 psi			
		Tension ⁵	Shear	Tension ⁵	Shear	Tension ⁵	Shear	Tension	Shear
1/4	3/4	230	230	325	330	400	400	1620	1080
	1	355	380	500	535	615	655		
3/8	1-1/2	650	850	920	1205	990	1475	4355	2905
	2	1005	1390	1420	1965	1740	2410		
1/2	2	1005	1515	1420	2145	1740	2625	7775	5180
	3	1845	3020	2605	4270	3190	5230		
5/8	2-3/8	1300	2175	1835	3075	2250	3765	12145	8095
	3-7/8	2705	5000	3825	7070	4685	8660		
3/4	3-1/4	2080	3915	2940	5540	3600	6780	17495	11665
	4-1/2	3385	6810	4790	9630	5865	11705		

- 1 Apply any applicable edge distance and anchor spacing reduction factors to the concrete capacity prior to determining if concrete or steel capacity control design. See Table 5 in this Section.
- 2 Steel strength based on $0.22 F_u A_g$ for shear and $0.33 F_u A_g$ for tension.
- 3 Concrete strength based on a safety factor of 4.0.
- 4 Test results when reused four times: maximum 20% reduction in tensile capacity; no reduction in shear.

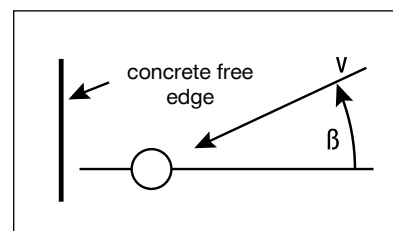
Table 4 - Carbon Steel HCA Ultimate Concrete/Steel Capacity in Concrete¹

Anchor Diameter in.	Embedment Depth in.	Ultimate Concrete Capacity ^{3,4} , lb						Ultimate Steel Strength ² , lb	
		2000 psi		4000 psi		6000 psi			
		Tension ⁵	Shear	Tension ⁵	Shear	Tension ⁵	Shear	Tension	Shear
1/4	3/4	920	930	1305	1315	1595	1610	3675	2830
	1	1420	1515	2005	2145	2460	2625		
3/8	1-1/2	2610	3410	3690	4825	4515	5910	9900	7615
	2	4015	5565	5675	7865	6950	9635		
1/2	2	4015	6065	5675	8575	6950	10505	17665	13570
	3	7375	12080	10430	17085	12770	20930		
5/8	2-3/8	5195	8700	7345	12305	9000	15070	27605	21240
	3-7/8	10825	19995	15305	28275	18745	34630		
3/4	3-1/4	8315	15660	11760	22150	14400	27125	39760	30590
	4-1/2	13545	27235	19160	38515	23465	47170		

- 1 Apply any applicable edge distance and anchor spacing reduction factors to the concrete capacity prior to determining if concrete or steel capacity control design. See Table 5 in this Section.
- 2 Steel strength based on $0.57 F_u A_g$ for shear and $0.75 F_u A_g$ for tension.
- 3 Concrete capacity based on Concrete Capacity Design method and verified by test data.
- 4 Test results when reused four times: maximum 20% reduction in tensile capacity; no reduction in shear.

Table 5 - HCA Edge Distance and Anchor Spacing Guidelines^{1,2}

Load Direction		Critical	Minimum	Influence Factor ³
Spacing	Tension	$3.0 h_{ef}$	$1.0 h_{ef}$	$f_{AN} = 0.70$
	Shear	$2.0 h_{ef}$	$1.0 h_{ef}$	$f_{AV} = 0.70$
Edge Distance	Tension	$1.5 h_{ef}$	$0.8 h_{ef}$	$f_{RN} = 0.75$
	Shear (⊥ toward edge) ⁴	$2.5 h_{ef}$	$1.0 h_{ef}$	$f_{RV1} = 0.25$
	Shear (or ⊥ away from edge) ⁴	$2.5 h_{ef}$	$1.0 h_{ef}$	$f_{RV2} = 0.50$

See Note 4


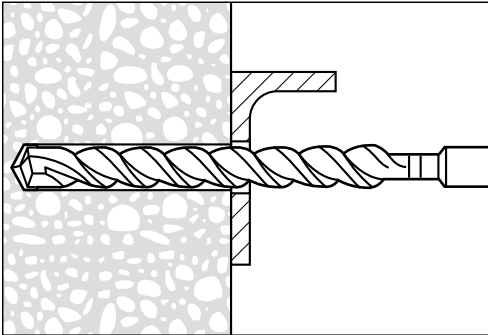
- 1 For edge and spacing distances between critical and minimum spacing/edge distances, use linear interpolation.
- 2 Influence factors are cumulative.
- 3 Influence factor at minimum spacing/edge distance. Influence factor at critical equals 1.0.
- 4 For shear loads in between perpendicular toward edge and parallel with edge, use the following equation, $f_{RVB} = 0.25 / (\cos \beta + 0.5 \sin \beta)$ for $55^\circ \leq \beta < 90^\circ$. For $0^\circ \leq \beta < 55^\circ$, use influence factor for shear perpendicular toward edge.

3.3.8 HCA Coil Anchor

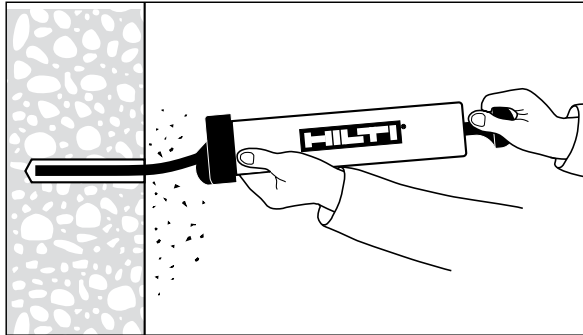
3.3.8.4 Installation Instructions

Important Installation Considerations

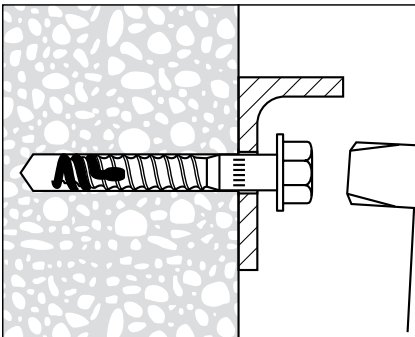
1. Hole depth is determined by the anchor length minus fixture thickness plus 1/4" minimum.
2. When reassembling the coil tab onto the tapered end of the bolt, the flattened portion (tang) must be in the direction of the head.
3. Anchors are to be initially inserted to where the depth set mark is flush with the surface of the fixture. Tap the anchor to the depth mark before tightening.



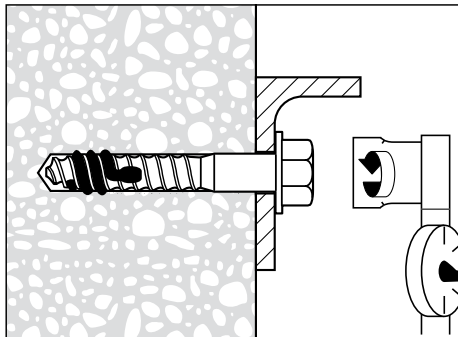
Drill hole same diameter as anchor



Clean hole



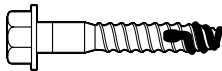
Insert (tap anchor) to anchor's **depth set mark**



Tighten to installation torque

3.3.8.5 Ordering Information

HCA HEX HEAD



Description	Box Qty.	Bit Dia.	Fixture Thickness at minimum embedment depth
HCA 1/4" X 1-3/4"	100	1/4"	5/8"
HCA 1/4" X 2-1/2"	100	1/4"	1-3/8"
HCA 1/4" X 3-1/2"	100	1/4"	2-3/8"
HCA 3/8" X 2-1/4"	100	3/8"	1/8"
HCA 3/8" X 3"	100	3/8"	7/8"
HCA 3/8" X 5"	50	3/8"	2-7/8"
HCA 1/2" X 3"	50	1/2"	3/8"
HCA 1/2" X 4"	25	1/2"	1-3/8"
HCA 1/2" X 5-1/2"	25	1/2"	2-7/8"
HCA 1/2" X 7"	25	1/2"	4-3/8"
HCA 5/8" X 3-1/2"	25	5/8"	3/8"
HCA 5/8" X 5"	25	5/8"	1-7/8"
HCA 5/8" X 8"	20	5/8"	4-7/8"
HCA 3/4" X 4-1/2"	20	3/4"	1/4"
HCA 3/4" X 6"	10	3/4"	1-3/4"
HCA 3/4" X 10"	10	3/4"	5-3/4"

HCT Replacement Coil



Description	Box Qty.
HCT 1/4"	100
HCT 3/8"	100
HCT 1/2"	100
HCT 5/8"	100
HCT 3/4"	50

* Test results when reused four times: maximum 20% reduction in tensile capacity; no reduction in shear.

HDI and HDI-L Drop-in Anchor 3.3.9

3.3.9.1 Product Description

The Hilti HDI/HDI-L Drop-in anchor is an internally threaded, flush mounted expansion anchor for use in concrete.

Product Features

HDI

- Anchor, setting tool and Hilti drill bit form a matched tolerance system to provide reliable fastenings
- Allows shallow embedment without sacrificing performance
- Lip provides flush installation, consistent anchor depth, and easy rod alignment (HDI-L)
- Lip allows accurate flush surface setting, independent of hole depth (HDI-L)
- Ideal for repetitive fastenings with threaded rods of equal length

- Intelligent expansion section adapts to the base material and reduces number of hammer blows up to 50% (HDI-L)

Guide Specifications

Expansion Anchor Expansion anchors shall be flush or shell type and zinc plated in accordance with ASTM B633, SC 1, Type III. Anchors shall be Hilti HDI/HDI-L anchors as supplied by Hilti.

Installation Install shell or flush type anchors in holes drilled with Hilti carbide tipped drill bits. Install anchors as per manufacturer's recommendations.

3.3.9.1 Product Description

3.3.9.2 Material Specifications

3.3.9.3 Technical Data

3.3.9.4 Installation Instructions

3.3.9.5 Ordering Information

3.3.9.2 Material Specifications

HDI/HDI-L, 1/4", 3/8", 1/2", and HDI 5/8" and 3/4" are manufactured from mild carbon steel which is plated with a zinc finish for corrosion protection in accordance with ASTM B633, SC 1, Type III

HDI Stainless Steel material meets the requirements of AISI 303

Listings/Approvals

FM (Factory Mutual)

Pipe Hanger Components for Automatic Sprinkler Systems (3/8" - 3/4") (HDI and HDI-L)

UL (Underwriters Laboratories)

UL 203 Pipe Hanger Equipment for Fire Protection Services (3/8" - 3/4")

3.3.9.3 Technical Data

Table 1 - HDI/HDI-L Specification Table

Details	Anchor Size	in. (mm)	HDI/HDI-L			HDI	
			1/4 (6.4)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)
d _{bit}	nominal bit diameter	in.	3/8	1/2	5/8	27/32	1
h _{nom}	std. depth of embedment	in.	1	1-9/16	2	2-9/16	3-3/16
ℓ	anchor length	(mm)	(25)	(40)	(51)	(65)	(81)
h ₁	hole depth						
ℓ _{th}	useable thread length	in.	7/16	5/8	11/16	7/8	1-3/8
		(mm)	(11)	(15)	(17)	(22)	(34)
	threads per inch		20	16	13	11	10
h	min. base material thickness	in.	3	3-1/8	4	5-1/8	6-3/8
		(mm)	(76)	(79)	(102)	(130)	(162)
T _{inst}	installation torque	ft-lb	4	11	22	37	80
		(Nm)	(5.4)	(14.9)	(29.8)	(50.2)	(108.5)

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right)^{5/3} + \left(\frac{V_d}{V_{rec}} \right)^{5/3} \leq 1.0 \quad (\text{Ref. Section 4.1.8.3})$$

3.3.9 HDI and HDI-L Drop-in Anchor

Table 2 - Carbon Steel HDI Allowable Loads in Concrete¹

Anchor size in. (mm)	2000 psi (13.8 MPa)				4000 psi (27.6 MPa)				6000 psi (41.4 MPa)			
	Tension		Shear		Tension		Shear		Tension		Shear	
	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L
1/4 (6.4)	500 (2.2)	500 (2.2)	450 (8.0)	450 (8.0)	570 (2.5)	570 (2.5)	625 (2.8)	625 (2.8)	790 (3.5)	790 (3.5)	700 (3.1)	700 (3.1)
3/8 (9.5)	890 (4.0)	890 (4.0)	965 (4.3)	965 (4.3)	1115 (5.0)	1115 (5.0)	1250 (5.6)	1250 (5.6)	1360 (6.0)	1360 (6.0)	1500 (6.7)	1500 (6.7)
1/2 (12.7) ²	1120 (5.0)	1120 (5.0)	1500 (6.7)	1500 (6.7)	1785 (7.9)	1785 (7.9)	2125 (9.5)	1940 (8.6)	2345 (10.4)	2345 (10.4)	2500 (11.1)	2500 (11.1)
5/8 (15.9)	1875 (8.3)	-	2500 (11.1)	-	2920 (13.0)	-	3250 (14.5)	-	3715 (16.5)	-	3750 (16.7)	-
3/4 (19.1)	2500 (11.1)	-	3875 (17.2)	-	4065 (18.1)	-	5000 (22.2)	-	5565 (24.8)	-	5500 (24.5)	-

1 The ultimate shear and allowable shear values are based on the use of SAE Grade 5 bolts, ($f_y = 85$ ksi, $f_{ult} = 120$ ksi) with the exception of the 1/4" HDI/HDI-L in $f'_c = 6000$ psi concrete which is based upon the use of a SAE Grade 8 bolt ($f_y = 120$ ksi, $f_{ult} = 150$ ksi).

2 Allowable and Ultimate tension loads for the HDI 1/2 are applicable to the HDI-S 1/2.

Table 3 - Carbon Steel HDI Ultimate Loads in Concrete¹

Anchor size in. (mm)	2000 psi (13.8 MPa)				4000 psi (27.6 MPa)				6000 psi (41.4 MPa)			
	Tension		Shear		Tension		Shear		Tension		Shear	
	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L	HDI	HDI-L
1/4 (6.4)	1995 (8.9)	1995 (8.9)	1800 (8.0)	1800 (8.0)	2270 (10.1)	2270 (10.1)	2500 (11.1)	2500 (11.1)	3150 (14.0)	3150 (14.0)	2800 (12.5)	2800 (12.5)
3/8 (9.5)	3555 (15.8)	3555 (15.8)	3850 (17.1)	3850 (17.1)	4460 (19.8)	4460 (19.8)	5000 (22.2)	5000 (22.2)	5430 (24.2)	5430 (24.2)	6000 (26.7)	6000 (26.7)
1/2 (12.7) ²	4470 (19.9)	4470 (19.9)	6000 (26.7)	6000 (26.7)	7140 (31.8)	7140 (31.8)	8500 (37.8)	7750 (34.4)	9375 (41.7)	9375 (41.7)	10000 (44.5)	10000 (44.5)
5/8 (15.9)	7500 (33.4)	-	10000 (44.5)	-	11685 (52.0)	-	13000 (57.8)	-	14865 (66.1)	-	15000 (66.7)	-
3/4 (19.1)	10000 (44.5)	-	15500 (69.0)	-	16260 (72.3)	-	20000 (89.0)	-	22250 (99.0)	-	22000 (97.9)	-

1 The ultimate shear and allowable shear values are based on the use of SAE Grade 5 bolts, ($f_y = 85$ ksi, $f_{ult} = 120$ ksi) with the exception of the 1/4" HDI/HDI-L in $f'_c = 6000$ psi concrete which is based upon the use of a SAE Grade 8 bolt ($f_y = 120$ ksi, $f_{ult} = 150$ ksi).

2 Allowable and Ultimate tension loads for the HDI 1/2 are applicable to the HDI-S 1/2.

Table 4 - Carbon Steel HDI Allowable Loads in Lightweight Concrete and Lightweight Concrete over Metal Deck^{1,2}

Anchor size in. (mm)	Anchor Installed in 3000 psi (20.7 MPa)		Anchor Installed Through Steel Deck Upper Flute		Anchor Installed Through Steel Deck Lower Flute	
	Lt. Wt. Concrete ³		Into 3000 psi (20.7 MPa) Lt. Wt. Concrete ⁴		Into 3000 psi (20.7 MPa) Lt. Wt. Concrete ⁴	
	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
1/4 (6.4)	465 (2.1)	340 (1.5)	530 (2.4)	335 (1.5)	375 (1.7)	250 (1.1)
3/8 (9.5)	755 (3.4)	940 (4.2)	880 (3.9)	1010 (4.5)	500 (2.2)	500 (2.2)
1/2 (12.7)	1135 (5.0)	1700 (7.6)	1105 (4.9)	1755 (7.8)	625 (2.8)	750 (3.3)
5/8 (15.9)	1465 (6.5)	2835 (12.6)	-	-	875 (3.9)	875 (3.9)
3/4 (19.1)	2075 (9.2)	3680 (16.4)	-	-	1250 (5.5)	1000 (4.4)

1 The allowable values are based on the use of SAE Grade 2 bolts installed in the anchors.

2 Based on using a safety factor of 4.0.

3 The tabulated shear and tensile values are for anchors installed in structural lightweight concrete having the designated ultimate compressive strength at the time of installation. The concrete must comply with ASTM C 330-05.

4 The tabulated shear and tensile values are for anchors installed through 20 gauge intermediate decking into structural lightweight concrete having the designated ultimate strength at the time of installation. The concrete must comply with ASTM C 330-05.

Table 5 - Stainless Steel HDI Allowable Loads in Concrete

Anchor size in. (mm)	4000 psi (27.6 MPa)		6000 psi (41.4 MPa)	
	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
SS HDI - 1/4 (6.4)	480 (2.1)	600 (2.7)	740 (3.3)	600 (2.7)
SS HDI - 3/8 (9.5)	1040 (4.6)	1230 (5.5)	1460 (6.5)	1230 (5.5)
SS HDI - 1/2 (12.7)	1840 (8.2)	2760 (12.4)	2410 (10.7)	2760 (12.3)
SS HDI - 5/8 (15.9)	2630 (11.7)	4510 (20.1)	3770 (16.8)	4510 (20.1)
SS HDI - 3/4 (19.1)	3830 (17.0)	5580 (24.8)	5030 (22.4)	5580 (24.8)

Note: The ultimate and allowable shear values are based on the use of Type 18-8 bolts.

Table 6 - Stainless Steel HDI Ultimate Loads in Concrete

Anchor Size in. (mm)	4000 psi (27.6 MPa)		6000 psi (41.4 MPa)	
	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
SS HDI - 1/4 (6.4)	1930 (8.6)	2400 (10.7)	2950 (13.1)	2400 (10.7)
SS HDI - 3/8 (9.5)	4170 (18.5)	4920 (21.9)	5850 (26.0)	4920 (21.9)
SS HDI - 1/2 (12.7)	7350 (32.7)	11040 (49.1)	9630 (42.8)	11040 (49.1)
SS HDI - 5/8 (15.9)	10540 (46.9)	18040 (80.2)	15100 (67.2)	18040 (80.2)
SS HDI - 3/4 (19.1)	15340 (68.2)	22320 (99.3)	20130 (89.5)	22320 (99.3)

HDI and HDI-L Drop-in Anchor 3.3.9

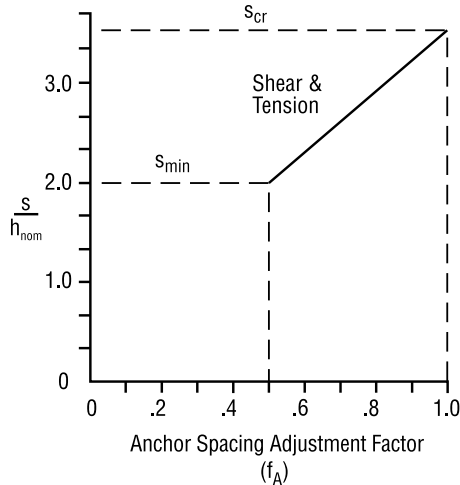
Anchor Spacing and Edge Distance Guidelines (See Anchoring Technology Section 4.1.8.2)

Anchor Spacing Adjustment Factors

s = Actual Spacing

$s_{min} = 2.0 h_{nom}$

$s_{cr} = 3.5 h_{nom}$

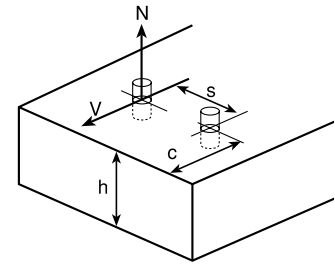
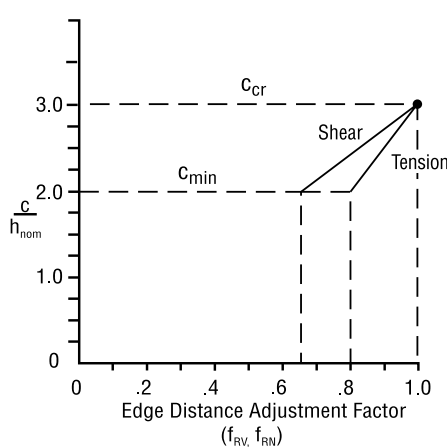


Edge Distance Adjustment Factors

c = Actual edge distance

$c_{min} = 2.0 h_{nom}$

$c_{cr} = 3.0 h_{nom}$



Influence of Anchor Spacing and Edge Distance f_A, f_R

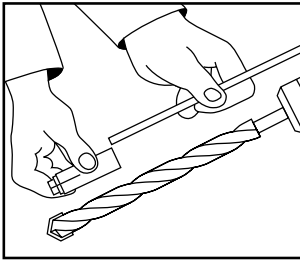
Anchor Size		h_{nom}	
in.	(mm)	in.	(mm)
1/4	(6.4)	1	(25)
3/8	(9.5)	1-9/16	(40)
1/2	(12.7)	2	(51)
5/8	(15.8)	2-9/16	(65)
3/4	(19.1)	3-3/16	(81)

h_{nom} = standard embedment depth

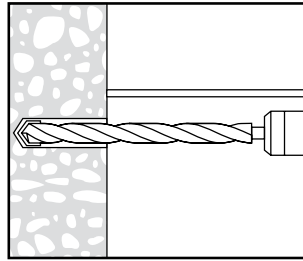
Load Adjustment Factors (Anchor Spacing) f_A							Load Adjustment Factors (Edge Distdntce) f_R											
Tension/Shear Loads							Tension f_{RN}							Shear f_{RV}				
Spacing s		Anchor Diameter					Edge Distance c		Anchor Diameter					Anchor Diameter				
in.	(mm)	1/4	3/8	1/2	5/8	3/4	in.	(mm)	1/4	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 $c_{cr} > c > c_{min}$				

3.3.9 HDI and HDI-L Drop-in Anchor

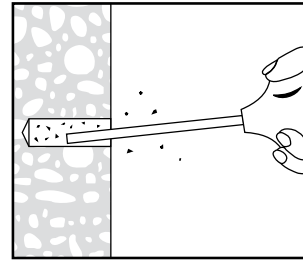
3.3.9.4 Installation Instructions



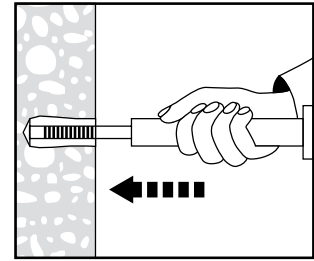
1. Adjust depth gauge so that anchor will be flush with the concrete surface when installed.



2. Hammer drill hole.



3. Clean hole.



4. Install anchor using proper setting tool. Setting tool to be driven into anchor until setting tool shoulder meets top of anchor.

3.3.9.5 Ordering Information

HDI Anchors

Carbon Steel

Anchor Thread Size	Description	Description	Description	Box Qty.
1/4"	HDI 1/4	HDI-L 1/4		100
3/8"	HDI 3/8	HDI-L 3/8		50
1/2"	HDI 1/2	HDI-L 1/2	HDI-S 1/2	50
5/8"	HDI 5/8	-		25
3/4"	HDI 3/4	-		25

HDI Anchors

Stainless Steel

Anchor Thread Size	Description	Box Qty.
1/4"	HDI 1/4 (SS 303)	100
3/8"	HDI 3/8 (SS 303)	50
1/2"	HDI 1/2 (SS 303)	50
5/8"	HDI 5/8 (SS 303)	25
3/4"	HDI 3/4 (SS 303)	25

Setting Tools for HDI, HDI-L and HDI-S

Anchor Thread Size	Description
1/4"	HST 1/4 Setting Tool
3/8"	HST 3/8 Setting Tool
1/2"	HST 1/2 Setting Tool
5/8"	HST 5/8 Setting Tool
3/4"	HST 3/4 Setting Tool

Anchor Thread Size	Description
3/8"	HSD-MM 3/8" (TE-C-24SD10 3/8" Setting tool)
1/2"	HSD-MM 1/2" (TE-C-24SD12 1/2" Setting tool)

1 Use automatic setting tools with TE-C style (SDS plus) hammer drills.

HDI-P Drop-in Anchor 3.3.10

3.3.10.1 Product Description

The Hilti HDI-P Drop-In anchor is an internally threaded, flush mounted expansion anchor for solid and hollow concrete.

Product Features

- Optimized 3/4" – anchor length to allow reliable fastenings in hollow core panels, precast plank and post tensioned slabs
- Shallow drilling enables fast installation
- Lip provides flush installation, consistent anchor depth and easy rod alignment
- Setting tool leaves mark on flange when anchor is set properly to enable inspection and verification of proper expansion

Guide Specifications

Expansion Anchor Expansion anchors shall be flush or shell type and zinc plated in accordance with ASTM B633, SC 1, Type III. Anchors shall be Hilti HDI-P anchors as supplied by Hilti.

Installation Install shell or flush type anchors in holes drilled with Hilti carbide tipped drill bits. Install anchors in accordance with manufacturer's instructions.

3.3.10.1 Product Description

3.3.10.2 Material Specifications

3.3.10.3 Technical Data

3.3.10.4 Installation Instructions

3.3.10.5 Ordering Information

3.3.10.2 Material Specifications

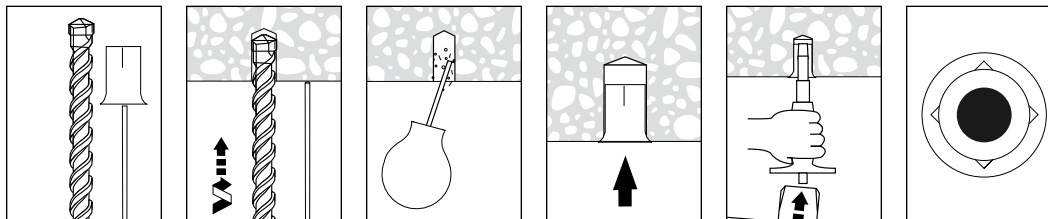
The HDI-P is manufactured from mild carbon steel, which is zinc plated for corrosion protection in accordance with ASTM B633, SC 1, Type III

3.3.10.3 Technical Data

HDI-P Specification Table

Desc.	Length in. (mm)	Bit Size in.	Average Ultimate Loads, lb (kN)				Allowable Loads, lb (kN)			
			4000 psi Concrete (27.6 MPa)		Hollow Core (Spancrete)		4000 psi Concrete (27.6 MPa)		Hollow Core (Spancrete)	
			Tension	Shear	Tension	Shear	Tension	Shear	Tension	Shear
HDI-P 3/8	3/4 (19.1)	1/2	1900 (8.5)	3000 (13.3)	2100 (9.3)	4000 (17.8)	380 (1.7)	600 (2.7)	420 (1.9)	800 (3.6)

3.3.10.4 Installation Instructions



1. Set depth gauge on drill.

2. Hammer-drill hole.

3. Clean hole.

4. Insert anchor.

5. Insert setting tool and strike with hammer until anchor is fully set.

6. Collar of setting tool will leave an indentation on flange of anchor when properly expanded.

3.3.10.5 Ordering Information

HDI-P Anchor

Description	Bit Dia.	Box Qty.
HDI-P 3/8	1/2"	100

Setting Tools for HDI-P Anchors

Description

HSD-G 3/8" – 3/4" Setting Tool w/ hand guard
HST-P 3/8" – 3/4" Setting Tool

3.3.11 HCI-WF/MD Cast-in Anchor

3.3.11.1 Product Description

3.3.11.2 Material Specifications

3.3.11.3 Technical Data

3.3.11.4 Installation Instructions

3.3.11.5 Ordering Information

HCI-WF

HCI-MD

Listings/Approvals

FM (Factory Mutual)

Pipe Hanger Components for Automatic Sprinkler Systems (3/8" - 3/4")

UL (Underwriters Laboratories)

UL 203 Pipe Hanger Equipment for Fire Protection Services (3/8" - 3/4")



3.3.11.1 Product Description

The Hilti HCI-WF/MD is an internally threaded cast-in anchor suitable for use with either wood (WF) or metal deck (MD) form work. The HCI-WF/MD is ideally suited for a variety of rod hanging applications and offers significant anchor installation time savings over traditional post-installed anchor solutions.

Product Features

- Installation from above
 - No overhead drilling and anchor installation.
 - No ladders or platforms needed.
- Hexagon head prevents spinning in concrete.
- Identification decals for flexible color application.
- WF: Large plastic flange helps ensure anchor is flush with wood form to prevent concrete from entering threads.
- WF: Easy break-off nails
- MD: Protective plastic sleeve to prevent concrete/firestop spray /insulation spray from entering threads.
- MD: Flange prepared for additional screws if required for pre-concrete rod installation.
- MD: Strong placement spring for reliable placement.

Guide Specifications

Anchor:

HCI-WF: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a zinc/yellow chromate plating and contained by a plastic flange. Anchor shall have break-off nails for attachment to the surface of wood forms. Anchor will bear the diameter and manufacturer name on its hexagon head. Anchors shall be HCI-WF as supplied by Hilti.

HCI-MD: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a zinc/yellow chromate plating. Anchor shall have a protective plastic sleeve, steel flange

with pre-drilled additional fastening holes and placement spring for attachment to metal deck, anchor is to be secured by clamping the deck between the steel flange and the protective plastic sleeve. Anchor shall bear the diameter and manufacturer name on its hexagon head. Anchors shall be HCI-MD as supplied by Hilti.

Installation:

HCI-WF: Prior to pouring the concrete over the wood form, place the anchor (nails down) on the surface of the wood form at the pre-determined location. Drive the anchor down until plastic flange is flush with the surface of the wood form. When all anchors are installed, pour the concrete. When wood form is removed, the colored flange is exposed and the three break-off nails usually remain. Wear eye protection. Removal of the nails is best done by striking with hammer. After the concrete has properly cured and reached its design compressive strength, install the threaded rod, ensuring full thread engagement.

HCI-MD: Prior to pouring concrete, drill a hole through the metal deck at the pre-determined location (either lower or upper flute of the deck), using the specified diameter metal hole saw. From the topside of the deck, place the plastic sleeve through the hole. By stepping on the head of the anchor (or by using a hammer), push it through the hole, compressing the spring until the anchor plastic sleeve snaps into place (i.e. the metal deck is between the sleeve and the flange of the anchor). After all inserts are installed, pour the concrete. After the concrete has properly cured and achieved its design compressive strength, install the threaded rod, ensuring full thread engagement. To install threaded rod before concrete pour, secure anchor to steel deck material with two screws.

HCI-WF/MD Cast-in Anchor 3.3.11

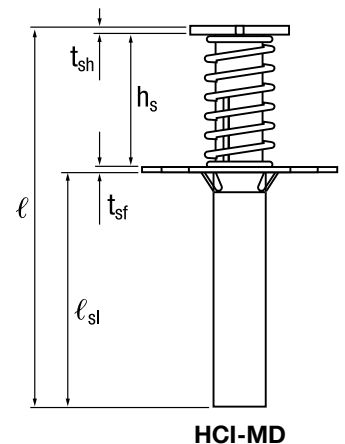
3.3.11.2 Material Specifications

Component	HCI-WF	HCI-MD
Insert Body	Heat Treated Carbon Steel	Heat Treated Carbon Steel
Flange	Engineered Plastic	Heat Treated Carbon Steel
Spring	N/A	Carbon Steel Wire
Plating	Zinc – yellow chromate	Zinc – yellow chromate
Protective Sleeve	N/A	Engineered Plastic

3.3.11.3 Technical Data

Table 1 - HCI-MD Specification Table

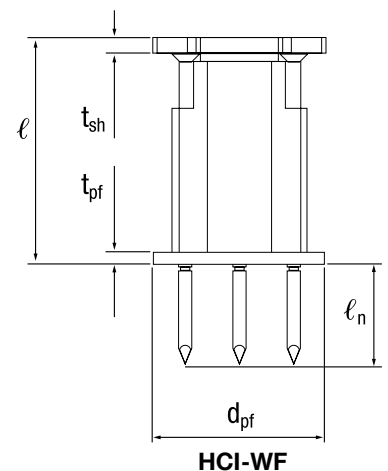
Nominal Anchor Dia. (Thread Size)	in.	1/4	3/8	1/2	5/8	3/4
Details	(mm)	(6.4)	(9.5)	(12.7)	(15.9)	(19.1)
d_{bit} Metal hole saw diameter	in.	7/8	7/8	1-3/16	1-3/16	1-1/4
h_s Height of spring (assembled)	in.	1-7/8	1-7/8	1-7/8	1-7/8	1-7/8
	(mm)	(47.6)	(47.6)	(47.6)	(47.6)	(47.6)
ℓ_{th} Thread length (minimum)	in.	1/4	3/8	1/2	5/8	3/4
	(mm)	(6.4)	(9.5)	(12.7)	(15.9)	(19.1)
ℓ_{sl} Length of sleeve	in.	3-3/8	3-3/8	3-3/8	3-3/8	3-3/8
	(mm)	(85.7)	(85.7)	(85.7)	(85.7)	(85.7)
ℓ Overall length	in.	5-7/16	5-7/16	5-7/16	5-7/16	5-7/16
	(mm)	(138)	(138)	(138)	(138)	(138)
T_{sh} Steel head thickness	in.	1/8	1/8	1/8	1/8	1/8
	(mm)	(3.18)	(3.18)	(3.18)	(3.18)	(3.18)
T_{sf} Steel flange thickness	in.	5/64	5/64	5/64	5/64	5/64
	(mm)	(2.00)	(2.00)	(2.00)	(2.00)	(2.00)
h Min. slab thickness ¹	in.	4	4	4	4	4
	(mm)	(102)	(102)	(102)	(102)	(102)



1 Measured at the location of installation.

Table 2 - HCI-WF Specification Table

Nominal Anchor Dia. (Thread Size)	in.	1/4	3/8	1/2	5/8	3/4
Details	(mm)	(6.4)	(9.5)	(12.7)	(15.9)	(19.1)
ℓ_{th} Thread length (minimum)	in.	1/4	3/8	1/2	5/8	3/4
	(mm)	(6.4)	(9.5)	(12.7)	(15.9)	(19.1)
d_{pf} Plastic flange diameter	in.	1-1/2	1-1/2	1-1/2	1-1/2	1-3/4
	(mm)	(38.0)	(38.0)	(38.0)	(38.0)	(44.5)
t_{pf} Plastic flange thickness	in.	7/64	7/64	7/64	7/64	7/64
	(mm)	(2.78)	(2.78)	(2.78)	(2.78)	(2.78)
ℓ Overall length (w/o break-off nail)	in.	2	2	2-3/16	2-3/16	2-3/16
	(mm)	(51)	(51)	(55.6)	(55.6)	(55.6)
t_{sh} Steel head thickness	in.	1/8	1/8	1/8	1/8	1/8
	(mm)	(3.18)	(3.18)	(3.18)	(3.18)	(3.18)
ℓ_n Length of break-off nail	in.	7/8	7/8	7/8	7/8	7/8
	(mm)	(22.2)	(22.2)	(22.2)	(22.2)	(22.2)
h Minimum slab thickness ¹	in.	4	4	4	4	4
	(mm)	(102)	(102)	(102)	(102)	(102)



1 Measured at the location of installation.

3.3.11 HCI-WF/MD Cast-in Anchor

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right)^{5/3} + \left(\frac{V_d}{V_{rec}} \right)^{5/3} \leq 1.0 \quad (\text{Ref. Section 4.1.9.6})$$

Table 3 - HCI-MD Ultimate Loads in 3000 psi (20.7 Mpa) Lightweight Concrete Over Metal Deck^{1,2}

Nominal Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Minimum Spacing in. (mm)	Minimum End Distance in. (mm)	Anchor installed in the Upper Flute of the Deck		Anchor installed in the Lower Flute of the Deck ³		
				Tension	Shear	Tension	Shear lb (kN)	
				lb (kN)	lb (kN)	lb (kN)	to flute	⊥ to flute
1/4 (6.4)	2 (51)	9 (229)	12 (305)	6250 (27.8)	6940 (30.9)	3280 (14.6)	4660 (20.7)	3825 (17.0)
3/8 (9.5)	2 (51)	9 (229)	12 (305)	6250 (27.8)	6940 (30.9)	3280 (14.6)	4660 (20.7)	3825 (17.0)
1/2 (12.7)	2 (51)	9 (229)	12 (305)	9485 (42.2)	11010 (49.0)	4710 (21.0)	4660 (20.7)	3825 (17.0)
5/8 (15.9)	2 (51)	9 (229)	12 (305)	9485 (42.2)	11010 (49.0)	4710 (21.0)	4660 (20.7)	3825 (17.0)
3/4 (19.1)	2 (51)	9 (229)	12 (305)	11195 (49.8)	11010 (49.0)	5010 (22.3)	4660 (20.7)	3825 (17.0)

1 Allowable loads should be calculated using a minimum safety factor of 4.

2 Load values based on base material or anchor failure modes. Engineer of record must independently evaluate rod/bolt capacity.

3 Anchors installed in lower flute of metal deck should be installed as close to the center as possible. Load values for anchors installed a maximum of 1-3/8" offset from center of flute. For deck dimensions, see Figure 3 in the KWIK Bolt 3 section.

Table 4 - HCI-WF Ultimate Loads in 3000 psi (20.7 Mpa) Lightweight Concrete^{1,2}

Nominal Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Minimum Insert Spacing in. (mm)	Minimum Insert Edge Distance in. (mm)	Tension lb (kN)	Shear lb (kN)
1/4 (6.4)	1-7/8 (48)	9 (229)	6 (152)	6000 (26.7)	4945 (22.0)
3/8 (9.5)	1-7/8 (48)	9 (229)	6 (152)	6000 (26.7)	4945 (22.0)
1/2 (12.7)	2 (51)	9 (229)	6 (152)	6000 (26.7)	10510 (46.8)
5/8 (15.9)	2 (51)	9 (229)	6 (152)	6000 (26.7)	10510 (46.8)
3/4 (19.1)	2 (51)	9 (229)	6 (152)	6000 (26.7)	10510 (46.8)

1 Allowable loads should be calculated using a minimum safety factor of 4.

2 Load values based on base material or anchor failure modes. Engineer of record must independently evaluate rod/bolt capacity.

Table 5 - Underwriters Laboratories Inc. (UL)^{1,2} and Factory Mutual (FM)

Anchor/Rod Diameter in.	HCI-MD						HCI-WF		
	Upper Flute			Lower Flute					
	UL Max Pipe Size (in.)	UL Test Load ³ (lb)	FM Max Pipe Size (in.)	UL Max Pipe Size (in.)	UL Test Load ³ (lb)	FM Max Pipe Size (in.)	UL Max Pipe Size (in.)	UL Test Load ³ (lb)	FM Max Pipe Size (in.)
3/8	4	1500	4	4	1500	4	4	1500	4
1/2	8	4050	8	8	4050	8	8	4050	8
5/8	12	7900	12	–	–	–	8	4050	–
3/4	12	7900	12	–	–	–	8	4050	–

1 Intended for installation and use in accordance with NFPA 13.

2 All diameter HCI-MD and HCI-WF anchors are suitable for use in air handling spaces at a minimum 9' spacing.

3 UL Listing based upon resisting the tabulated load for one minute.

HCI-WF/MD Cast-in Anchor 3.3.11

3.3.11.4 Installation Instructions

Installation Procedure for HCI-MD

1. Prior to pouring concrete, drill a hole through the metal deck, using the specified diameter metal hole saw.
2. From the topside of the deck, place the plastic sleeve through the hole.
3. By stepping on the head of the anchor (or by using a hammer), push it through the hole until the anchor plastic sleeve snaps into place (i.e. the deck is between the sleeve and the flange of the anchor). After all inserts are installed, pour the concrete.
4. After the concrete has properly cured and achieved its design compressive strength, install the threaded rod, ensuring full thread engagement. (Note: Rod may be installed prior to concrete pour, but should not be loaded or disturbed until concrete has cured and achieved its design compressive strength .

Installation Procedure for HCI-WF

1. Prior to pouring the concrete over the wood form, place the anchor (nails down) on the surface of the wood form.
- 2,3. Drive the anchor down until flush with the surface of the wood form. When all anchors are installed, pour the concrete. When wood form is removed, the three break-off nails usually remain. Wearing eye protection, remove these nails.
4. After the concrete has properly cured and reached its design compressive strength, install the threaded rod, ensuring full thread engagement.

3.3.11.5 Ordering Information

HCI – WF Cast – In Anchor for use in Wood Forms

Description	Packaging Content
HCI – WF 1/4"	150
HCI – WF 3/8"	150
HCI – WF 1/2"	100
HCI – WF 5/8"	100
HCI – WF 3/4"	100

Color Identification Decals for use with HCI-WF

Description	Packaging Content
HCI – WFID Decal Color: Blue	300
HCI – WFID Decal Color: Green	300

HCI – MD Cast – In Anchor for use in Metal Deck and Accessories

Description	Packaging Content	Hole Saw Diameter
HCI – MD 1/4"	100	7/8"
HCI – MD 3/8"	100	7/8"
HCI – MD 1/2"	60	1-3/16"
HCI – MD 5/8"	60	1-3/16"
HCI – MD 3/4"	60	1-1/4"

Color Identification Decals for use with HCI – MD

Description	Packaging Content
HCI – MDID Decal Color: Blue	300
HCI – MDID Decal Color: Green	300

3.3.12 HLC Sleeve Anchor

3.3.12.1 Product Description

3.3.12.2 Material Specifications

3.3.12.3 Technical Data

3.3.12.4 Installation Instructions

3.3.12.5 Ordering Information

3.3.12.1 Product Description

Hilti HLC Sleeve Anchors are mechanical expansion anchors consisting of an externally threaded stud with an expanding sleeve for use in concrete and hollow and solid masonry base materials.

Product Features

- Stud bolt type anchor design allows easy through-type fastenings and setting in bottomless hole.
- Pre-assembled anchor allows easy/fast installation.
- Anchor size is same as drill bit size allowing easy installation.
- Variety of head styles, lengths/sizes allow versatile application/use.
- Comprehensive testing to provide performance data in block, masonry/concrete base materials.

- Bulged mid-section with round and diamond shaped openings help prevent anchor from spinning in the hole or dropping out when being set overhead.

Guide Specifications

Expansion Anchor Expansion anchors shall be stud or flush sleeve type and zinc plated in accordance with ASTM B633, Type II or stainless steel in accordance with AISI grade 304. Anchors shall be Hilti sleeve anchors as supplied by Hilti.

Installation Install sleeve anchors in holes drilled with Hilti carbide tipped drill bits. Install anchors in accordance with manufacturer's recommendations.

3.3.12.2 Material Specifications

Carbon steel sleeves and spacers are manufactured from cold rolled steel

Carbon steel anchors are zinc plated to minimum 5 µm thickness in accordance with ASTM B633, Type II

Stainless steel anchor material (stud, sleeve, nuts and washers) meet the requirements for AISI 304 stainless steel

Bolt Head (HLC-H)

3.3.12.3 Technical Data

Sleeve Anchor Specification Table

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

Anchor Size		in.	1/4	5/16	3/8	1/2	5/8	3/4
Details		(mm)	(6.4)	(7.9)	(9.5)	(12.7)	(15.9)	(19.1)
d	Thread diameter	in.	3/16	1/4	5/16	3/8	1/2	5/8
d _{bit}	Bit diameter ¹	in.	1/4	5/16	3/8	1/2	5/8	3/4
h _{min}	minimum depth of embedment	in.	1	1	1-1/4	1-1/2	2	2
		(mm)	(25)	(25)	(32)	(38)	(51)	(51)
h _o	Minimum Hole depth	in.	1-3/8	1-3/8	1-3/4	2-1/8	2-5/8	2-5/8
		(mm)	(35)	(35)	(45)	(54)	(67)	(67)
T _{inst}	Installation torque	HLC-HX, FPH, AC, RS, RC	ft-lb	2.2	5	10	15	60
			(Nm)	(3)	(6.8)	(13.6)	(20)	(81.4)
	HLC-H		ft-lb	12	18	35	-	-
			(Nm)	(16)	(24.4)	(47.4)		

¹ Hilti carbide tipped drill bits

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}} \right)^{5/3} + \left(\frac{V_d}{V_{rec}} \right)^{5/3} \leq 1.0 \quad (\text{Ref. Section 3.1.8.3})$$

HLC Sleeve Anchor 3.3.12

Carbon Steel Sleeve Anchor Allowable Loads in Concrete^{1,2}

Sleeve Anchor Size in. (mm)	Bolt Diameter in. (mm)	Embedment Depth in. (mm)	2000 psi (13.8 MPa)				4000 psi (27.6 MPa)				6000 psi (41.4 MPa)			
			Tension lb (kN)		Shear lb (kN)		Tension lb (kN)		Shear lb (kN)		Tension lb (kN)		Shear lb (kN)	
1/4 ³ (6.4)	3/16 (4.8)	1 (25)	225 (1.0)	305 (1.4)	250 (1.1)	305 (1.4)	250 (1.1)	305 (1.4)	250 (1.1)	305 (1.4)	250 (1.1)	305 (1.4)	250 (1.1)	305 (1.4)
5/16 (7.9)	1/4 (6.4)	1 (25)	350 (1.5)	560 (2.5)	450 (2.0)	560 (2.5)	450 (2.0)	560 (2.5)	450 (2.0)	560 (2.5)	500 (2.2)	560 (2.5)	500 (2.2)	560 (2.5)
3/8 ³ (9.5)	5/16 (7.9)	1-1/4 (32)	450 (2.0)	870 (3.9)	565 (2.5)	870 (3.9)	565 (2.5)	870 (3.9)	565 (2.5)	870 (3.9)	700 (3.1)	890 (4.4)	700 (3.1)	890 (4.4)
1/2 (12.7)	3/8 (9.5)	1-1/2 (38)	675 (3.0)	1250 (5.6)	925 (4.1)	1325 (5.9)	925 (4.1)	1325 (5.9)	925 (4.1)	1325 (5.9)	1100 (4.9)	1325 (5.9)	1100 (4.9)	1325 (5.9)
5/8 (15.9)	1/2 (12.7)	2 (51)	1035 (4.6)	1750 (7.8)	1500 (6.7)	2295 (10.2)	1500 (6.7)	2295 (10.2)	1500 (6.7)	2295 (10.2)	1950 (8.7)	2295 (10.2)	1950 (8.7)	2295 (10.2)
3/4 (19.1)	5/8 (15.9)	2 (51)	1125 (5.0)	1750 (7.8)	1500 (6.7)	3000 (13.3)	1500 (6.7)	3000 (13.3)	1500 (6.7)	3000 (13.3)	1950 (8.7)	3010 (13.4)	1950 (8.7)	3010 (13.4)

- Based on a safety factor of 4.0.
- Refer to KWIK Bolt 3 data, in Section 3.3.6.4, for spacing and edge distance guidelines in Concrete.
- For 1/4" and 3/8" 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.

Stainless Steel Sleeve Anchor Allowable Loads¹

Anchor Size in. (mm)	Embedment Depth in. (mm)	Concrete ²						Hollow C-90 Concrete Block ^{3,4}					
		2000 psi (13.8 MPa)				4000 psi (27.6 MPa)				Tension lb (kN)			
		Tension lb (kN)		Shear lb (kN)		Tension lb (kN)		Shear lb (kN)		Tension lb (kN)		Shear lb (kN)	
1/4 (6.4)	1-1/8 (29)	235 (1.0)	450 (2.0)	300 (1.3)	450 (2.0)	200 (0.9)	400 (1.8)	200 (0.9)	400 (1.8)	200 (0.9)	400 (1.8)	200 (0.9)	400 (1.8)
5/16 (7.9)	1-1/4 (32)	310 (1.4)	675 (3.0)	410 (1.8)	675 (3.0)	335 (1.5)	600 (2.7)	335 (1.5)	600 (2.7)	335 (1.5)	600 (2.7)	335 (1.5)	600 (2.7)
3/8 (9.5)	1-1/2 (38)	450 (2.0)	1000 (4.4)	600 (2.7)	1000 (4.4)	470 (2.1)	890 (4.0)	470 (2.1)	890 (4.0)	470 (2.1)	890 (4.0)	470 (2.1)	890 (4.0)

- Based on using a safety factor of 4.0.
- Refer to KWIK Bolt 3 data, in Section 3.3.6.4 for spacing and edge distance guidelines in Concrete.
- ASTM Specification C90, Type II.
- Refer to HY 20 data, in Section 3.2.9.3, for spacing and edge distance guidelines in Hollow Concrete Block.

Carbon Steel Sleeve Anchor Allowable Loads

in Grout Filled Block^{1,2,3,4,5,6,7}

Anchor Size in. (mm)	Embed. Depth in. (mm)	Edge Distance in. (mm)	Tension lb (kN)	Shear lb (kN)
1/4 (6.4)	1 (25)	4 (101)	290 (1.3)	305 (1.4)
		≥ 12 (305)		
5/16 (7.9)	1 (25)	4 (101)	385 (1.7)	500 (2.2)
		≥ 12 (305)		
3/8 (9.5)	1-1/4 (32)	4 (101)	435 (1.9)	725 (3.2)
		≥ 12 (305)		
1/2 (12.7)	1-1/2 (38)	4 (101)	605 (2.7)	865 (3.8)
		≥ 12 (305)		1145 (5.1)
5/8 (15.9)	2 (51)	4 (101)	710 (3.2)	1050 (4.7)
		≥ 12 (305)		1815 (8.1)
3/4 (19.1)	2 (51)	4 (101)	840 (3.7)	1050 (4.7)
		≥ 12 (305)		1970 (8.8)

- Values are for Lightweight, Medium Weight or Normal Weight concrete masonry units conforming to ASTM C90 with 2000 psi grout conforming to ASTM C474.
- Embedment depth is measured from the outside face of the concrete masonry unit.
- Values are for anchors located in the grouted cell, bed joint, cross web or any combination of the above.
- For anchors installed in the "T" joint or head joint reduce tension values by 20%.
- Values for edge distances between 4 inches and 12 inches may be calculated by linear interpolation.
- Anchors are limited to one per unit cell.
- Based on using a safety factor of 4.0.

Carbon Steel Sleeve Anchor Allowable Loads

in Hollow Concrete Block^{1,2,3}

Sleeve Anchor Size in. (mm)	Embedment Depth in. (mm)	Tension lb (kN)	Shear lb (kN)
1/4 (6.4)	1 (25)	350 (1.5)	305 (1.4)
5/16 (7.9)	1 (25)	375 (1.7)	560 (2.5)
3/8 (9.5)	1-1/4 (32)	435 (1.9)	800 (3.5)
1/2 (12.7)	1-1/2 (38)	565 (2.5)	1125 (5.0)

- Based on using a safety factor of 4.0.
- ASTM Specification C90, Type II.
- Refer to HY 20 data, in Section 3.2.9.3, for spacing and edge distance guidelines in Hollow Concrete Block.

Carbon Steel Sleeve Anchor Allowable Loads

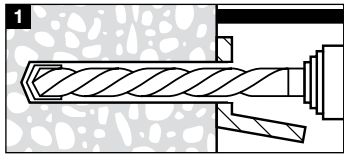
in Clay Brick^{1,2,3}

Anchor Size in. (mm)	Embedment Depth in. (mm)	Tension lb (kN)	Shear lb (kN)
1/4 (6.4)	1 (25)	295 (1.3)	335 (1.5)
5/16 (7.9)	1 (25)	345 (1.5)	530 (2.3)
3/8 (9.5)	1-1/4 (32)	375 (1.7)	850 (3.8)
1/2 (12.7)	1-1/2 (38)	435 (1.9)	1230 (5.5)

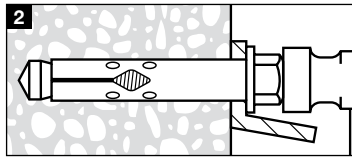
- Based on using a safety factor of 4.0.
- Due to wide strength variations encountered in masonry, these values should be considered as guide values.
- Refer to HY 20 data, in Section 3.2.9.3, for spacing and edge distance guidelines in brick.

3.3.12 HLC Sleeve Anchor

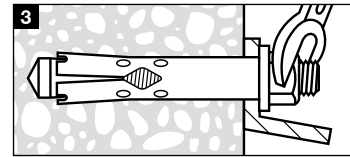
3.3.12.4 Installation Instructions



1. **Drill:** Drill the hole. Clean hole with blow out bulb. For hollow masonry, switch to drilling only mode before penetrating backside.



2. **Insert:** Drive the sleeve anchor into the hole. For the bolt version, place the nut flush to the top of the bolt before driving the sleeve anchor.



3. **Set:** Tighten anchor to the recommended torque value. Over-torquing will reduce the pullout and shear loads, up to the point of complete failure.

3.3.12.5 Ordering Information

← A →

Round Head Slotted (RS)

Description	Bit Diameter ¹ In.	Bolt Diameter In.	Minimum Embed. Depth in. (mm)	Fastens Materials Up To in. (mm)	Box Qty
HLC-RS 1/4 x 1-1/4	1/4	3/16	1 (25)	1/4 (6.4)	100
HLC-RS 1/4 x 2	1/4	3/16	1 (25)	1 (25)	100
HLC-RS 1/4 x 4	1/4	3/16	1 (25)	3 (76)	100

← A →

Bolt Head (H)

Description	Bit Diameter ¹ In.	Bolt Diameter In.	Minimum Embed. Depth in. (mm)	Fastens Materials Up To in. (mm)	Box Qty
HLC-H 5/16 x 1-5/8	5/16	1/4	1 (25)	5/8 (16)	100
HLC-H 5/16 x 2-5/8	5/16	1/4	1 (25)	1-5/8 (41)	100
HLC-H 3/8 x 1-7/8	3/8	5/16	1-1/4 (32)	5/8 (16)	50
HLC-H 3/8 x 3	3/8	5/16	1-1/4 (32)	1-3/4 (44)	50
HLC-H 1/2 x 2-1/4	1/2	3/8	1-1/2 (38)	3/4 (20)	50
HLC-H 1/2 x 3	1/2	3/8	1-1/2 (38)	1-1/2 (38)	25
HLC-H 1/2 x 4	1/2	3/8	1-1/2 (38)	2-1/2 (64)	25

← A →

Flat Phillips Head (FPH)

Description	Bit Diameter ¹ In.	Bolt Diameter In.	Minimum Embed. Depth in. (mm)	Fastens Materials Up To in. (mm)	Box Qty
HLC-FPH 1/4 x 1-3/8	1/4	3/16	1 (25)	3/8 (10)	100
HLC-FPH 1/4 x 2	1/4	3/16	1 (25)	1 (25)	100
HLC-FPH 1/4 x 3	1/4	3/16	1 (25)	2 (51)	100
HLC-FPH 1/4 x 4	1/4	3/16	1 (25)	3 (76)	100
HLC-FPH 3/8 x 2-7/8	3/8	5/16	1-1/4 (32)	1-1/2 (38)	50
HLC-FPH 3/8 x 4	3/8	5/16	1-1/4 (32)	2-3/4 (70)	50
HLC-FPH 3/8 x 5	3/8	5/16	1-1/4 (32)	3-3/4 (95)	25
HLC-FPH 3/8 x 6	3/8	5/16	1-1/4 (32)	4-3/4 (120)	25

1 Hilti carbide tipped drill bits

Definition of Nomenclature

Outside diameter of sleeve, see tables for threaded bolt diameter

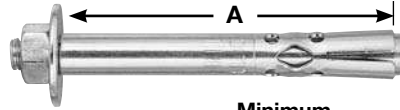
HLC-AC 1/4 X 1-3/8

Nut Configuration

A: the overall length from bottom of washer to end of sleeve

HLC Sleeve Anchor 3.3.12

Hex Nut (HX)



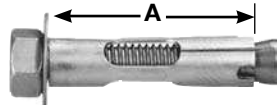
Description	Bit Diameter ¹ In.	Bolt Diameter In.	Minimum Embed. Depth in. (mm)	Fastens Materials Up To in. (mm)	Box Qty
HLC-HX 5/16 x 1-5/8	5/16	1/4	1 (25)	1/2 (38)	100
HLC-HX 5/16 x 2-5/8	5/16	1/4	1 (25)	1/2 (13)	100
HLC-HX 3/8 x 1-7/8	3/8	5/16	1-1/4 (32)	5/8 (16)	50
HLC-HX 3/8 x 3	3/8	5/16	1-1/4 (32)	1-3/4 (44)	50
HLC-HX 1/2 x 2-1/4	1/2	3/8	1-1/2 (38)	3/4 (19)	25
HLC-HX 1/2 x 3	1/2	3/8	1-1/2 (38)	1-1/2 (38)	25
HLC-HX 1/2 x 4	1/2	3/8	1-1/2 (38)	2-1/2 (64)	25
HLC-HX 1/2 x 6	1/2	3/8	1-1/2 (38)	4-1/2 (114)	15
HLC-HX 5/8 x 2-1/4	5/8	1/2	2 (51)	1/4 (6)	25
HLC-HX 5/8 x 4-1/4	5/8	1/2	2 (51)	2-1/4 (57)	10
HLC-HX 5/8 x 6	5/8	1/2	2 (51)	4 (102)	10
HLC-HX 3/4 x 2-1/2	3/4	5/8	2 (51)	1/2 (13)	10
HLC-HX 3/4 x 4-1/4	3/4	5/8	2-1/2 (64)	1-3/4 (44)	10
HLC-HX 3/4 x 6-1/4	3/4	5/8	2-1/2 (64)	3-3/4 (95)	10

Acorn Head (AC)



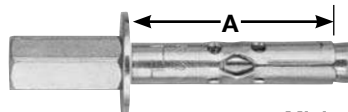
Description	Bit Diameter ¹ In.	Bolt Diameter In.	Minimum Embed. Depth in. (mm)	Fastens Materials Up To in. (mm)	Box Qty
HLC-AC 1/4 x 1-3/8	1/4	3/16	1 (25)	3/8 (10)	100
HLC-AC 1/4 x 2-1/4	1/4	3/16	1 (25)	1-1/4 (32)	100

304SS Sleeve Anchors



Description	Bit Diameter ¹ In.	Bolt Diameter In.	Minimum Embed. Depth in. (mm)	Fastens Materials Up To in. (mm)	Box Qty
HLC-HX 304SS 1/4 x 2-1/4	1/4	3/16	1-1/8 (29)	1-1/8 (29)	100
HLC-HX 304SS 5/16 x 1-1/2	5/16	1/4	1-1/4 (32)	1/4 (6.4)	100
HLC-HX 304SS 5/16 x 2-1/2	5/16	1/4	1-1/4 (32)	1-1/4 (32)	100
HLC-HX 304SS 3/8 x 1-7/8	3/8	5/16	1-1/2 (38)	3/8 (9.5)	50
HLC-HX 304SS 3/8 x 3	3/8	5/16	1-1/2 (38)	1-1/2 (38)	50

Rod Coupling (RC)



Description	Bit Diameter ¹ In.	Bolt Diameter In.	Minimum Embed. Depth in. (mm)	Rod Coupler	Box Qty
HLC-RC 3/8 x 1-7/8	3/8	5/16	1-1/4 (32)	5/16" x 3/8"	50
HLC-RC 1/2 x 2-1/4	1/2	3/8	1-1/2 (38)	3/8" x 1/2"	25

¹ Hilti carbide tipped drill bits

Definition of Nomenclature

HLC-AC 1/4 X 1-3/8

Nut Configuration

Outside diameter of sleeve, see tables for threaded bolt diameter

A: the overall length from bottom of washer to end of sleeve

3.3.13 KWIK-CON II+ Fastening System

3.3.13.1 Product Description

3.3.13.2 Material Specifications

3.3.13.3 Technical Data

3.3.13.4 Installation Instructions

3.3.13.5 Ordering Information

3.3.13.1 Product Description

The Hilti KWIK-CON II+ Fastening System for concrete and masonry consists of the KWIK-CON II+ fastener, the KWIK-CON II+ drive tool, and a Hilti matched tolerance carbide-tipped drill bit.

Product Features

- Choice of head styles—Torx Hex Washer Head for fast, secure driving; Torx or Phillips Flat Head for countersinking applications
- Matched tolerance carbide-tipped drill bit supplied with each box of 100 KWIK-CON II+ fasteners
- Exclusive internal TORX drive
- Choice of 1/4" or 3/16" diameter fasteners
- Fasteners protected by corrosive resistant coating; stainless steel fasteners available in select sizes
- High quality Hilti SDS and straight shank drill bits (Refer to section 4.3.12.5)

Guide Specifications

Concrete Screw Anchors

Concrete or masonry screw anchors shall be manufactured from AISI 1021 cold rolled steel case hardened to a minimum Rockwell Hardness C 45 or stainless steel conforming to AISI 410. The concrete or masonry screw anchors shall have a trilobular, cold formed thread design and 8 threads per inch. Screw anchors shall have one of the following head designs: Tapered flat head with T-25 TORX recess, Tapered flat head with T-27 TORX recess or 5/16" hex washer with internal T-25 TORX recess. Anchor plating shall be in accordance with ASTM B633 SC 2 Type II to a minimum thickness of 8 µm. Anchors shall be Hilti KWIK-CON II anchors as supplied by Hilti.

Installation

Concrete or masonry screw anchors shall be installed in holes drilled with matched tolerance Hilti carbide-tipped drill bits supplied with each box of KWIK-CON II anchors. Installation shall be in accordance with manufacturer's installation instructions.



Listings/Approvals

Metro-Dade County
NOA No. 07-0924.03

KWIK-CON II+ Fastening System 3.3.13**3.3.13.2 Material Specifications**

		Mechanical Properties	
		f_y ksi	min. f_u ksi
Material Composition 1018 to 1022 cold rolled steel (case hardened to HRC 45 minimum)	3/16"	137	138
	1/4"	157	163
or 410 Stainless Steel	3/16"	157	184
	1/4"	170	194

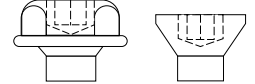
Head Styles

Tapered flat head with #3 Phillips recess (3/16" and 1/4" diameter anchors)

Tapered flat head with T-25 TORX recess (3/16" diameter anchor)

Tapered flat head with T-27 TORX recess (1/4" diameter anchor)

5/16" hex washer with internal T-25 TORX recess (3/16" and 1/4" diameter anchors)

**Head Diameter**

0.507" maximum (3/16" and 1/4" tapered Phillips flat head and 1/4" tapered T-27 TORX flat head anchors)

0.385" maximum (3/16" tapered T-25 TORX flat head anchor)

0.432" maximum (3/16" and 1/4" T-25 TORX hex washer head anchors)

Thread DiameterNominal 3/16"; Major: 0.217"; Minor²: 0.145"Nominal 1/4"; Major: 0.283"; Minor²: 0.190"**Shank Diameter**

3/16" – 0.170"

1/4" – 0.224"

Lengths

1-1/4", 1-3/4", 2-1/4", 2-3/4", 3-1/4", 3-3/4", 4" (See Ordering Information Section 4.3.10.5)

Thread Design

Trilobular, cold formed

Threads per inch

3/16" anchor = 8 T.P.I.

1/4" anchor = 8 T.P.I.

Inches of Thread per fastener

1.875" maximum

Plating

8 µm zinc/chromate plating in accordance with ASTM B633, Sc 2, Type II, on carbon steel anchors

Bending Capacity

Ductility at 10° minimum

- 1 Mechanical properties based on limited (30 samples) testing of actual KWIK-CON II samples (i.e. not based on minimum steel properties).
- 2 Minor diameter based on average root diameter of 30 KWIK-CON II samples (i.e. not a controlled dimension).

3.3.13 KWIK-CON II+ Fastening System

3.3.13.3 Technical Data

Table 1 - Tension and Shear Allowable Loads in Concrete ^{1,2}

Anchor Dia. in.	Embedment Depth in. (mm)	2000 psi (13.8 MPa)		4000 psi (27.6 MPa)		6000 psi (41.4 MPa)	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
3/16	1 (25)	100 (0.44)	260 (1.16)	125 (0.56)	260 (1.16)	185 (0.82)	280 (1.25)
3/16	1-3/4 (44)	275 (1.22)	260 (1.16)	295 (1.31)	265 (1.18)	325 (1.45)	300 (1.33)
1/4	1 (25)	190 (0.85)	325 (1.45)	240 (1.07)	390 (1.73)	275 (1.22)	540 (2.40)
1/4	1-3/4 (44)	425 (1.89)	560 (2.49)	625 (2.78)	600 (2.82)	650 (2.89)	600 (2.67)

1 Published load values represent the average test results of testing conducted in local base materials using Hilti matched-tolerance drill bits. Because of variations in materials, on-site testing is necessary to determine actual performance at any specific site.

2 Allowable working loads are based on a safety factor of 4.0.

Table 2 - Tension and Shear Ultimate Loads in Concrete¹

Anchor Dia. in.	Embedment Depth in. (mm)	2000 psi (13.8 MPa)		4000 psi (27.6 MPa)		6000 psi (41.4 MPa)	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
3/16	1 (25)	400 (1.78)	1050 (4.67)	500 (2.22)	1050 (4.67)	750 (3.34)	1150 (5.12)
3/16	1-3/4 (44)	1100 (4.89)	1050 (4.67)	1180 (5.25)	1070 (4.76)	1300 (5.78)	1200 (5.34)
1/4	1 (25)	760 (3.38)	1300 (5.78)	970 (4.31)	1575 (7.01)	1100 (4.89)	2175 (9.68)
1/4	1-3/4 (44)	1700 (7.56)	2250 (10.0)	2500 (11.1)	2400 (11.3)	2600 (11.6)	2400 (10.7)

1 Published load values represent the average test results of testing conducted in local base materials using Hilti matched-tolerance drill bits. Because of variations in materials, on-site testing is necessary to determine actual performance at any specific site.

2 Allowable working loads are based on a safety factor of 4.0.

Table 3 - Tension and Shear Allowable Loads
in Hollow Block^{1,2}

Anchor Dia. in.	Embed. Depth in. (mm)	Tension lb (kN)	Shear lb (kN)
3/16	1 (25)	150 (0.67)	225 (1.00)
3/16	1-3/4 (44)	290 (1.29)	300 (1.33)
1/4	1 (25)	165 (0.73)	275 (1.22)
1/4	1-3/4 (44)	310 (1.38)	400 (1.78)

1 ASTM Specification C90 Grade N. Type II pilot holes drilled with TKB matched tolerance bits for concrete blocks.

2 Allowable working loads are based on a safety factor of 4.0.

Table 4 - Tension and Shear Allowable Loads
in Red Brick^{1,2}

Anchor Dia. in.	Embed. Depth in. (mm)	Tension lb (kN)	Shear lb (kN)
3/16	1 (25)	125 (0.56)	235 (1.05)
3/16	1-3/4 (44)	350 (1.56)	300 (1.33)
1/4	1 (25)	205 (0.91)	415 (1.85)
1/4	1-3/4 (44)	350 (1.56)	500 (2.22)

1 This test was performed on individual specimens of ASTM C62 common red brick. Due to the wide variations encountered in the compressive strength of brick, these values should be considered Guide Values.

2 Allowable working loads are based on a safety factor of 4.0.

The anchors are installed a minimum of 12 diameters on center with a minimum edge distance of six diameters for 100 percent anchor efficiency. Spacing and edge distance may be reduced to six diameter spacing and three diameter edge distance providing values are reduced 50 percent. Linear interpolation may be used for intermediate spacing and edge margins.

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_d} \right) + \left(\frac{V_d}{V_d} \right) \leq 1.0 \quad (\text{Ref. Section 4.1.9.6})$$

KWIK-CON II+ Fastening System 3.3.13

3.3.13.4 Installation Instructions

Determining the Correct

KWIK-CON II+ Fastener & Hole Depth

The Hilti KWIK-CON II+ masonry fastening system consists of the KWIK-CON II+ fastener, the KWIK-CON II+ drive tool, and a TKC or TKB matched tolerance carbide-tipped drill bit. Consistent performance and maximum pullout strength can be assured only when all three elements of the system are properly used.

Fastener Length

The length of the KWIK-CON II+ fastener to be used is determined by combining the thickness of the fixture being attached (A) with the desired depth of embedment in the masonry material (B). It is recommended that a minimum of 1" and a maximum of 1-3/4" embedment be used in determining fastener length.

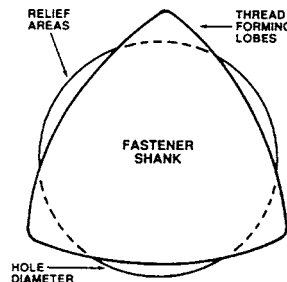
KWIK-CON II+ fasteners are available in 1/4" and 3/16" diameters. The diameter of the fastener and the depth of embedment affect pullout strengths. Application strength requirements and safety factors should be considered when determining the depth of embedment and fastener diameter. For assistance, contact your local Hilti Sales Representative.

Hole Depth

A TKC matched tolerance carbide tipped drill bit is supplied with each box of KWIK-CON II+ fasteners. The correct hole depth (B+C) can normally be obtained by drilling the full length of this bit. In all cases, the hole must be at least 1/2" deeper than the depth of the fastener embedment.

Hole Diameter

The diameter of the drilled hole is also important to the performance of the KWIK-CON II+ masonry fastening system. Using Hilti TKC (concrete) or TKB (block) matched tolerance carbide-tipped bits will help assure consistent fastener performance and maximum pullout strength.



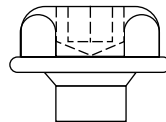
Head Styles

TORX Hex Washer Head

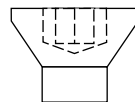
Uses either TORX or hex drives
Washer head provides a bearing surface for fast, secure fastening.

TORX or Phillips Flat Head

Used when a countersunk appearance is desirable



Torx Hex Washer Head Internal Torx



Torx or Phillips Flat Head

A

B

C

A = Fixture being attached

B = KWIK-CON II+ embedment
minimum of 1", maximum of 1-3/4" is recommended

A + B = Length KWIK-CON II+ to be used

B + C = Depth of hole drilled
must be at least 1/2" deeper than KWIK-CON II+ embedment

3.3.13 KWIK-CON II+ Fastening System

3.3.13.5 Ordering Information

KWIK-CON II+ Fasteners (100 per box including 1 bit except bulk which are 1,000 pieces per box without bit)

5/16" Magnetic Nut Setter or T-25 TORX Bit

Description	Diameter (In.)	Total Length (In.)	Thread Length (In.)	Shank Length (In.)
KWIK-CON II+ 316-114 THWH	3/16	1-1/4	1-1/4	0
KWIK-CON II+ 316-114 THWH Bulk	3/16	1-1/4	1-1/4	0
KWIK-CON II+ 316-134 THWH	3/16	1-3/4	1-3/4	0
KWIK-CON II+ 316-134 THWH Bulk	3/16	1-3/4	1-3/4	0
KWIK-CON II+ 316-214 THWH	3/16	2-1/4	1-3/4	1/2
KWIK-CON II+ 316-234 THWH	3/16	2-3/4	1-3/4	1
KWIK-CON II+ 316-234 THWH Bulk	3/16	2-3/4	1-3/4	1
KWIK-CON II+ 316-314 THWH	3/16	3-1/4	1-3/4	1-1/2
KWIK-CON II+ 316-334 THWH	3/16	3-3/4	1-3/4	2
KWIK-CON II+ 316-4 THWH	3/16	4	1-3/4	2-1/4

5/16" Magnetic Nut Setter or T-25 Bit

Description	Diameter (In.)	Total Length (In.)	Thread Length (In.)	Shank Length (In.)
KWIK-CON II+ 14-114 THWH	1/4	1-1/4	1-1/4	0
KWIK-CON II+ 14-114 THWH Bulk	1/4	1-1/4	1-1/4	0
KWIK-CON II+ 14-134 THWH	1/4	1-3/4	1-3/4	0
KWIK-CON II+ 14-134 THWH Bulk	1/4	1-3/4	1-3/4	0
KWIK-CON II+ 14-214 THWH	1/4	2-1/4	1-3/4	1/2
KWIK-CON II+ 14-234 THWH	1/4	2-3/4	1-3/4	1
KWIK-CON II+ 14-234 THWH Bulk	1/4	2-3/4	1-3/4	1
KWIK-CON II+ 14-314 THWH	1/4	3-1/4	1-3/4	1-1/2
KWIK-CON II+ 14-334 THWH	1/4	3-3/4	1-3/4	2
KWIK-CON II+ 14-334 THWH Bulk	1/4	3-3/4	1-3/4	2
KWIK-CON II+ 14-4 THWH	1/4	4	1-3/4	2-1/4
KWIK-CON II+ 14-114 THWH Stainless Steel	1/4	1-1/4	1-1/4	0
KWIK-CON II+ 14-234 THWH Stainless Steel	1/4	2-3/4	1-3/4	1

T-25 TORX Bit

Description	Diameter (In.)	Total Length (In.)	Thread Length (In.)	Shank Length (In.)
KWIK-CON II+ 316-114 TFH	3/16	1-1/4	1-1/8	0
KWIK-CON II+ 316-134 TFH	3/16	1-3/4	1-5/8	0
KWIK-CON II+ 316-134 TFH Bulk	3/16	1-3/4	1-5/8	0
KWIK-CON II+ 316-214 TFH	3/16	2-1/4	1-3/4	3/8
KWIK-CON II+ 316-234 TFH	3/16	2-3/4	1-3/4	7/8
KWIK-CON II+ 316-234 TFH Bulk	3/16	2-3/4	1-3/4	7/8
KWIK-CON II+ 316-314 TFH	3/16	3-1/4	1-3/4	1-3/8
KWIK-CON II+ 316-334 TFH	3/16	3-3/4	1-3/4	1-7/8
KWIK-CON II+ 316-334 TFH Bulk	3/16	3-3/4	1-3/4	1-7/8
KWIK-CON II+ 316-4 TFH	3/16	4	1-3/4	2-1/8

T-27 TORX Bit

Description	Diameter (In.)	Total Length (In.)	Thread Length (In.)	Shank Length (In.)
KWIK-CON II+ 14-114 TFH	1/4	1-1/4	1-1/16	0
KWIK-CON II+ 14-134 TFH	1/4	1-3/4	1-9/16	0
KWIK-CON II+ 14-134 TFH Bulk	1/4	1-3/4	1-9/16	0
KWIK-CON II+ 14-214 TFH	1/4	2-1/4	1-3/4	5/16
KWIK-CON II+ 14-234 TFH	1/4	2-3/4	1-3/4	13/16
KWIK-CON II+ 14-314 TFH	1/4	3-1/4	1-3/4	1-5/16
KWIK-CON II+ 14-314 TFH Bulk	1/4	3-1/4	1-3/4	1-5/16
KWIK-CON II+ 14-334 TFH	1/4	3-3/4	1-3/4	1-13/16
KWIK-CON II+ 14-4 TFH	1/4	4	1-3/4	2-1/16

KWIK-CON II+ Fastening System 3.3.13

KWIK-CON II+ Fasteners (100 per box including 1 bit except bulk which are 1,000 pieces per box without bit)

Description	#3 Phillips Bit			
	Diameter (In.)	Total Length (In.)	Thread Length (In.)	Shank Length (In.)
KWIK-CON II+ 316-114 PFH	3/16	1-1/4	1-1/16	0
KWIK-CON II+ 316-134 PFH	3/16	1-3/4	1-9/16	0
KWIK-CON II+ 316-134 PFH Bulk	3/16	1-3/4	1-9/16	0
KWIK-CON II+ 316-214 PFH	3/16	2-1/4	1-3/4	5/16
KWIK-CON II+ 316-234 PFH	3/16	2-3/4	1-3/4	13/16
KWIK-CON II+ 316-234 PFH Bulk	3/16	2-3/4	1-3/4	13/16
KWIK-CON II+ 316-314 PFH	3/16	3-1/4	1-3/4	1-5/16
KWIK-CON II+ 316-334 PFH	3/16	3-3/4	1-3/4	1-13/16
KWIK-CON II+ 316-4 PFH	3/16	4	1-3/4	2-1/16
KWIK-CON II+ 316-114 PFH Stainless Steel	3/16	1-1/4	1-1/16	0
KWIK-CON II+ 316-234 PFH Stainless Steel	3/16	2-3/4	1-3/4	13/16

Description	#3 Phillips Bit			
	Diameter (In.)	Total Length (In.)	Thread Length (In.)	Shank Length (In.)
KWIK-CON II+ 14-114 PFH	1/4	1-1/4	1-1/16	0
KWIK-CON II+ 14-134 PFH	1/4	1-3/4	1-9/16	0
KWIK-CON II+ 14-134 PFH Bulk	1/4	1-3/4	1-9/16	0
KWIK-CON II+ 14-214 PFH	1/4	2-1/4	1-3/4	5/16
KWIK-CON II+ 14-234 PFH	1/4	2-3/4	1-3/4	13/16
KWIK-CON II+ 14-234 PFH Bulk	1/4	2-3/4	1-3/4	13/16
KWIK-CON II+ 14-314 PFH	1/4	3-1/4	1-3/4	1-5/16
KWIK-CON II+ 14-334 PFH	1/4	3-3/4	1-3/4	1-13/16
KWIK-CON II+ 14-4 PFH	1/4	4	1-3/4	2-1/16

KWIK-CON II+ Hex Driver System

Description	Box Qty
KWIK-CON Hex Driver Deluxe Kit	1
KWIK-CON Hex Driver	1
5/16" Hex Driver (all THWH)	1
5/16" Hex Nut Setter/Depth Locator	1
Insert Bit Holder/Depth Locator	1
#3 Phillips Driver (all PFH)	1
T-25 TORX Driver (3/16" TFH)	1
T-27 TORX Driver (1/4" TFH)	1

KWIK-CON II+ Matched Tolerance Drill Bits

Description	Bit Diameter (In.)	Box Qty
For 1/4" KWIK-CON II+ Applications in Dense Concrete (2000 psi+)		
TKC Large Concrete Bit SDS+ Hex	0.2402	1
TKC Large Concrete Bit TM Hex	0.2402	1
For 1/4" KWIK-CON II+ Applications in Light Concrete, Brick or Block		
TKB Large Block Bit SDS+ Hex	0.2260	1
TKB Large Block Bit TM Hex	0.2260	1
For 3/16" KWIK-CON II+ Applications in Dense Concrete (2000 psi+)		
TKC Small Concrete Bit SDS+ Hex	0.1902	1
TKC Small Concrete Bit TM Hex	0.1902	1
For 3/16" KWIK-CON II+ Applications in Light Concrete, Brick or Block		
TKB Small Block Bit SDS+ Hex	0.1752	1
TKB Small Block Bit TM Hex	0.1752	1

3.3.14 Metal Hit Anchor

3.3.14.1 Product Description

3.3.14.2 Material Specifications

3.3.14.3 Technical Data

3.3.14.4 Installation Instructions

3.3.14.5 Ordering Information

3.3.14.1 Product Description

The Hilti Metal Hit Anchor is a drive-in type expansion anchor consisting of a zinc plated or stainless steel drive pin and an alloy expanding body for light duty fastenings in concrete and masonry.

Product Features

- Quick and easy fastening for maximum speed and installation
- Low profile mushroom head style provides a clean, tamper proof fastening
- Anchor design allows easy through-type fastenings even in bottomless holes
- Consistent load values provide light duty fastenings in concrete and masonry
- Choice of stainless steel or carbon steel finish allows outdoor or indoor use

3.3.14.2 Material Specifications

Body material: Aluminum/Zinc Alloy

Drive Pin: Zinc plated carbon steel conforming to AISI 1018. Type 304 Stainless Steel (Stainless Steel Version)

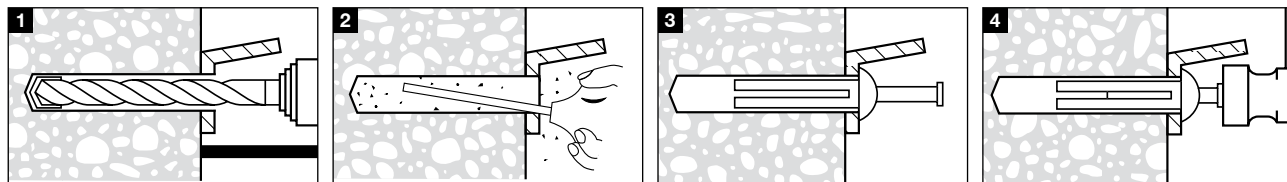
3.3.14.3 Technical Data

Metal Hit Allowable Loads in Normal Weight Concrete

Anchor Size in.	Embed. Depth in. (mm)		Concrete						Hollow Concrete block				Red Clay block			
			Tension lb (kN)				Shear lb (kN)		Tension lb (kN)		Shear lb (kN)		Tension lb (kN)		Shear lb (kN)	
			2000psi		4000psi		2000psi									
3/16	5/8	(16)	–		–		–		180	(0.8)	180	(0.8)	–		–	
1/4	3/4	(19)	135	(0.6)	210	(0.9)	280	(1.2)	255	(1.1)	320	(1.4)	180	(0.8)	280	(1.2)
1/4	1	(25)	160	(0.7)	240	(1.1)	315	(1.4)	310	(1.4)	320	(1.4)	245	(1.1)	290	(1.3)

For overhead application reduce the allowable load values by a factor of 2.

3.3.14.4 Installation Instructions



1. Drill hole at least 1/4" deeper than anchor.

2. Clean hole.

3. Install anchor through fixture.

4. Hammer in nail until nail head is flush with anchor body. Do not overdrive.

3.3.14.5 Ordering Information

Description	Carbon Item No.	Stainless Item No.	Bolt Diameter ¹ In.	Box Qty
Metal Hit 3/16" x 7/8"	66137	N/A	3/16	100
Metal Hit 1/4" x 3/4"	15538	N/A	1/4	100
Metal Hit 1/4" x 1"	66138	230567	1/4	100
Metal Hit 1/4" x 1-1/4"	66139	230568	1/4	100
Metal Hit 1/4" x 1-1/2"	66140	230569	1/4	100
Metal Hit 1/4" x 2"	45453	230570	1/4	100

HPS-1 Impact Anchor 3.3.15

3.3.15.1 Product Description

The HPS-1 Impact Anchor consists of a carbon or stainless steel drive-screw and a plastic expansion body, which combine to form an easy-to-install yet removable fastening, for light duty applications in concrete and masonry.

Product Features

- Recessed philips drive connection in the screw head provides protection during hammering, allowing simple setting and removal
- Anchor collar and screw head form a compact unit which allows countersinking in soft wood and solid clamping action with metal parts
- Expanding head opens in hollow base material to provide reliable keying effect
- One type anchor reduces inventory, provides versatile use in brick, hollow block and concrete
- Can be set with hammer or screw driver for quick and easy installation
- Available with 304 Stainless Steel Nail for use in corrosive environments
- Plastic body is temperature resistant from -40°F to 176°F. Anchor can be installed from 14°F to 104°F. Both temperature ranges allow use in extreme climactic conditions
- Suitable for through-hole fastenings to improve productivity
- Easy removal adds to HPS-1 versatility.

3.3.15.1 Product Description

3.3.15.2 Material Specifications

3.3.15.3 Technical Data

3.3.15.4 Installation Instructions

3.3.15.5 Ordering Information

3.3.15.2 Material Specifications

Corrosion resistant body made of polyamide 6.6 plastic

Carbon steel drive screw material meets the requirements of AISI 1010

Carbon steel drive screw zinc plated to minimum 5 µm thickness in accordance with ASTM B633, SC 1, Type III

Stainless steel drive screw material meets the requirements of AISI 304

3.3.15.3 Technical Data

HPS-1 Allowable Loads¹

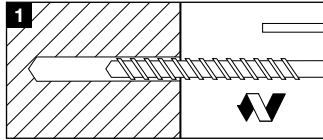
Anchor		HPS-1	HPS-1	HPS-1	HPS-1	HPS-1
		3/16 to 1/2	1/4 to 1 1/2	1/4 to 1 5/8 1/4 to 2-1/16 1/4 to 2-5/8	5/16 to 1-5/8 5/16 to 2-1/2	5/16 to 3-5/8 5/16 to 4-3/8
Base Material						
Concrete 2000 psi (13.8 MPa)	Tension lb (N)	30 (133)	55 (245)	70 (311)	80 (356)	90 (400)
	Shear lb (N)	95 (422)	130 (578)	135 (600)	215 (956)	110 (489)
Brick Masonry	Tension lb (N)	35 (155)	40 (178)	45 (200)	45 (200)	N/A
	Shear lb (N)	105 (467)	145 (645)	165 (734)	220 (979)	N/A
Hollow Concrete Block (Normal Wt.)	Tension lb (N)	50 (222)	55 (245)	60 (600)	65 (289)	N/A
	Shear lb (N)	120 (534)	140 (623)	160 (712)	185 (823)	N/A
Min. Embed. Depth	Concrete	in. (mm)	3/4 (19)	7/8 (22)	1 (25)	1-3/16 (30)
	Hollow Base	in. (mm)	5/8 (16)	13/16 (21)	1 (25)	N/A

¹ Representative results of testing and a safety factor of 5.0.

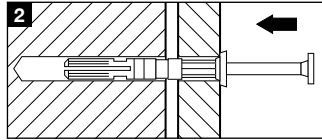
3.3.15 HPS-1 Impact Anchor

3.3.15.4 Installation Instructions

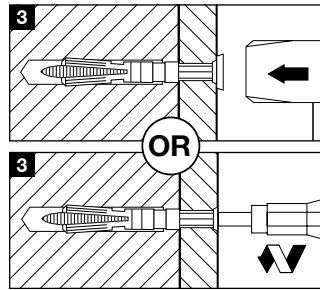
Solid Base Materials



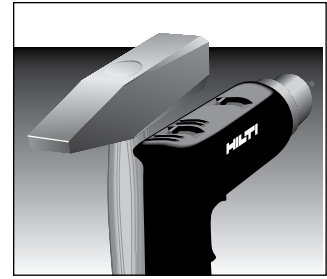
1. Drill hole (depth = anchor length minus thickness fastened plus 1/2").



2. Insert anchor.

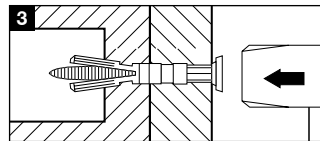
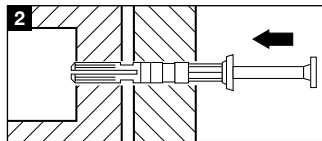
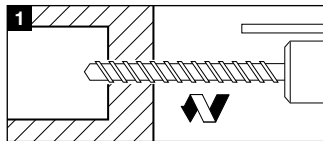


3. Set the anchor with a hammer or with an electric screwdriver.



- Drive with a hammer or an electric screwdriver
- An accurately matched anchor length provides optimized holding power by allowing for expansion in the first part of the brick or block.

Hollow Base Materials



3.3.15.5 Ordering Information

Carbon Steel

Description	Fastenable Material Thickness in Concrete		Fastenable Material Thickness in Hollow Base Materials		Bit	
	max In.	(mm)	max In.	(mm)	Diameter In.	Box Qty
HPS-1 3/16 x 1	3/16	(5)	3/8	(9)	3/16	200
HPS-1 3/16 x 1-1/2	5/8	(15)	3/4	(19)	3/16	200
HPS-1 1/4 x 1	1/8	(3)	3/16	(5)	1/4	200
HPS-1 1/4 x 1-5/8	5/8	(15)	3/4	(19)	1/4	100
HPS-1 1/4 x 2-1/16	1	(25)	1-3/16	(30)	1/4	100
HPS-1 1/4 x 2-5/8	1-5/8	(41)	1-3/4	(44)	1/4	100
HPS-1 5/16 x 1-5/8	3/8	(9)	5/8	(15)	5/16	100
HPS-1 5/16 x 2-1/2	1-3/16	(30)	1-3/8	(35)	5/16	50
HPS-1 5/16 x 3-5/8	2-3/8	(60)	N/A		5/16	50
HPS-1 5/16 x 4-3/8	3-1/8	(85)	N/A		5/16	50

Stainless Steel

Description	Fastenable Material Thickness in Concrete		Fastenable Material Thickness in Hollow Base Materials		Bit	
	max In.	(mm)	max In.	(mm)	Diameter In.	Box Qty
HPS-1 R 3/16 x 1	3/16	(5)	3/8	(9)	3/16	200
HPS-1 R 3/16 x 1-1/2	5/8	(15)	3/4	(19)	3/16	200
HPS-1 R 1/4 x 1	1/8	(3)	3/16	(5)	1/4	200
HPS-1 R 1/4 x 1-5/8	5/8	(15)	3/4	(19)	1/4	100
HPS-1 R 1/4 x 2-1/16	1	(25)	1-3/16	(30)	1/4	100
HPS-1 R 1/4 x 2-5/8	1-5/8	(41)	1-3/4	(44)	1/4	100
HPS-1 R 5/16 x 3-5/8	2-3/8	(60)	N/A		5/16	50
HPS-1 R 5/16 x 4-3/8	3-1/8	(85)	N/A		5/16	50

1 Hilti carbide tipped drill bits

HTB TOGGLER® Bolt 3.3.16

3.3.16.1 Product Description

The Hilti HTB TOGGLER® Bolt fastening system consists of a metal channel threaded to accept a machine bolt, and unique plastic legs and locking cap for fastening in a wide range of hollow-wall materials.

Product Features

- Unique installation legs and locking cap facilitate fastening in wide range of drywall and hollow wall materials up to 2-1/4" thick
- One piece metal channel provides greater holding power
- Plastic pull ring assists in setting lock cap
- Anchor is adjustable for various base material thicknesses providing easier installation as well as minimizing inventory investment
- Remains mounted in the wall without screw for convenient handling, installation and reuse
- Available in stainless steel and carbon steel for different environments
- Comprehensive offering with and without machine screws

3.3.16.2 Material Specifications

Zinc plated metal channel material meets the requirements for AISI 1010 steel

3.3.16.3 Technical Data

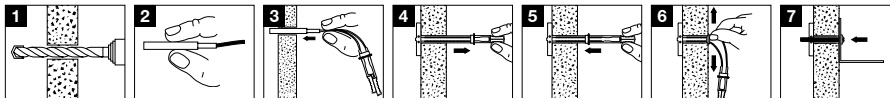
HTB TOGGLER® Bolt Allowable Loads¹

Toggler Bolt Size in.	Hole Dia. in.	1/2" Drywall		5/8" Drywall		Hollow Concrete Block	
		Tension lb (N)	Shear lb (N)	Tension lb (N)	Shear lb (N)	Tension lb (N)	Shear lb (N)
3/16	1/2	30 (133)	70 (311)	45 (200)	95 (423)	140 (623)	160 (712)
1/4	1/2	35 (155)	85 (378)	50 (222)	105 (467)	160 (712)	240 (1068)
3/8	3/4	35 (155)	70 (311)	50 (222)	105 (467)	200 (890)	380 (1690)
1/2	3/4	35 (155)	85 (378)	50 (222)	110 (489)	240 (1068)	420 (1868)

1 Based on using a safety factor of 4.0.

TOGGLER® is the registered trademark of Mechanical Plastics Corp.

3.3.16.4 Installation Instructions



- 1 Drill correct size hole into wall cavity.
- 2 Position the metal channel parallel with the plastic legs.
- 3 Insert the metal channel through the drilled hole into the wall cavity.
- 4 Pull the metal channel firmly against the inner wall cavity by tugging the plastic pull ring.
- 5 Slide the plastic cap forward along the legs until it is seated flush to the work surface.
- 6 Snap the plastic legs off flush at the plastic cap by pushing outward.
- 7 Secure the item to be fastened with the proper size machine screw and screw driver. NOTE: Maximum torque on screw or rod is 5 ft-lb.

3.3.16.5 Ordering Information

Description	Machine Screw Dia. (In.)	Machine Screw Length (In.)	Bit Dia. (in.) ¹	Box Qty
HTB TOGGLER® Bolt 3/16" with SRH screw ¹	3/16	2-1/2	1/2	100
HTB TOGGLER® Bolt 3/16" with PFH screw ²	3/16	2-1/2	1/2	100
HTB TOGGLER® Bolt 3/16" w/o screw ³	3/16	–	1/2	100
HTB TOGGLER® Bolt 1/4" with SRH screw ¹	1/4	2-1/2	1/2	100
HTB TOGGLER® Bolt 1/4" with PFH screw ²	1/4	2-1/2	1/2	100
HTB TOGGLER® Bolt 1/4" w/o screw ³	1/4	–	1/2	100
HTB TOGGLER® Bolt 3/8" with SRH screw ¹	3/8	2-1/2	3/4	25
HTB TOGGLER® Bolt 3/8" w/o screw ³	3/8	–	3/4	25
HTB TOGGLER® Bolt 1/2" with SRH screw ¹	1/2	2-1/2	3/4	25
HTB TOGGLER® Bolt 1/2" w/o screw ³	1/2	–	3/4	25

1 Round Head (Combination Slotted/Phillips)

2 Phillips Flat Head

3 Machine screws not included

TOGGLER® is the registered trademark of Mechanical Plastics Corp.

3.3.16.1 Product Description

3.3.16.2 Material Specifications

3.3.16.3 Technical Data

3.3.16.4 Installation Instructions

3.3.16.5 Ordering Information



3/16" & 1/4"

3/8" & 1/2"

3.3.17 HLD Kwik Tog

3.3.17.1 Product Description

3.3.17.2 Material Specifications

3.3.17.3 Technical Data

3.3.17.4 Installation Instructions

3.3.17.5 Ordering Information

3.3.17.1 Product Description

The Hilti HLD KWIK Tog is a plastic anchor designed to accept #8 or #10 screws for light duty applications in hollow or solid base materials

- Leg braces provide added support
- Ribs on body help prevent anchor from spinning during installation
- Remains mounted in the wall without screw for convenient handling, installation and reuse

Product Features

- Unique one piece design for easy setting
- Three convenient sizes for use in a variety of hollow base materials from 1/4" drywall to block and concrete

3.3.17.2 Material Specifications

Plastic: polypropylene for use in temperature range from -40°F to 140°F

3.3.17.3 Technical Data

Base Material Thickness (in.)	Drill Bit Dia. (in.)	L	d
HLD KWIK Tog 2 specially designed for 1/2" sheetrock			
5/32" to 1/2"	3/8"	1-1/4" + S	#8 / #10
17/32" to 19/32"	3/8"	1-1/4" + S	#8 / #10
greater than 1-3/8"	3/8"	1-9/16" + S	#10 / #12
HLD KWIK Tog 3 specially designed for 5/8" sheetrock			
5/8" to 3/4"	3/8"	1-1/2" + S	#8 / #10
3/4" to 7/8"	3/8"	1-1/2" + S	#8 / #10
greater than 1-5/8"	3/8"	1-13/16" + S	#10 / #12
HLD KWIK Tog 4			
15/16" to 1-1/8"	3/8"	1-7/8" + S	#8 / #10
1-1/8" to 1-1/4"	3/8"	1-7/8" + S	#8 / #10
greater than 2"	11/32"	2-3/16" + S	#10 / #12

Specification Table

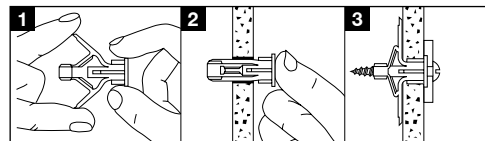
S = Thickness of material being fastened		

HLD KWIK-Tog Allowable Loads¹

Description	1/2" Drywall Tension lb (N)	5/8" Drywall Tension lb (N)	Hollow Concrete Block Tension lb (N)
HLD 2	20 (89)	25 (111)	40 (178)
HLD 3	—	35 (156)	50 (222)
HLD 4	—	—	70 (311)

¹ Based on using a safety factor of 5.0.

3.3.17.4 Installation Instructions



1. Compress wings together.
2. Insert anchor through drilled hole.
3. Insert and tighten screw through fixture to expand wings.

3.3.17.5 Ordering Information

HLD KWIK-Tog Anchor Program

Description	Bit Dia. (In.)	Hollow Base Matl. Thickness (In.)	Allowable Load in 5/8" Drywall		Recommended Screw Size ¹		Qty Per Bag
			Tension lb	(kN)	Hollow Base Matl.	Solid Base Matl.	
HLD KWIK Tog 2 (HLD2)	3/8	3/16 to 5/8	25	(0.11)	#8 or #10	#10	150
HLD KWIK Tog 3 (HLD3)	3/8	5/8 to 7/8	35	(0.16)	#8 or #10	#10	100
HLD KWIK Tog 4 (HLD4)	3/8	15/16 to 1-1/4	—	—	#8 or #10	#10	100

¹ Screw not included

HSP/HFP Drywall Anchor 3.3.18

3.3.18.1 Product Description

The Hilti HSP/HFP Drywall Anchor is a self-drilling anchor designed for fast and reliable fastenings in drywall.

Product Features

- Shark tooth design for correct positioning and quick installation
- Cuts its own thread, no predrilling necessary
- Can be set with electric or standard screwdriver for quick and simple installation
- Removability adds to the anchor versatility
- Available in non-conductive nylon or zinc for a variety of applications
- Available with and without screws for your convenience

3.3.18.1 Product Description

3.3.18.2 Material Specifications

3.3.18.3 Technical Data

3.3.18.4 Installation Instructions

3.3.18.5 Ordering Information

3.3.18.2 Material Specifications

HSP Die cast zinc conforming to DIN 1734

HFP Polyamide 6.6 plastic; glass fiber reinforced

3.3.18.3 Technical Data

HSP/HFP Drywall Anchor Allowable Loads¹

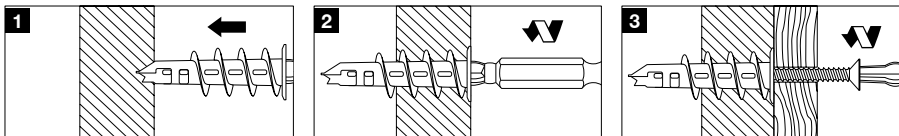
Gypsum Wall Board Thickness	1/2"				5/8"			
	Tension		Shear		Tension		Shear	
Description	lb	(N)	lb	(N)	lb	(N)	lb	(N)
HSP with Screw # 8 x 1-3/16	15	(70)	40	(180)	22	(100)	60	(270)
HFP with Screw # 8 x 1-3/16	15	(70)	40	(180)	22	(100)	60	(270)

¹ Based on using a safety factor of 5.0.

HSP

HFP

3.3.18.4 Installation Instructions



1. Push the teeth of the anchor into the drywall panel.

2. Drive the anchor (clockwise rotation) until it lies flush with the wall.

3. Drive and tighten the screw with the Hilti Insert Bit.

3.3.18.5 Ordering Information

Description	Anchor Length (in.)	Screw Dia.	Box Qty
HSP	1-1/2	# 8	100
HSP-S Delivered with 100 screws, # 8 x 1-3/16"	1-1/2	# 8	100
HFP	1-1/8	# 8	100
HFP-S Delivered with 100 screws, # 8 x 1-3/16"	1-1/8	# 8	100
D-B PH2 HSP/HFP Phillips Head Bit	-	-	5

3.3.19 IDP Insulation Anchor

3.3.19.1	Product Description
3.3.19.2	Material Specifications
3.3.19.3	Technical Data
3.3.19.4	Installation Instructions
3.3.19.5	Ordering Information



3.3.19.1 Product Description

The Hilti IDP Insulation Anchor is a plastic anchor designed for attaching insulation to concrete and masonry.

Product Features

- Specially structured head helps ensure bonding of plaster applied directly over the anchor

- Suitable for insulation thickness up to 4-3/4" for enhanced versatility
- Installation in concrete or masonry allows versatile use
- No metal reduces potential condensation behind finish coat of EIFS

3.3.19.2 Material Specifications

Plastic: polypropylene (not UV resistant)

In-place temperature range: -40°F to 176°F (-40°C to 80°C)

Temperature when setting: 32°F to 104°F (0°C to 40°C)

3.3.19.3 Technical Data

Description	Anchor Length in. (mm)	Bit ¹ Dia. in. (mm)	Minimum Embed. Depth in. (mm)	Insulation Thickness in. (mm)	Average Ultimate Pullout ^{4,5}		
					Concrete ² lb (N)	Hollow Concrete Block ³ lb (N)	Brick lb (N)
IDP 0/2	2 (50)	5/16	1-1/8 (29)	0 to 7/8 (0-20)	110 (489)	45 (200)	55 (245)
IDP 2/4	2-3/4 (70)	5/16	1-1/8 (29)	7/8 to 1-3/4 (20-40)			
IDP 4/6	3-1/2 (90)	5/16	1-1/8 (29)	1-3/4 to 2-3/8 (40-60)			
IDP 6/8	4-1/4 (110)	5/16	1-1/8 (29)	2-3/8 to 3-1/8 (60-80)			
IDP 8/10	5 (130)	5/16	1-1/8 (29)	3-1/8 to 4 (80-100)			
IDP 10/12	6 (150)	5/16	1-1/8 (29)	4 to 4-3/4 (100-120)			

1 Hilti carbide tipped drill bits

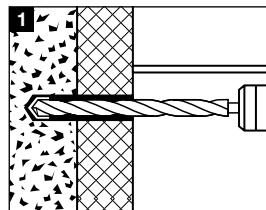
2 Concrete strength $f'_c = 2500$ psi (17.2 MPa).

3 Hollow Concrete Block meets ASTM C90 Grade N Type II.

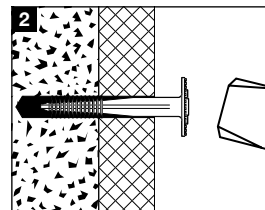
4 Pullout values may be limited by the strength of the material fastened.

5 Allowable loads should be calculated using a minimum safety factor of 4.

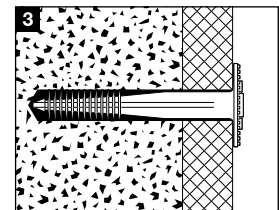
3.3.19.4 Installation Instructions



1. Drill a 5/16" diameter hole through insulation into base material.



2. Hammer anchor into place until washer is flush with insulation.



3. Anchor is set. For outdoor application, anchor head must be covered by finish.

3.3.19.5 Ordering Information

Description	Box Qty
IDP 0/2	250
IDP 2/4	250
IDP 4/6	250
IDP 6/8	250
IDP 8/10	250
IDP 10/12	250

Construction Chemicals 4.0

4.1 Chemical Systems Overview

Product Description	Features	Application
CI 060 EP Crack Injection System For use in repairing small cracks up to 1/4" in concrete base material.	<ul style="list-style-type: none"> • 100% solids epoxy • Easy to use • No power source needed 	<ul style="list-style-type: none"> • Cracks in walls • Basements • Pools • Columns
RM 700 EP Epoxy Based Repair Mortar Epoxy mortar designed for applications where there is high traffic.	<ul style="list-style-type: none"> • 100% solids epoxy • No primer needed • Application temp. 50°F to 90°F (10°C to 32°C) 	<ul style="list-style-type: none"> • Heavy traffic with chemical exposure
RM 710 EP Epoxy Based Lo-Temp Repair Mortar Epoxy mortar designed for applications where temperatures are below freezing or a rapid patch is needed in high traffic areas.	<ul style="list-style-type: none"> • Low temperature formulation • Premeasured • Easy to mix • Application temp. 25° to 90°F (-4°C to 32°C) 	<ul style="list-style-type: none"> • Heavy traffic with chemical exposure
RM 800 PC Portland Cement Based Repair Mortar Fast-setting high early strength concrete repair material.	<ul style="list-style-type: none"> • Mixes with water • No primer needed • Excellent adhesion 	<ul style="list-style-type: none"> • Heavy Traffic • Short down-time
CB-G MG Multipurpose Buy American-compliant, non-shrink, non-metallic ready to use grout ideal for general construction grouting applications.	<ul style="list-style-type: none"> • Available in 50 lb bags • 7,800 psi (Plastic - 28 day) Compressive Strength • Fluid, flowable or plastic consistency • Positive expansion, non-shrink • Pumpable 	<ul style="list-style-type: none"> • Structural grouting of baseplates, columns, beams, precast concrete, dowels, etc. • General construction grouting applications • Can be used above or below grade
CB-G PG Precision Grout Buy American-compliant, non-shrink, non-metallic, high performance, cementitious precision grout for use in virtually all applications where high strength combined with high fluidity is required.	<ul style="list-style-type: none"> • Available in 50 lb bags & 50 lb buckets • High early and ultimate strengths • 11,000 psi (Plastic - 28 day) Compressive Strength • High flow capacity • Positive expansion, non-shrink • Pumpable 	<ul style="list-style-type: none"> • Grouting of machinery and equipment with high load requirements • Applications where early commissioning quick job startup are required
CB-G EG Epoxy Grout Buy American-compliant, three component, 100% solids, VOC and BGE free, non-corrosive, high performance epoxy grouting system. This specially formulated grout offers high strength providing excellent resistance to impact and vibration.	<ul style="list-style-type: none"> • Available in 65 lb bucket kit • Non-hazardous and non-corrosive per DOT shipping classification • High early and ultimate strengths • 13,500 psi (7 day) Compressive Strength • High vibration resistance • Self-leveling • Deep pour, low shrinkage • High resistance to a variety of chemicals 	<ul style="list-style-type: none"> • Grouting of machinery and equipment with high load requirements • Precision alignment under dynamic load conditions • Structural grouting of baseplates, columns, beams, crane rails, bridge seats, dowels, etc. • Chemical processing facilities
CFP-S WB Fire Protection Steel Spray (Intumescent Coating) Fire protection dispersion to protect load-bearing structural steel through the protective intumescent coating for indoor applications	<ul style="list-style-type: none"> • Available in 55 lb bucket • Water Based, low VOC – allows for fast, easy and safe clean up • Reduced drying time permits additional coats to be applied faster • Infinite color options possible with approved topcoats 	<ul style="list-style-type: none"> • All exposed structural steel members including columns, beams, brace members, etc. • Wide flange steel members • Hollow structural sections (HSS) members • Restrained and unrestrained beams • Steel floor and form units

4.1	Chemical Systems Overview
4.2.1	CI 060
4.3.1	RM 700 EP
4.3.2	RM 710 EP
4.3.3	RM 800 PC
4.4.1	CB-G MG Multipurpose
4.4.2	CB-G PG Precision
4.4.3	CB-G EG Epoxy
4.5.1	CFP-S WB Fire Protection Steel Spray (Intumescent Coating)

4.2 Crack Injection System

4.2.1 CI 060 Crack Injection System

Listings, Approvals & Testing Standards

Meets requirements of ASTM C 881,
Type IV, Grade 1, Class B

4.2.1.2 Material Specifications

• Injection Resin CI 060 EP

**Shelf life from date of manufacture
when stored at 50°F to 80°F (10°C
and 27°C)**

Resin and hardener: 2 years

Rec. application temp. Range

50° to 113°F (10°C and 45°C)

Working Time

90 minutes at 50°F (10°C)

40 minutes at 73°F (23°C)

15 minutes at 90°F (32°C)

Min. curing time at 68°F (20°C)

Approx. 24 hrs

Compressive Strength

12,000 psi

Tensile Strength

7,120 psi

Compressive Modulus

265,000 psi

Contents

1 tube CI 060 EP resin and
hardener=14.3 in³

• Surface Sealing Compounds

**Shelf life from date of manufacture
when stored at 59°F to 77°F (15°C
and 25°C)**

Resin and hardener: 1 year

Rec. application temp. Range

40° to 90°F (4°C and 32°C)

CI 070EP

Working Time

34 mins at 40°F (4°C)

10 mins at 77°F (25°C)

Approx. Cure Schedule

Min. 3 hrs at 70°F (21°C)

Compressive Strength

11,000 psi

Tensile Strength

6,900 psi

Compressive Modulus

293,000 psi

Contents

1 quart resin and hardener (covers
approx. 50–70 ft)

Quick Set Epoxy

Working Time

6 mins at 40°F (4°C)

3–4 mins at 77°F (25°C)

Approx. Cure Schedule

Approx. 30 mins at 73°F (23°C)

Contents

9 fl oz tube (covers approx. 50–70 ft)

4.2.1.1 Product Description

CI 060 EP is a liquid epoxy that is packaged in a self-contained cartridge with resin and hardener. The CI 060 EP is designed for repairs of thin cracks less than 1/4" (6 mm) in concrete base material.

Product Features

- Low viscosity, penetrates cracks as narrow as 0.002" (0.051mm)
- No shrinkage, no solvent fumes
- Bonds to both concrete and steel
- Excellent resistance to water, salt water, alkalis and many chemicals
- Forms strong, permanent, water resistant bonds

4.2.1.3 Installation Data

Basic Use

CI 060 EP is a heavy duty, low viscosity epoxy, designed to make repairs in cracked concrete structures. CI 060 EP offers no shrinkage, no solvent fumes and bonds to concrete and steel. Cracks as narrow as 0.002" to 1/4" wide can be repaired. CI 060 EP forms strong, permanent water resistant bonds that provide excellent resistance to water, salt water, alkalis and many chemicals.

Coverage

- 1 cartridge of CI 060 EP = 14.3 in³ (234 cm³)
- One quart of Surface Sealing Compound = 58 in³ (32 fl oz, 950 cm³) and covers approx. 50-70 ft of crack

Limitations

- Minimum crack width 0.002" to maximum crack width 1/4"
- Do not use CI 060 EP system at less than 40°F (4°C) base material temperature
- Do not use CI 060 EP in cracks with flowing or standing water
- Sealing only one side of a crack may cause the loss of epoxy resin

CI 060 EP Crack Injection System Volume of Epoxy required (in³) per Linear Foot of Crack¹

Depth of Crack (in)	Crack Width (in.)												
	0.0050	0.0100	0.0200	0.0312 (1/32")	0.0400	0.0550	0.0625 (1/16")	0.0700	0.1250 (1/8")	0.1450	0.1770	0.1870 (3/16")	0.2050
1"	0.06	0.12	0.24	0.37	0.48	0.66	0.75	0.84	1.50	1.74	2.12	2.24	2.46
2"	0.12	0.24	0.48	0.75	0.96	1.32	1.50	1.68	3.00	3.48	4.25	4.49	4.92
4"	0.24	0.48	0.96	1.50	1.92	2.64	3.00	3.36	6.00	6.96	8.50	8.98	9.84
6"	0.36	0.72	1.44	2.25	2.88	3.96	4.50	5.04	9.00	10.44	12.74	13.46	14.76
8"	0.48	0.96	1.92	3.00	3.84	5.28	6.00	6.72	12.00	13.92	16.99	17.95	19.68
10"	0.60	1.20	2.40	3.74	4.80	6.60	7.50	8.40	15.00	17.40	21.24	22.44	24.60
12"	0.72	1.44	2.88	4.49	5.76	7.92	9.00	10.08	18.00	20.88	25.49	26.93	29.52
16"	0.96	1.92	3.84	5.99	7.68	10.56	12.00	13.44	24.00	27.84	33.98	35.90	39.36
18"	1.08	2.16	4.32	6.74	8.64	11.88	13.50	15.12	27.00	31.32	38.23	40.39	44.28
24"	1.44	2.88	5.76	8.99	11.52	15.84	18.00	20.16	36.00	41.76	50.98	53.86	59.04
36"	2.16	4.32	8.64	13.48	17.28	23.76	27.00	30.24	54.00	62.64	76.46	80.78	88.56

¹ Assumes no waste.

Crack Injection System 4.2

4.2.1.4 Installation Instructions

1. Clean surface along the crack. Blow out crack with dry and oil-free compressed air.
2. Bond injection ports with CI 070 EP Crack Sealing Compound. Port spacing approximately 6" to 12" with wider spacing for thinner slabs.
3. Seal the crack with CI 070 EP surface sealing compound in strips of minimum 2" wide, 1/8" deep. (Seal both sides if crack goes completely through concrete.)
4. A light tap with a hammer to the rear end of the CI 060 EP cartridge breaks the internal glass cylinder, releasing the hardener. Mix by see-saw motion for approximately 30 motions. Do not shake.
5. Puncture the seal of the cartridge tip. Then screw on connection hose.
6. Plug connection hose to bottom port. Place air relief stopper in next port above.
7. Inject CI 060 EP resin until it appears visibly in the next port above. Remove air relief stopper (non-return valve is now closed) and insert into next port. Continue injecting into original port until the port accepts no more resin (when normal hand pressure is used on the dispenser).
8. Detach connection hose from port and plug to the next higher port. Repeat operating steps 6 and 7 up to the end of the crack.
9. After the injection resin has set, generally over night, the ports and the sealing compound can be removed with a flat chisel. If required, the surface can be ground even.

4.2.1.5 Ordering Information*

Description

CI 060 EP Kit

Includes 12 tubes injection epoxy (172 in³), injection epoxy, 30 ports with non-return valves, 6 connection hoses with non-return valves, 4 air relief stoppers

CI 070 EP Surface Sealing Compound (1 quart)

CI 070 EP Surface Sealing Compound, Case of 4 quarts

Bag of 30 ports with non-return valves

Bag of 6 connection hoses with non-return valves

Bag of 4 air relief stoppers

CB 200 PI dispenser (fully enclosed)

Adhesive dispenser for 10.5 oz tubes

*Not available in Canada

4.3 Repair Mortar

4.3.1 RM 700 EP Epoxy Repair Mortar

Listings, Approvals

& Testing Standards

- ASTM D 638
- ASTM D 695
- ASTM D 790

Meets or exceeds all current
V.O.C. regulations
USDA Acceptable

4.3.1.2 Material Specifications

Solids Content

100%

Color

Light gray

Shelf Life

2 years from date of manufacture

Application Temp. Range

50° to 90° F (10°C to 32°C)

Pot Life

0.45 cu. ft. mix @ 20–30 mins

Cure Schedule at 70°F (21°C)

Recoat or top coat: 4–5 hrs

Light foot traffic: 10–12 hrs

Full cure traffic: 2–7 days

Compressive Strength (psi)

10,489 @ ASTM D 695

Tensile Strength (psi)

8,157 @ ASTM D 638

Impact Strength (IZOD)

Excellent

Heat Deflection Temperature

ASTM D 648, 1/2" x 1/2" bars,
span = 4"

156°F (69°C) @ ASTM D648

Chemical Resistance

xylene	C
1,1,1 trichlorethane	C
MEK	A
methanol	A
ethyl alcohol	A
skydrol	B
10% sodium hydroxide	C
50% sodium hydroxide	C
10% sulfuric acid	B
70% sulfuric acid	A
10% HC1 (aq)	C
5% acetic acid	B

Rating Key: A - not recommended,

B - 2 hour term splash spill, C - 8 hour
term splash spill

Volatile Organic Content (VOC)

Zero pounds per gallon

4.3.1.1 Product Description

RM 700 EP consists of a 100% solids, 2-part epoxy packaged in kit form with the proper amount of graded sand to make a perfect patch. RM 700 EP is high strength and designed to resist wear and abrasion for most concrete repair applications.

4.3.1.3 Installation Data

Basic Use

RM 700 EP is a heavy duty trowelable mortar designed for repairing damaged concrete subject to heavy loads or severe impact. RM 700 EP is specifically formulated to be used in federally inspected meat and poultry plants, and is acceptable for use in facilities regulated by the U.S. Department of Agriculture.

RM 700 EP's fast cure and high compressive strength make it ideal for repair work in areas where downtime must be kept to a minimum, such as plant and warehouse aiseways, truck docks and entryways. Its inherent resistance to thermal shock is crucial when repaired areas are subject to hot water washing. Areas which are at ambient temperatures as low as 50°F (10°C) may be subjected to cleaning solutions and water at temperatures of 200°F (93°C) with no adverse effects.

Product Features

- Virtually unaffected by freezing/thawing
- Bonds to concrete and steel
- No primer required
- Easily troweled
- All components pre-measured

Coverage

- 65 lb unit yields 0.45 ft³
- One 65 lb bucket RM 700 EP covers approximately 21.54 square feet at 1/4" thickness
- One 9 lb bucket RM 700 EP covers approximately 2.7 square feet at 1/4" thickness

Limitations

- Substrate temperature must be 5°F (3°C) above dew point
- Minimum depth of patch is 1/8", except at edges of patch, which should be 1/4"
- Avoid mixing more RM 700 EP than can be placed in 20 minutes at 70°F (21°C)
- Do not place RM 700 EP when slab temperatures are below 50°F (10°C) or above 80°F (27°C)
- Do not install RM 700 EP on vertical surfaces without providing suitable formwork to retain the patch during cure
- Do not attempt to feather edges of patch. Terminate all applications into a 1/4" sawcut, reveal or reglet
- All new concrete must be cured for 30 days prior to application

Repair Mortar 4.3

4.3.1.4 Installation Instructions

Surface Preparation

The surface to be repaired must be clean, dry, and free of oil, grease and loose matter. The bonding surface should be roughened, using a small chipping hammer or bushing tool, swept clean and blown with clean, dry, oil-free compressed air, or vacuumed clean.

Where the patch will terminate, the concrete must be sawcut and chipped out 1/4" deep.

No priming is required with RM 700 EP, so installation is quick, easy and economical.

Temperature

RM 700 EP should be stored at temperatures between 55°F and 90°F (13°C and 32°C) prior to use. Substrate temperatures may be between 50°F and 80°F (10°C and 27°C).

Mixing

Proper mixing is critical when installing epoxy repair mortars. Do not mix more mortar than can be applied in 20 minutes. Drain the contents of Part B completely into a clean mixing container. Then drain the contents of Part A into the same container. Mix the liquids until the resultant mixture is free of streaking. Next, add the aggregate, a little at a time, while mixing with a mortar mixer or a drill with a mixing paddle. Mix until uniform, being sure that there is no dry aggregate on the bottom or sides of the pail. Do Not Mix Partial Units. Failure to combine components in the proper ratios can result in poor cure or no cure.

Troweling

For large patches, apply RM 700 EP mortar in 2 foot wide strips. Lattice boards will help ensure proper thickness. Spread and finish with a rectangular steel trowel, taking care to minimize trowel marks. Be sure the edges of patch are flush with the surrounding concrete. For smaller patches, a trowel alone may be sufficient.

Trowels may be coated with a commercial solvent such as mineral spirits, to give the finished work a smoother appearance.

Maintenance

RM 700 EP may be cleaned with most floor cleaning detergents. Aggressive solvents should be avoided.

Floor Cleaning

Caution: Some cleaners may affect the color of the floor installed. Test each cleaner in a small area, utilizing your cleaning technique. If no ill effects are noted, you can continue to clean with the product and process tested.

Recoat or Topcoating

No recoating or topcoating is necessary. However, if you opt to topcoat the applied mortar, allow it to cure before topcoating. Many epoxies and urethanes can be used.

Estimating Formula*

$$\text{Number of Units Required} = (L * W * (D_{\text{avg}} / 12)) / Y_{\text{prod}}$$

L = length of void in feet

W = width of void in feet

D_{avg} = avg. depth of void in inches

Y_{prod} = Yield for product
(see table below)

Estimated Yield for Repair Mortars & Grout (Y_{prod}) in ft³

Product	Y _{prod}
RM 700 EP (65 lb. unit)	0.450
RM 700 EP (9 lb. unit)	0.056

*Numbers are approximate and assume no waste.

**Read product labeling
and accompanying
literature before using.**

4.3.1.5 Ordering Information

RM700EP is available in a convenient, pre-proportioned kit, containing resin, hardener and select, graded aggregate.

Description	Size
RM 700 EP	65 lb pai
RM 700 EP Sample Kit	9 lb unit
Stainless Steel Paddle Mixer smooth shank (shown below) specially designed for epoxy mortar. Use with Jacob's style chuck.	

4.3.2 RM 710 EP Lo-Temp Mortar

Listings, Approvals

& Testing Standards

- ASTM D 635
- ASTM D 638
- ASTM D 695
- ASTM D 790

Meets or exceeds all current V.O.C. regulations

USDA Acceptable

4.3.2.2 Material Specifications

Solids Content

100%

Color

light gray

Shelf Life

2 years from date of manufacture

Application Temp. Range

30°F to 80°F (-1°C to 27°C)

Pot Life at 70°F (21°C)

0.45 cu. ft. mix @ 10-15 min

Cure Schedule at 70°F (21°C)

Recoat or top coat . . . 3-4 hrs

Light foot traffic 6-8 hrs

Full cure traffic 2-7 days

Foot traffic

serviceable 24 hrs at 30°F (-1°C)

Compressive Strength (psi)

7,560 @ ASTM D695

Tensile Strength (psi) ASTM D 638

6,030 @ ASTM D638

Impact Strength (IZOD)

Excellent

Heat Deflection Temperature

113°F (45°C) @ ASTM D648

Chemical Resistance

xylene C

1,1,1 trichlorethane C

MEK A

methanol A

ethyl alcohol C

skydrol B

10% sodium hydroxide . . . D

50% sodium hydroxide . . . C

10% sulfuric acid C

70% sulfuric acid A

10% HC1 (aq) C

5% acetic acid B

Rating Key: A - not recommended,

B - 2 hour term splash spill, C - 8 hour

term splash spill, D - 72 hour immersion

Volatile Organic Content (VOC)

Zero pounds per gallon

4.3.2.1 Product Description

RM 710 EP consists of a 100% solids, 2-part epoxy packaged in kit form with the proper amount of graded sand to make a reliable patch. The RM 710 EP is designed for faster curing and applications at lower temperatures.

Product Features

- Virtually unaffected by freeze/thaw
- Can be applied at low base material temperatures
- Very fast curing
- No primer required
- Bonds to concrete and steel
- All components premeasured

4.3.2.3 Installation Data

Basic Use

RM 710 EP is a heavy duty trowelable mortar which is designed for repairing damaged concrete, subject to heavy loads or severe impact. RM 710 EP is specifically formulated to be applied on freezer floors and cold storage areas, at temperatures as low as 30°F (-1°C), where most epoxies will not cure.

RM 710 EP's fast cure and high compressive strength also make it ideal for rapid repair work in areas where downtime must be kept to a minimum, such as plant and warehouse aiseways, truck docks and entryways.

Coverage

- 65 lb unit yields 0.45 ft³
- One 65 lb bucket RM 710 EP covers approximately 20.58 ft² at 1/4" thickness
- One 9 lb bucket RM 710 EP covers approximately 2.57 ft² at 1/4" thickness

Limitations

- Minimum depth of patch is 1/8", except at edges of patch, which should be 1/4"
- Avoid mixing more RM 710 EP than can be placed in 10-15 minutes at 35°F (2°C) to 70°F (21°C)
- Do not place RM 710 EP when slab temperatures are below 30°F (-1°C) or above 80°F (27°C)
- Do not install RM 710 EP on vertical surfaces without providing suitable formwork to retain the patch during cure
- Do not attempt to feather edges of patch. Terminate all applications into a 1/4" sawcut, reveal or reglet
- Not recommended for immersion in aggressive solvents
- Not suitable for outdoor use without UV-resistant coating
- Substrate temperature must be 5°F (3°C) above the dew point
- When temperatures are low, extended time may be required for the material to cure before allowing industrial traffic

RM 710 EP Lo-Temp Mortar 4.3.2

4.3.2.4 Installation Instructions

Surface Preparation

The surface to be repaired must be clean, dry, and free of oil, grease and loose matter. The bonding surface should be roughened, using a small chipping hammer or bushing tool, swept clean and blown with clean, dry, oil-free compressed air, or vacuumed clean.

Where the patch will terminate, the concrete must be sawcut and chipped out 1/4" deep.

No priming is required with RM 710 EP, so installation is quick, easy and economical.

Temperature

RM 710 EP should be stored at temperatures between 55°F and 90°F (13°C and 32°C) prior to use. Substrate temperatures may be between 30°F and 80°F (-1°C and 27°C).

Mixing

Proper mixing is critical when installing epoxy repair mortars.

Do not mix more mortar than can be applied in 10-15 minutes at 35°F (2°C) to 70°F (21°C). Drain the contents of

Part B completely into a clean mixing container. Then drain the contents of Part A into the same container. Mix the liquids until the resultant mixture is free of streaking. Next, add the aggregate, a little at a time, while mixing with a mortar mixer or a drill with a mixing paddle. Mix until uniform, being sure that there is no dry aggregate on the bottom or sides of the pail. Do Not Mix Partial Units. Failure to combine components in the proper ratios can result in poor cure or no cure.

Troweling

For large patches, apply RM 710 EP mortar in 2 foot wide strips. Lattice boards will help ensure proper thickness. Spread and finish with a rectangular steel trowel, taking care to minimize trowel marks. Be sure the edges of patch are flush with the surrounding concrete. For smaller patches, a trowel alone may be sufficient. Trowels may be coated with a commercial solvent such as mineral spirits, to give the finished work a smoother appearance.

Maintenance

RM 710 EP may be cleaned with most floor cleaning detergents. Aggressive solvents should be avoided.

Floor Cleaning

Caution: Some cleaners may affect the color of the floor installed.

Test each cleaner in a small area, utilizing your cleaning technique.

If no ill effects are noted, you can continue to clean with the product and process tested.

Recoat or Topcoating

No recoating or topcoating is necessary. However, if you opt to topcoat the applied mortar, allow it to cure before topcoating. Many epoxies and urethanes can be used.

4.3.2.5 Ordering Information

RM 710 EP is available in a convenient, pre-proportioned kit containing resin, hardener and select, graded aggregate.

Description	Size
RM 710 EP	65 lb pail
RM 710 EP Sample Kit	9 lb unit
Stainless Steel Paddle Mixer smooth shank (shown below) specially designed for epoxy mortar. Use with Jacob's style chuck.	

4.3.3 RM 800 PC Cement Repair Mortar

Listings, Approvals & Testing Standards

ASTM C 928

4.3.3.2 Material Specifications

Working Time

15 mins at 75°F (24°C)

Set Time (ASTM C 266)

Initial (Hrs:Min): 0:20

Final (Hrs:Min): 0:30

Flexural Strength (ASTM C 348) 28 Days

900 psi

Compressive Strength (ASTM C 109)

3 hrs 3000 psi

1 day 6000 psi

28 days 8000 psi

Percentage Length Change (ASTM C 157)

Air-cured -0.082%

Moist-cured +0.031%

Resistance to deicing salts (ASTM C 672)

(10% Calcium Chloride Solution)

25 cycles - 1 Rating

Water Absorption (ASTM C 642)

9.8%

Freeze-Thaw Resistance, 3000 cycles (ASTM C 666, Procedure A)

88% Dynamic modulus

Flow, 5 min (ASTM C 109)

142%

Color

Concrete gray

Splitting Tensile Strength (ASTM C 496)

7 day 390 psi

28 day 450 psi

4.3.3.1 Product Description

RM 800 PC is a fast setting concrete patching material which exhibits high early strength. RM 800 PC is a self-bonding patching compound blended with special cements and additives. No bonding agents are required. RM 800 PC can accept vehicular traffic in three hours and meets the requirements of ASTM C 928 for packaged, dry, rapid-hardening cementitious materials for concrete repairs.

4.3.3.3 Installation Data

Basic Use

RM 800 PC is suitable for repair of damaged concrete on parking structures, airport runways, warehouse floors and loading docks. It can also be used for setting posts, railing and parking meters.

Product Features

- DOT approved (Tennessee & Mississippi)
- Self-bonding, requires no bonding agents or primers
- Minimizes downtime
- Pre-blended; just add water
- Suitable for vehicular traffic in 3 hours at 70°F (21°C)
- Initial set time 20 minutes, final set time 30 minutes

Coverage

One 50 lb (22.7 kg) bucket yields 0.42 ft³ (0.011 m³) and covers approximately 10 ft² when applied 1/2" (13 mm) thick.

Limitations

RM 800 PC is designed for use on horizontal surfaces in thicknesses from 1/2" to 8".

4.3.3.4 Installation Instructions

Surface Preparation

The damaged area should be prepared by back-cutting, or sawing of a vertical edge. This preparation should be performed in a manner which prevents damage to the surrounding concrete. Provide a minimum depth of 1/2".

Loose scale or dust must be removed using compressed air or water blasting, leaving only clean, sound concrete. The area to be repaired should be saturated with water, but there should be no puddles present.

Mixing

- Do Not add excessive amounts of water
- Do Not mix more than can be used in 10 minutes
- Up to 1 lb of cement colorant may be added to color patch

Working time is approximately 10 minutes at 75°F (24°C), and becomes shorter as the temperature increases. Do Not mix more product than you can place in 10 minutes. Clean mixer or mixing paddle with water between mixes and after last mix, to avoid build-up of product.

RM 800 PC Cement Repair Mortar 4.3.3

Application

Air, mix and substrate temperatures should be between 45°F (7°C) and 90°F (32°C) during repair and for 24 hours afterward. Place RM 800 PC in the area to be repaired, filling flush with surrounding concrete, and consolidate during placement by

rodding. Surface is ready for brooming or texturing in 20 to 30 minutes.

- Do Not use in vertical or overhead surfaces

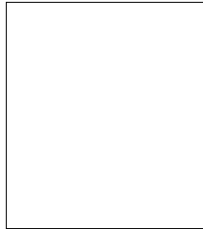
Storage Life

One year from date of manufacture, in original, unopened container.

Maintenance

RM 800 PC may be cleaned with most floor cleaning detergents. Aggressive solvents should be avoided.

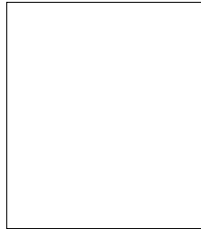
Installation Instructions



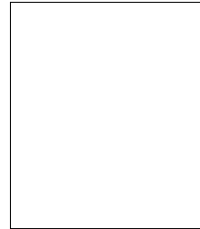
1. Score concrete around damaged area at a slight backward angle to a minimum depth of 1/2" using Hilti Dry Diamond Blade.



2. Expose fresh concrete surface and chip out edges to a depth of 1/2" using a Hilti Combihammer (Hilti TE 56 suggested) and chisel or bushing head. Remove dust and debris with vacuum or compressed air.



3. Saturate prepared area with water. Add 2 quarts of potable water to an empty 5 gallon pail. Slowly add powdered RM 800PC and mix using a drill (or equivalent) and a mixing paddle (sold below) until free of lumps. Add an additional quart of water, alternating with remaining powder, until entire contents have been thoroughly blended.



4. After removing excess water from prepared area, use a trowel to place mortar and push into all corners and edges.

5. Finish patch with trowel. Protect patch from traffic until cured.

CAUTION: Contains Silicon Dioxide, Portland Cement and Calcium Hydroxide.
Your skin may be sensitive to cement. Wearing rubber gloves is recommended. Avoid contact with eyes or prolonged contact with skin. In case of contact, flush thoroughly with water.
For eyes, flush with clean water for at least 15 minutes and get prompt medical attention.
Keep out of reach of children.

Estimating Formula*

Number of Units Required =

$$(L \cdot W \cdot (D_{avg} / 12)) / Y_{prod}$$

L = length of void in feet

W = width of void in feet

D_{avg} = avg. depth of void in inches

Y_{prod} = Yield for product

Estimated Yield for Repair Mortars & Grout (Y_{prod}) in ft³

Product	Y_{prod}
RM 800 PC	0.420

* Numbers are approximate and assume no waste.

4.3.3.5 Ordering Information

RM 800 PC is packaged in convenient, reclosable plastic pails, containing 50 lb (22.7 kg) of product.

Description

RM 800 PC 50 lb pail

Stainless Steel Paddle Mixer smooth shank specially designed for mortar repair. Use with Jacob's style chuck.

4.4 Grout

4.4.1 CB-G MG Multipurpose Grout

4.4.1.2 Material Specifications

Listings, Approvals & Testing Standards

ASTM C 1107
Corps of Engineers CRD-C-621

Product Features

- Non-metallic
- Positive expansion, non-shrink
- Non-corrosive contains no chlorides or other salts
- Pumpable
- Excellent freeze/thaw resistance

Purposes and Uses

- Structural grouting of baseplates, columns, beams, precast concrete, dowels, etc.
- General construction grouting applications
- Can be used above or below grade
- Grouting applications where shrinkage must be eliminated and corrosion (staining) cannot be accepted

4.4.1.1 Product Description

Hilti Multipurpose Grout is a Buy-American compliant, non-shrink, non-metallic ready to use grout ideal for general construction grouting applications. This versatile grout can be used at various consistencies including pumping and meets the standards of ASTM C-1107.

For applications requiring better flow characteristics and higher initial and ultimate strengths, refer to Hilti Precision Grout.

4.4.1.3 Material Specifications / Technical Data

Color: Concrete gray			
	Plastic	Flowable	Fluid
Compressive Strength psi (MPa) ASTM C 109			
1 day	4,000 (27.6)	3,500 (24.1)	2,500 (17.2)
3 days	6,000 (41.4)	5,100 (35.2)	4,500 (31.0)
7 days	7,000 (48.3)	6,000 (41.4)	5,200 (35.9)
28 days	7,800 (53.8)	7,000 (48.3)	6,500 (44.8)
Water Requirements qts. (L) per 50 lb. bag			
per 50 lb. bag	3.1 qts. (2.9 L)	3.4 qts. (3.2 L)	4.1 qts. (3.9 L)
Setting time (hrs/min) ASTM C 191			
Initial	3 Hrs 15 Min	5 Hrs 30 Min	7 Hrs 30 Min
Final	4 Hrs 45 Min	6 Hrs 45 Min	8 Hrs 00 Min
Volume Change (% expansion) ASTM C 1090			
3 days	0.04%	0.03%	0%
28 days	0.04%	0.03%	0.01%

4.4.1.4 Installation Instructions

Read product instructions and MSDS before use

Preparation

The surfaces to be grouted must be solid, clean and free from oil, grease, and other contaminants that may act as a bond breaker. Remove all loose material and laitance. Concrete surfaces must be sound and roughened to obtain proper bond. Prior to grouting, area should be saturated to an SSD (saturated surface-dry) condition with water after which all excess water is removed.

The grout and the affected grouting area should be kept between 40° F

and 95° F (4° C and 35° C) and shaded from direct sunlight until fully cured. For application temperatures outside this range please refer to ACI 305 for hot weather and ACI 306 for cold weather application advice or contact Hilti. Set times and strength developments are dependent on temperature. Hot temperatures will accelerate the setting process of the grout while cold temperatures will have a retarding effect.

All metal components to be in contact with grout must be free of rust, paint, or oils.

Grout 4.4**Form Work**

The formwork must provide rapid, continuous grout placement and needs to retain grout without leakage. For baseplate forms should be at least 1" (2.54cm) higher than the bottom of the baseplate, as referenced in ACI 351. The clearance between the formwork and the baseplate should be sufficient to allow for a headbox. The clearance for the remaining sides shall be 1" – 3" (2.54cm – 7.62cm).

Mixing

An optimal, homogeneous mix can only be achieved by means of mechanical mixing. For small quantities, up to the size of a single bag, a low speed drill (400-600rpm) and paddle mixer is acceptable. For large quantities and continuous pours a mortar mixer or grout pump is recommended.

Place 3/4 of the required mixing water into the mixer, start the mixer and slowly add the grout. After all of the powder has been added, put in the remaining 1/4 water necessary to achieve the desired consistency and continue mixing. For applications greater than 3" (7.62cm), up to 50% by weight weight of clean, washed and dried 3/8" (9mm) pea gravel may be added.

Thoroughly mix for a minimum of 5 minutes until a lump free, uniform consistency is achieved.

** The water requirements are listed in the table above.

Application

Immediately after mixing, place grout into the form, pouring from one side and allowing it to flow to the opposite and adjacent sides thereby avoiding air entrapment. Provide vent holes where needed to prevent air entrapment. Compaction can be achieved by rodding, chaining or light vibration.

Minimum application thickness per pour: 1/2" (13mm)

Maximum application thickness per pour, without the extension of pea gravel: 3" (76mm)

Maximum application thickness per pour, with the extension of pea gravel: 10" (254mm)

Finishing

Forms may be removed after the grout has hardened to an initial set and is completely self-supporting. This time period will vary according to temperature. When grouting at higher temperatures, shade the area to be grouted and prevent rapid water loss by covering the exposed grout surfaces with wet burlap during the first 48 hours or apply an acceptable amount of water based cure and seal agent.

For placement and curing please also refer to ACI 351.

Clean-up

Clean equipment with water and detergent immediately after use.

Storage

Always keep in cool dry place unexposed to sunlight.

Limitations

- Do not use if bag is damaged
- Do not re-temper after mixing
- Do not over water or add other cements or additives

Yield

- One 50lb. (22.7kg) bag yields approximately 0.44ft³ (0.012m³) at 4.1qts. (3.9 L) of water
- One 50lb. (22.7kg) bag extended with 25lbs. (11.3kg) of 3/8" (9mm) washed pea gravel yields approx. 0.60 ft³ (0.017 m³) at 4.1qts. (3.9L) of water

Packaging

- 50lb. (22.7kg) moisture resistant bag

Shelf life

12 months from date of manufacture when stored in original unopened container

4.4.1.5 Ordering Information

Description	Package Contents	Qty
Multipurpose Grout	50 lb. Bag, small pallet	25
Multipurpose Grout	50 lb. Bag, large pallet	50

4.4.2 CB-G PG Precision Grout

Listings, Approvals & Testing Standards

ASTM C 1107
Corps of Engineers CRD-C-621

Product Features

- High early and ultimate strengths
- High flow capacity
- Positive expansion, non-shrink
- Non-metallic, non-corrosive
- Contains no chlorides or other salts
- Pumpable
- Excellent freeze/thaw resistance
- Precision alignment

Purposes and Uses

- Structural grouting of baseplates, columns, beams, precast concrete, crane rails, bridge seats, dowels, etc.
- Grouting of machinery and equipment with high load requirements
- Applications where early commissioning and quick job start up are required while providing high early compressive strength

4.4.2.1 Product Description

Hilti Precision Grout is a Buy-American compliant, non-shrink, non-metallic, high performance, cementitious precision grout for use in virtually all applications where high strength combined with high fluidity is required. This specially formulated grout expands at a controlled rate providing maximum load bearing coverage. Hilti Precision Grout

meets the standards of ASTM C-1107 and Corps of Engineers CRD-C621 specification.

For applications requiring better flow characteristics and higher initial and ultimate strengths, refer to Hilti Precision Grout.

4.4.2.2 Material Specifications / Technical Data

Color: Concrete gray			
	Plastic	Flowable	Fluid
Compressive Strength psi (MPa) ASTM C 109			
1 day	6,500 (44.8)	5,500 (37.9)	3,750 (25.9)
3 days	7,500 (51.7)	7,100 (49.0)	6,000 (41.4)
7 days	9,500 (65.5)	9,000 (62.1)	7,500 (51.7)
28 days	11,000 (75.8)	10,500 (72.4)	9,500 (65.5)
Water Requirements qts. (L) per 50 lb. bag			
per 50 lb. bag	3.75 qts. (3.5 L)	4.0 qts.(3.8 L)	4.75 qts. (4.5 L)
Setting time (hrs/min) ASTM C 191			
Initial	5 Hrs 30 Min	5 Hrs 45 Min	6 Hrs 45 Min
Final	6 Hrs 05 Min	6 Hrs 35 Min	7 Hrs 45 Min
Volume Change (% expansion) ASTM C 1090			
3 days	0.01%	0.02%	0.02%
28 days	0.01%	0.02%	0.02%

4.4.2.3 Installation Instructions

Read product instructions and MSDS before use

Preparation

The surfaces to be grouted must be solid, clean and free from oil, grease, and other contaminants that may act as a bond breaker. Remove all loose material and laitance. Concrete surfaces must be sound and roughened to obtain proper bond. Prior to grouting, area should be saturated to an SSD (saturated surface-dry) condition with water after which all excess water is removed.

The grout and the affected grouting area should be kept between 40° F

and 95° F (4° C and 35° C) and shaded from direct sunlight until fully cured. For application temperatures outside this range please refer to ACI 305 for hot weather and ACI 306 for cold weather application advice or contact Hilti. Set times and strength developments are dependent on temperature. Hot temperatures will accelerate the setting process of the grout while cold temperatures will have a retarding effect.

All metal components to be in contact with grout must be free of rust, paint, or oils.

CB-G PG Precision Grout 4.4.2**Form Work**

The formwork must provide rapid, continuous grout placement and needs to retain grout without leakage. For baseplate forms should be at least 1" (2.54cm) higher than the bottom of the baseplate, as referenced in ACI 351. The clearance between the formwork and the baseplate should be sufficient to allow for a headbox. The clearance for the remaining sides shall be 1" – 3" (2.54cm – 7.62cm).

Mixing

An optimal, homogeneous mix can only be achieved by means of mechanical mixing. For small quantities, up to the size of a single bag, a low speed drill (400-600rpm) and paddle mixer is acceptable. For large quantities and continuous pours a mortar mixer or grout pump is recommended.

Place 3/4 of the required mixing water into the mixer, start the mixer and slowly add the grout. After all of the powder has been added, put in the remaining 1/4 water necessary to achieve the desired consistency and continue mixing. For applications greater than 3" (7.62cm), up to 50% by weight weight of clean, washed and dried 3/8" (9mm) pea gravel may be added.

Thoroughly mix for a minimum of 5 minutes until a lump free, uniform consistency is achieved.

** The water requirements are listed in the table above.

Application

Immediately after mixing, place grout into the form, pouring from one side and allowing it to flow to the opposite and adjacent sides thereby avoiding air entrapment. Provide vent holes where needed to prevent air entrapment. Compaction can be achieved by rodding, chaining or light vibration.

Minimum application thickness per pour: 1/2" (13mm)

Maximum application thickness per pour, without the extension of pea gravel: 3" (76mm)

Maximum application thickness per pour, with the extension of pea gravel: 10" (254mm)

Finishing

Forms may be removed after the grout has hardened to an initial set and is completely self-supporting. This time period will vary according to temperature. When grouting at higher temperatures, shade the area to be grouted and prevent rapid water loss by covering the exposed grout surfaces with wet burlap during the first 48 hours or apply an acceptable amount of water based cure and seal agent.

For placement and curing please also refer to ACI 351.

Clean-up

Clean equipment with water and detergent immediately after use.

Storage

Always keep in cool dry place unexposed to sunlight.

Limitations

- Do not use if bag is damaged
- Do not re-temper after mixing
- Do not over water or add other cements or additives

Yield

- One 50lb. (22.7kg) bag yields approximately 0.42ft³ (0.012m³) at 4.75 qts. (4.5 L) of water
- One 50lb. (22.7kg) bag extended with 25lbs. (11.3kg) of 3/8" (9mm) washed pea gravel yields approx. 0.58 ft³ (0.016 m³) at 4.75qts. (4.5L) of water

Packaging

- 50lb. (22.7kg) moisture resistant bag or 50 lb. (22.7 kg) bucket

Shelf life

12 months from date of manufacture when stored in original unopened container

4.4.2.4 Ordering Information

Description	Package Contents	Qty
Precision Grout	50 lb. Bucket	1
Precision Grout	50 lb. Bag, small pallet	25
Precision Grout	50 lb. Bag, large pallet	50

4.4.3 CB-G EG Epoxy Grout

Advantages

- Non-hazardous and non-corrosive per DOT shipping classification
- High early and ultimate strengths
- High vibration resistance
- Deep pour, low shrinkage
- Self-leveling
- High resistance to a variety of chemicals

Trades and Facilities

- Civil projects
- Concrete professionals
- Energy facilities
- General contractors / construction managers
- Industrial plants
- Ornamental steel artisans
- Steel erectors

Purposes and Uses

- Grouting of machinery and equipment with high load requirements
- Precision alignment under dynamic load conditions
- Structural grouting of baseplates, columns, beams, crane rails, bridge seats, dowels, etc.
- Chemical processing facilities

4.4.3.1 Product Description

Hilti Epoxy Grout is a Buy-American compliant, three component, 100% solids, VOC and BGE free, non-corrosive, high performance epoxy grouting system. This specially formulated grout offers high strength providing excellent

resistance to impact and vibration. Using the most advanced amine technology this grout meets today's needs of an effective and easy to use epoxy grout designed to help protect people and the environment.

4.4.3.2 Material Specifications / Technical Data

Color: Concrete gray			
	Aspect	Imperial	Metric
Compressive strength, psi (MPa) per ASTM D 695	8 hour	3,450	(23.8)
	16 hour	8,500	(58.6)
	1 day	10,450	(72.1)
	3 days	11,700	(80.7)
	7 days	13,500	(93.8)
Flexural strength, psi (MPa) per ASTM C 580 - 7 days		3,900	(27.0)
Tensile strength, psi (MPa) per ASTM C 307 - 7 days		2,100	(14.0)
Heat distortion temperature, °F (°C) per ASTM D 648		170	(77)
Working time at 72°F (22°C), minutes		45	

4.4.3.3 Installation Instructions

Read product instructions and MSDS before use

Preparation

The surfaces to be grouted must be solid, clean and free from oil, grease, and other contaminants that may act as a bond breaker. Remove all loose material and laitance. Concrete surfaces must be dry, sound and roughened to obtain proper bond. The grout and the affected grouting area should be kept between 50° F and 90° F (10° C and 32° C) and shaded from direct sunlight. During cold weather it is important that the grouted areas be kept warm (above 50°F or 10°C) until the grout has cured

completely. Store material at room temperature for at least 24 hours before use. Set time and strength development are dependant on ambient temperature. Hot temperatures will accelerate the setting process of the grout where cold temperatures will have a retarding effect. Metal surfaces to come into contact with the epoxy grout should be sandblasted to a white metal finish and wiped clean with a solvent before grout is applied. Apply grout immediately to prevent re-oxidizing or moisture condensation.

CB-G EG Epoxy Grout 4.4.3**Form Work**

Standard wood or metal forming may be used. The formwork must provide rapid, continuous grout placement and needs to retain grout without leakage. The forms should be protected with heavy coats of paste wax, grease or form release agent.

For baseplates, forms should be at least 1" (2.54cm) higher than the bottom of the baseplate. The forms should have 45° chamfer strips at all vertical corners and horizontal grout grade elevation in order to eliminate sharp corners. The clearance for remaining sides (distance between the baseplate and the form) shall be 2" - 6" (50 mm – 152 mm).

Mixing

Pour the hardener into the resin container and mix with a slow speed mixer (400 – 600 rpm) for approximately 1 – 2 minutes until thoroughly blended (the mix will show a uniform color). Keep the mix paddle submerged to avoid air entrapment. Pour mixed resin and hardener into a larger container. While mixing at low speed, slowly add the included aggregate and mix until thoroughly blended (aggregate must be completely wet). Always mix in complete units – do not mix smaller batches.

Application

Immediately after mixing, place grout from one side allowing it to flow to the opposite and adjacent sides thereby avoiding air entrapment. Provide vent holes where needed to prevent air entrapment. Where grout cannot be adequately worked to fill the cavity, because of large size or limited space, a headbox will greatly assist flow. Compaction can be achieved by rodding, chaining or light vibration.

Minimum application thickness per pour: 1" (25.4mm)

Maximum application thickness per pour: 8" (203mm)

Finishing

If a smooth finish is desired, the surface of the grout may be ground and painted with an appropriate paint or protective coating.

Clean-up

All tools and equipment may be cleaned with warm water and a detergent solution before material hardens.

Storage

Always keep in closed container in a dry warm place unexposed to sunlight.

Limitations

- Do not use if the container is damaged
- Aggregate (part C) must be kept dry before use
- Do not add solvent, water, or any other material to the grout

Yield

- One 65 lb. (29.5 kg) kit yields approximately 0.44 ft³ (0.012m³).

Shelf life

24 months from date of manufacture when stored in original unopened container

Packaging

Three component kit in one plastic container

Aspect	Imperial	Metric
Part A: Resin	0.71gal.	2.69 L
Part B: Hardener	0.17gal.	0.64 L
Part C: Aggregate	53.10lbs.	24.1 kg

4.4.3.4 Ordering Information

Description	Package Contents	Qty
Epoxy Grout	65 lb. Bucket	1

4.5 Fire Protection Steel Spray

4.5.1 CFP-S WB Fire Protection Steel Spray (Intumescent Coating)

4.5.1.1 Product Description

Fire protection dispersion to help protect load bearing steel structures in interior environments against the effects of fire. The new Fire Protection Steel Spray CFP-S WB is a water-based, low VOC spray which allows for fast, easy and safe clean up.

Featuring a reduced dry time, it helps increase productivity for a variety of applications. And with up to a 4 hour fire rating, common uses include wide flange steel columns, hollow section columns, restrained and unrestrained beams and steel floor and form unit.

The combination of outstanding service and superior products solidifies Hilti's ability to deliver unmatched value to architects and fire protection contractors.

Features

- Tested to ASTM E119 for up to 4 hr fire rating
- Water based, low VOC – allows for fast, easy clean up
- Reduced dry time permits additional coats to be applied faster
- Infinite color options possible with approved topcoats

Applications

- Wide flange steel columns
- Hollow section columns
- Restrained and unrestrained beams
- Restrained and unrestrained concrete and steel floor units

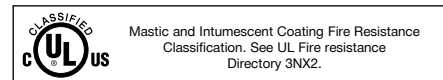
4.5.1.2 Material Specifications / Technical Data

Technical Data	CFP-S WB
Packaging	55 lb pail (25 kg pail)
Chemical basis	Water based polymer dispersion
Consistency	Sprayable liquid
Color	White
UL test design	Up to 4 hours fire rating (ASTM E119)
Surface burning characteristics	Flame spread 0 (ASTM E84) Smoke development 20 (ASTM E84)
Solid substance content	72 ± 2 (% v/v)
Density	11.1 lb/gal (1.33 kg/l)
Ph-value	8-9
Recommended storage temperature	41°F to 104°F (5°C to 40°C)
Recommended application temperature	50°F to 104°F (10°C to 40°C)
Drying time	Approx. 6 hours at 75° F (24° C) and 50% relative humidity for 30 mils (0.76 mm) WFT
Adhesion	210 psi (ASTM D4541)
Durometer hardness	61 shore D (ASTM D2240)
Impact resistance	72.6 in lbs (ASTM D2794)
Abrasion resistance	0.468 g / 1000 cycles (ASTM D4060)
VOC	49 g/L

Cross bracing protected with intumescent coating

UL-Listing

- BXUV.Y611 – for wide flange steel columns
- BXUV.Y612 – for hollow sections columns
- BXUV.N631 – for beams
- BXUV.D975 – for concrete and steel floor units



MSDS & LEEDS available at www.us.hilti.com as a technical download.

Fire Protection Steel Spray 4.5

4.5.1.3 Installation Instructions

Precaution

1. All structural steel to be coated with Hilti Fire Protection Steel Spray must be primed with an approved primer. The primer must be applied in full compliance with the manufacturer's recommendations, and must be fully cured. The surface must be clean, dry and free of grease, oil or any other contaminant that may inhibit bonding with the steel surface.
2. Hilti Fire Protection Steel Spray must be thoroughly mixed before use. A drill type mixer is recommended.
3. To achieve an optimum appearance, apply Hilti Fire Protection Steel Spray in several thin coats with

an airless sprayer. The maximum coating thickness per coat is 62 mil wet film thickness (WFT) via airless sprayer.

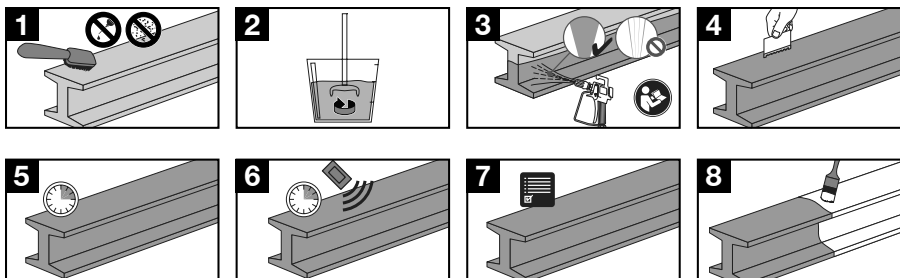
4. Check the wet film thickness by using a wet film thickness gauge.
5. Allow each layer sufficient time to dry before applying further coats.
6. After the last coat has been applied, allow the Fire Protection Steel Spray to dry sufficiently before measuring the dry film thickness (DFT) via permanent magnetic type (banana gauge) or electronic electromagnetic type gauge. The product has cured sufficiently when periodic DFT measurements provide a consistent reading. Monitor the dry film thickness at multiple

places of the steel member, subtracting the thickness of the primer.

7. Once finished, the work can be inspected by an independent inspector/monitor.
8. If desired, one of the above listed tested and approved top coats may be applied for decorative purposes.

Storage and shelf life

- Shelf life is 12 month when stored between 41°F (5°C) to 104°F (40°C) in original, unopened container. See side of pail for Batch Number/Expiry Date (e.g. xxxxxx MM.YYYY).



4.5.1.4 Installation Data

Primer

The primer used should be of the phenolic resin modified alkyd type. A corresponding listing of tested and approved primers can be provided by your local Fire Protection Specialist or other Technical Service Department personnel.

Top coats

If desired or required the following tested and approved top coats may be applied for decorative purposes.

- Glidden Premium Exterior Latex Semi-Gloss GL68XX
- Benjamin Moore Moorglo® Soft Gloss Fortified Acrylic House Paint
- Sherwin Williams Steel Master 9500 30% Silicone Alkyd

Typical Hilti Fire Protection
Steel Spray application

4.5 Fire Protection Steel Spray

4.5.1.4.1 Coverage

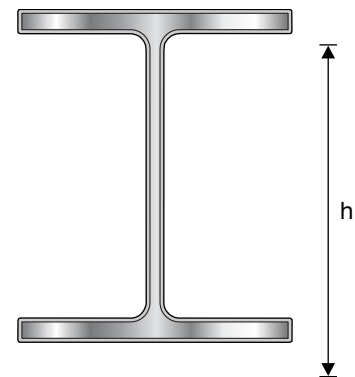
Dry film thickness		Wet film thickness		Coverage	
mils	mm	mils	mm	(ft ²) per gal	(ft ²) per 5 gal
1	0.03	1.4	0.04	1155	5775
20	0.51	28	0.71	58	290
50	1.27	69	1.75	23	115
100	2.54	139	3.53	12	60
150	3.81	208	5.28	8	40
200	5.08	278	7.06	6	30

The coverage values shown are theoretical values, which have been calculated based on the solid content of the material. Actual coverage depends on surface, substrate, application technique and method. No allowance is made for waste.

4.5.1.4.3 Overview UL Listings*

UL-listing BXUV.Y611 — Wide Flange Steel Columns

Steel Size	W/D***	1 Hr		1-1/2 Hr		2 Hr		3 Hr		4 Hr	
		Minimum dry thickness		Minimum dry thickness		Minimum dry thickness		Minimum dry thickness		Minimum dry thickness	
		mils	mm	mils	mm	mils	mm	mils	mm	mils	mm
W8 x 10**	0.33	145	3.68	266	6.76	-	-	-	-	-	-
W12 x 14	0.36	133	3.38	263	6.68	-	-	-	-	-	-
W12 x 16	0.41	117	2.97	230	5.84	-	-	-	-	-	-
W6 x 12	0.44	109	2.77	215	5.46	338	8.59	-	-	-	-
W8 x 15	0.48	100	2.54	197	5.00	310	7.87	-	-	-	-
W10 x 22	0.52	92	2.34	182	4.62	286	7.26	-	-	-	-
W4 x 13	0.55	87	2.21	172	4.37	271	6.88	-	-	-	-
W6 x 16	0.58	83	2.11	163	4.14	257	6.53	504	12.80	-	-
W8 x 24	0.59	75	1.91	130	3.30	213	5.41	504	12.80	-	-
W14 x 34	0.63	75	1.91	130	3.30	213	5.41	489	12.42	-	-
W8 x 28	0.68	70	1.78	130	3.30	213	5.41	453	11.51	-	-
W8 x 35	0.74	65	1.65	128	3.25	201	5.11	416	10.57	-	-
W10 x 39	0.78	61	1.55	121	3.07	191	4.85	395	10.03	-	-
W10 x 49	0.84	57	1.45	113	2.87	177	4.50	367	9.32	-	-
W10 x 45	0.89	54	1.37	106	2.69	167	4.24	346	8.79	-	-
W16 x 57	0.95	50	1.27	99	2.51	157	3.99	324	8.23	-	-
W8 x 48	1.00	48	1.22	95	2.41	149	3.78	308	7.82	-	-
W14 x 90	1.07	45	1.14	88	2.24	139	3.53	288	7.32	-	-
W10 x 68	1.14	42	1.07	83	2.11	131	3.33	270	6.86	-	-
W18 x 97	1.21	40	1.02	78	1.98	123	3.12	255	6.48	-	-
W10 x 77	1.28	38	0.97	74	1.88	116	2.95	241	6.12	-	-
W16 x 100	1.36	36	0.91	69	1.75	109	2.77	227	5.77	-	-
W10 x 88	1.45	34	0.86	65	1.65	103	2.62	213	5.41	-	-
W14 x 132	1.54	32	0.81	61	1.55	97	2.46	200	5.08	-	-
W12 x 120	1.64	30	0.76	58	1.47	91	2.31	188	4.78	-	-
W14 x 159	1.77	28	0.71	56	1.42	85	2.16	187	4.75	-	-
W14 x 176	1.95	25	0.64	51	1.30	77	1.96	178	4.52	-	-
W14 x 193	2.12	23	0.58	47	1.19	71	1.80	164	4.17	-	-
W14 x 211	2.30	23	0.58	43	1.09	66	1.68	151	3.84	-	-
W14 x 233	2.52	23	0.58	40	1.02	60	1.52	138	3.51	-	-
W14 x 257	2.75	23	0.58	36	0.91	55	1.40	126	3.20	-	-
W14 x 283	3.00	23	0.58	33	0.84	50	1.27	116	2.95	194	4.93



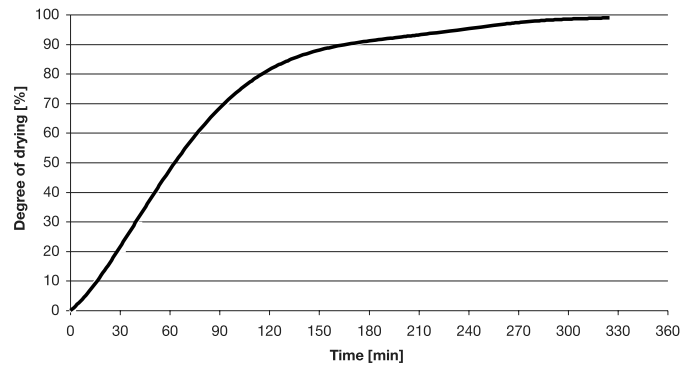
* See UL listing for the most current and complete information

** e.g. W8 x 10; [W = shape, 8 = h (height) in inches, 10 = lb/ft]

*** W/D = Weight of steel member per linear foot (lbs)/Perimeter of the member exposed to fire (inches)

4.5.1.4.2 Drying Time

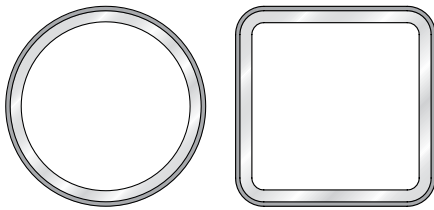
Drying time of a 30 mils (0.76 mm) layer at 75°F (24°C) / 50% r.H.



The drying curve shown is based on lab tests results and is exemplary for the given conditions. Overall the drying time strongly depends on the ventilation, temperature and humidity on the jobsite as well as on the applied coat thickness.

Fire Protection Steel Spray 4.5

UL-listing BXUV.Y612 – Hollow Steel Sections



* Hp/A = Heated Perimeter / Area

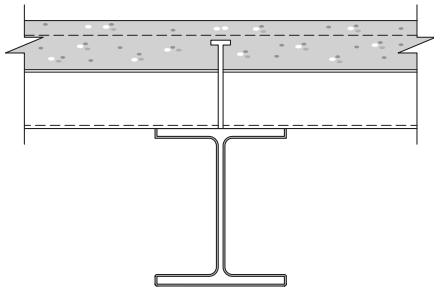
** A/P = Area / Perimeter

SP = Steel Pipe

ST = Steel Tube

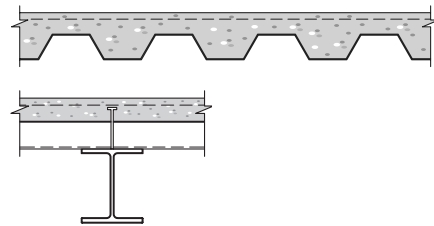
Steel size	Hp/A*	A/P**	1 Hr		1-1/2 Hr		2 Hr		3 Hr	
			Minimum dry thickness		Minimum dry thickness		Minimum dry thickness		Minimum dry thickness	
			mils	mm	mils	mm	mils	mm	mils	mm
SP 4.5 x 0.313	135	0.29	117	2.99	-	-	-	-	-	-
SP 8 x 0.875	49	0.79	97	2.46	97	2.46	120	3.05	-	-
SP 8.625 x 0.5	85	0.47	97	2.46	138	3.50	202	5.14	-	-
ST 3.5 x 3.5 x 3/16	224	0.18	165	4.18	-	-	-	-	-	-
ST 5 x 3 x 1/4	169	0.23	104	2.65	252	6.39	400	10.15	-	-
ST 5 x 3 x 5/16	135	0.29	84	2.13	218	5.54	353	8.96	-	-
ST 8 x 6 x 3/8	114	0.35	74	1.87	173	4.40	280	7.12	-	-
ST 8 x 6 x 7/16	100	0.41	74	1.87	151	3.84	244	6.21	-	-
ST 5 x 3 x 1/2	93	0.44	74	1.87	127	3.23	207	5.27	-	-
ST 8 x 8 x 1/2	85	0.47	74	1.87	95	2.41	164	4.17	327	8.31

UL-listing BXUV.N631 – Beams



Steel size	W/D	1 Hr		1-1/2 Hr		2 Hr		3 Hr	
		Minimum dry thickness		Minimum dry thickness		Minimum dry thickness		Minimum dry thickness	
		Unrestrained beam	Restrained beam	Unrestrained beam	Restrained beam	Unrestrained beam	Restrained beam	Unrestrained beam	Restrained beam
		mils	mm	mils	mm	mils	mm	mils	mm
W6x12	0.52	73	1.83	73	1.83	99	2.50	73	1.83
W8x24	0.7	53	1.34	53	1.34	66	1.67	53	1.34

UL-listing BXUV.D975 – Concrete and Steel Floor Units



Beams size	W/D	1 Hr		1-1/2 Hr		2 Hr		3 Hr	
		Minimum dry thickness		Minimum dry thickness		Minimum dry thickness		Minimum dry thickness	
		Unrestrained beam	Restrained Assembly	Unrestrained beam	Restrained Assembly	Unrestrained beam	Restrained Assembly	Unrestrained beam	Restrained Assembly
		mils	mm	mils	mm	mils	mm	mils	mm
W6x12	0.52	73	1.83	-	-	123	3.10	-	-
W8x24	0.7	53	1.34	-	-	95	2.41	-	-
Steel Floor Units		W/D							
Fluted or Cellular		0.7		103	2.62	-	-	-	-
Cellular		0.7		179	4.55	-	-	341	8.66

4.5.1.5 Ordering Information

Order Description

Qty

Fire Protection Steel Spray CFP-S WB

1

Fire Protection Steel Spray CFP-S WB (Pallet)

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5.0 Reference

5.1 Approvals and Listings

5.1.1 ICC-ES (International Code Council) Evaluation Reports

Report No.	Title
ESR-1385	Kwik Bolt 3 Masonry Anchors
ESR-1545	Hilti HSL-3 Carbon Steel Metric Heavy Duty Concrete Anchors in Concrete
ESR-1546	Hilti HDA Carbon Steel and Stainless Steel Metric Undercut Anchors in Concrete
ESR-1917	Hilti Kwik Bolt TZ Carbon and Stainless Steel Anchors in Concrete
ESR-1967	Hilti HIT HY-150 MAX Adhesive Anchor System for Grouted Masonry
ESR-2179	CF 810 Crack and Joint Foam
ESR-2262	Hilti HIT-HY 150 MAX Adhesive Anchors for Concrete
ESR-2302	Hilti KWIK BOLT 3 Anchors for Concrete
ESR-2322	Hilti HIT-RE 500-SD Adhesive Anchors in Concrete
ESR-2659	HIT HY-20 Adhesive Anchor Systems for Un-reinforced Masonry
ESR-3013	Hilti HIT-HY 150 MAX-SD Adhesive Anchors for Concrete
ESR-3027	Hilti KWIK HUS-EZ Anchors for Concrete

5.1.2 COLA (City of Los Angeles) Approvals

Report No.	Title
25652M	Hilti HIT-HY 150 MAX Adhesive Anchor System for Masonry
23709	Hilti HDI Expansion Anchors
24564	HIT HY 20 Adhesive Anchor and HIT Combination Anchor for use in unreinforced brick walls
25363	Hilti HVA (HVU) Adhesive Anchor System for Normal Weight Concrete
25577	Kwik Bolt 3 Concrete and Masonry Anchors
25700	Hilti HIT-RE 500-SD Adhesive Anchor System for Concrete
25881	Hilti HIT-HY 150 MAX-SD Adhesive Anchor System for Concrete

Report No.	Title
25897	Hilti KWIK HUS-EZ Screw Anchor for Concrete
25901	Hilti KWIK BOLT 3 Expansion Anchor for Concrete
25903	Hilti HSL-3 Heavy Duty Expansion Anchor for Concrete

5.1.3 Miami Dade County Approvals

Report No.	Title
06-0810.13	Hilti Kwik Bolt 3 Concrete Expansion Anchors
07-0924.03	Hilti Kwik-Con II Concrete Screw Anchor
09-0224.06	Hilti HIT-HY 150 MAX Adhesive Anchor System

5.1.4 Underwriters Laboratories Listings

Pipe Hanger Equipment for Fire Protection Service

Kwik Bolt 3 Anchors 3/8-in. to 3/4-in.

Kwik Bolt TZ Anchors 3/8-in. to 3/4-in.

HDI Anchors 3/8-in. to 3/4-in. Diameters
HDI-L Anchors 3/8-in. and 1/2-in. Diameters

HCI-WF Anchors 3/8-in. and 1/2-in. Diameters
HCI-MD Anchors 3/8-in. and 1/2-in. Diameters

SLC-EG 2-in. to 8-in.

5.1.5 FM Global Approvals

Pipe Hanger Components for Automatic Sprinkler Systems

HDI 3/8-in. to 3/4-in. HDI-L 3/8-in. and 1/2-in.
Kwik Bolt 3 Anchors 3/8-in. to 3/4-in.

Kwik Bolt TZ Anchors 3/8-in. to 3/4-in.

HCI-WF 3/8-in. to 3/4-in.
HCI-MD 3/8-in. to 3/4-in.

Reference Standards 5.2

5.2.1 ASTM Standards for Materials

Standard	Title	Standard	Title
A 36	Specification for Structural Steel	C 34	Standard Specification for Structural Clay Load-Bearing Wall Tile
A 108	Specification for Steel Bars, Carbon, Cold-finished, Standard Quality	C 36	Standard Specification for Gypsum Wallboard
A 109	Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled	C 62	Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
A 193	Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service	C 90	Specification for Load-Bearing Concrete Masonry Units
A 240	Specification for Heat-resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels	C 109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
A 276	Specification for Stainless and Heat-resisting Steel Bars and Shapes	C 150	Standard Specification for Portland Cement
A 307	Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength	C 157	Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete
A 420	Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service	C 191	Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
A 446	Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality (Withdrawn 1994)	C 230	Standard Specification for Flow Table for Use in Tests of Hydraulic Cement
A 493	Specification for Stainless and Heat-resisting Steel for Cold Heading and Cold Forging Bar and Wire	C 266	Standard Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
A 510	Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel	C 270	Standard Specification for Mortar for Unit Masonry
A 563	Specification for Carbon and Alloy Steel Nuts	C 330	Specification for Lightweight Aggregates for Structural Concrete
A 570	Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled (Withdrawn 2000)	C 332	Specification for Lightweight Aggregates for Insulating Concrete
A 572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel	C 474	Standard Test Methods for Joint Treatment Materials for Gypsum Board Construction
A 611	Standard Specification for Structural Steel (SS), Sheet, Carbon, Cold-Rolled (Withdrawn 2000)	C 476	Specification for Grout for Masonry
A 615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	C 580	Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concrete
A 616	Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement	C 642	Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
A 617	Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement	C 652	Standard Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)
A 653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process	C 666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
A 682	Standard Specification for Steel, Strip, High-Carbon, Cold-Rolled, General Requirements For	C 672	Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals
A 992	Standard Specification for Steel for Structural Shapes For Use in Building Framing	C 827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
B 117	Standard Practice for Operating Salt Spray (Fog) Apparatus	C 881	Specification for Epoxy-Resin-Base Bonding Systems for Concrete
C 33	Specification for Concrete Aggregates	C 882	Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete
		C 928	Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs

5.2 Reference Standards

5.2.1 ASTM Standards for Materials (cont'd)

Standard	Title
C 939	Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
C 942	Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
C 954	Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
C 1002	Standard Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Wood or Steel Studs
C 1090	Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout
C 1107	Standard Specification for packaged Dry, Hydraulic-Cement Grout (Nonshrink)
C 1513	Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
D 256	Standard Test Method for Determining the Izod Pendulum Impact Resistance of Plastics
D 635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
D 638	Test Method for Tensile Properties of Plastics
D 648	Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
D 695	Test Method for Compressive Properties of Rigid Plastics
D 790	Standard Test Method Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
E 380	Standard Practice for Use of the International System of Units, SI (The Modernized Metric System)
E 488	Test Method for Strength of Anchors in Concrete and Masonry Elements
E 1190	Test Methods for Strength of Powder-Actuated Fasteners Installed in Structural Members
E 1512	Standard Test Methods for Testing Bond Performance of Bonded Anchors
F 436	Specification for Hardened Steel Washers
F 593	Specification for Stainless Steel Bolts, Hex Cap Screws and Studs
F 594	Specification for Stainless Steel Nuts

Standard	Title
F 844	Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
G 15	Standard Terminology Relating to Corrosion and Corrosion Testing
G 85	Standard Practice for Modified Salt Spray (Fog) Testing
G 87	Standard Practice for Conducting Moist SO ₂ Tests

5.2.2 ASTM Plating Standards

Standard	Title
A 153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
B 633	Electrodeposited Coatings of Zinc on Iron and Steel
B 695	Coatings of Zinc Mechanically Deposited on Iron and Steel
F 1941	Standard Specification for Electrodeposited Coatings on Threaded Fasteners (Unified Screw Threads, UN/UNR)

5.2.3 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 Anchor)
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 (Wood Screw and Lag Bolt Self-Threading Anchors)

5.2.4 ANSI Standards

Standard	Title
B18.2.2	Square and Hex 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

Technical References 5.3

5.3.1 Metric Conversions and Equivalents

The Metric Conversion Act of 1975, as amended by the Omnibus Trade and Competitiveness Act of 1988, establishes the SI (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 (but specifically not 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 & 3.

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 1 : Diameters

Inch-Pound System 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 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

5.3 Technical References

5.3.2 Mechanical Properties of Materials

Carbon Steel

Grade Designation	Nominal Size (in.)	Min. Yield Strength		Min. Ultimate Strength	
		ksi	(MPa)	ksi	(MPa)
ASTM A36	All	36	(248)	58	(400)
ASTM A193, B 7	1/4 thru 2-1/2	105	(724)	125	(862)
AISI 1038 (As Rec'd)	1/4 to 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 to 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 to 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 to 1-1/2	36	(248)	60	(414)
SAE Grade 5	1/4 thru 1	92	(634)	120	(827)
	over 1 to 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)

Stainless Steel

Grade ASTM/AISI	Nominal Size (in.)	Yield Strength		Ultimate Strength	
		ksi	(MPa)	ksi	(MPa)
F 593 / 304 / 316	1/4 thru 5/8	65	(448)	100	(689)
	3/4 thru 1-1/2	45	(310)	85	(586)
A 193, B8/304/316	1/4 thru 1-1/2	30	(205)	74.6	(515)
A 276 / 304	1/4 thru 9/16	76	(524)	90	(620)
	over 9/16	64	(441)	76	(524)
A 276 / 316	1/4 thru 9/16	76	(524)	90	(620)
	over 9/16	64	(441)	76	(524)
A 493 / 304	All	60	(414)	90	(627)
A 582 / 303	All	60	(414)	100	(689)
DIN 267	All	65.3	(450)	101.5	(700)
Part 11, A4-70					

Technical References 5.3

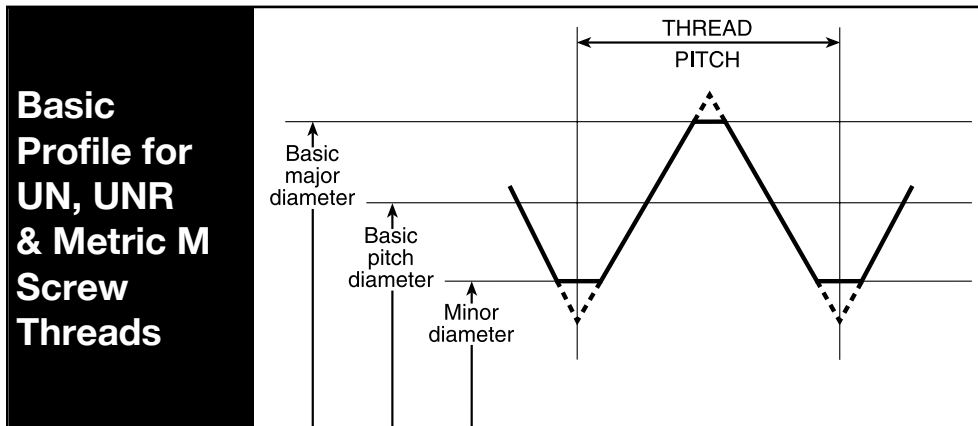
5.3.3 Bolt Thread Data

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 in ²	Tensile Stress 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

* Minor Area = $0.7854 (D - 1.3/n)^2$

Tensile Stress Area = $0.7854 (D - 0.9743/n)^2$



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 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

* Tensile Stress Area = $0.7854 (D - 0.9382 P)^2$

5.3 Technical References

5.3.4 Concrete Reinforcing Bar Data

ASTM Basic Dimensions for Deformed Steel Bars for Concrete Reinforcement, Imperial Units

Bar Designation No. ^A	Nominal Weight lb/ft	Nominal Dimensions ^B		
		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

A. Bar designation numbers are based on the number of eighths of an inch included in the nominal diameter.

B. 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.

ASTM Basic Dimensions for Deformed Steel Bars for Concrete Reinforcement, SI Units

Bar Designation No. ^A	Nominal Mass kg/m	Nominal Dimensions ^B		
		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

A. Bar designation numbers approximate the number of millimeters of the nominal diameter of the bar.

B. 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.

CSA G30.12 & G30.16 Basic Dimensions for Deformed Steel Bars for Concrete Reinforcement, SI Units (Canada Only)



Bar Number ^A	Nominal Mass kg/m	Nominal Dimensions ^B		
		Diameter mm	Area mm ²	Perimeter mm
10M	0.785	11.3	100	36
15M	1.570	16.0	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

A. Bar numbers are based on the rounded off nominal diameter of the bars.

B. Nominal dimensions are equivalent to those of a plain round bar having the same mass per meter as the deformed bar.

Notes

Terms and Conditions of Sale (U.S.)

Payment Terms:	Net 30 days from date of invoice. Customer agrees to pay all costs incurred by Hilti in collecting any delinquent amounts, including attorney's fees.
Freight:	All sales are F.O.B. Destination with transportation allowed via Hilti designated mode. Delivery dates are estimates only. Additional charges for expedited shipments, special handling requirements, and orders below certain dollar amounts shall be the responsibility of Customer. Fuel surcharges may apply depending on market conditions.
Credit:	All orders sold on credit are subject to Credit Department approval.
Return Policy:	Products must be in saleable condition to qualify for return. Saleable condition is defined as unused items in original undamaged packaging and unbroken quantities and in as-new condition. All returns are subject to Hilti inspection and acceptance, and a \$125 restocking charge if returned more than 90 days after invoice date. Proof of purchase is required for all returned materials.
Ineligible Return:	Special order products and discontinued items are not eligible for return or credit. Dated materials are only returnable in case quantity and within 14 days after invoice date. In no event shall any product be returnable or qualify for credit after 1 year from invoice date.
Warranty:	<p>Hilti warrants that for a period of 12 months from the date it sells a product it will, at its sole option and discretion, refund the purchase price, repair, or replace such product if it contains a defect in material or workmanship. Absence of Hilti's receipt of notification of any such defect within this 12-month period shall constitute a waiver of all claims with regard to such product.</p> <p>THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Hilti shall in no event be liable for, and Customer hereby agrees to indemnify Hilti against, all claims related to special, direct, indirect, incidental, consequential, and any other damages arising out of or related to the sale, use, or inability to use the product, including costs and attorney's fees.</p>
Order Acceptance:	Acceptance is limited to the express terms contained herein, and terms are subject to change by Hilti without notice. Additional or different terms proposed by Customer are deemed material and are objected to and rejected, but such rejection shall not operate as a rejection of the offer unless it contains variances in the terms of the description, quantity, price or delivery schedule of the goods. Orders are not deemed "accepted" by Hilti unless and until it ships the associated items.
Domestic Origin:	Origin information may be obtained by written request to Hilti, Inc., Contract Compliance, P. O. Box 21148, Tulsa, Oklahoma 74121. Hilti's Quality Department personnel are the only individuals authorized to warrant the country of origin of Hilti products.
Business Size:	Hilti is a large business.
Prices:	Prices are those stated on the order, and unless otherwise noted are based on purchasing all items on the order – pricing for individual products may vary for purchases of different quantities or item combinations. Hilti does not maintain most favored customer records, makes no representation with respect to same, and rejects any price warranty terms proposed by Customer. Hilti's published net price list is subject to change without notice.
Consent to Jurisdiction:	All transactions made pursuant hereto shall be deemed to have been made and entered into in Tulsa, Oklahoma. Any and all disputes arising directly or indirectly from such transactions shall be resolved in the courts of the County of Tulsa, State of Oklahoma, to the exclusion of any other court, and any resulting judgment may be enforced by any court having jurisdiction of such an action. All transactions shall be governed by and construed in accordance with the laws of the State of Oklahoma.
Indemnification:	Customer hereby agrees to indemnify Hilti for any costs, including attorney's fees, incurred by Hilti as a result, in whole or in part, of any violation by Customer of any Federal, State or Local statute or regulation, or of any nationally accepted standard. It shall be Customer's sole responsibility to comply with all applicable laws and regulations regarding the handling, use, transportation, or disposal of products upon taking possession of same.
Convert Check to EFT:	When you provide a check as payment, you authorize Hilti to use information from your check to make a one time electronic fund transfer from your checking account or to process the payment as a check transaction. When we use information from your check to make an electronic fund transfer, funds may be withdrawn from your account as soon as the same day we receive your payment, and you will not receive your check back from your financial institution.
Authorization:	HILTI LEGAL DEPARTMENT PERSONNEL ARE THE ONLY INDIVIDUALS AUTHORIZED TO MODIFY THESE TERMS AND CONDITIONS, WARRANT PRODUCT SUITABILITY FOR SPECIFIC APPLICATIONS, ACCEPT INFORMATION ON THE POTENTIAL FOR CONSEQUENTIAL DAMAGES, OR EXECUTE CUSTOMER DOCUMENTS, AND ANY SUCH ACTION IS NULL AND VOID UNLESS IN WRITTEN FORM SIGNED BY SUCH INDIVIDUAL. HILTI SALES REPRESENTATIVES (INCLUDING ACCOUNT MANAGERS, REGIONAL MANAGERS, AND CUSTOMER SERVICE REPRESENTATIVES) HAVE NO SUCH AUTHORITY.

Terms and Conditions of Sale (Canada)



Payment Terms:	Net 30 days from date of invoice. Customer agrees to pay all costs incurred by Hilti in collecting any delinquent amounts, if any, including reasonable attorney's fees.
Freight:	Sales are F.O.B. Destination Point with transportation allowed via Hilti designated mode. Additional charges may apply for expedited delivery, special handling requirements, and orders under certain limits. Fuel surcharges may apply depending on market conditions.
Credit:	All orders sold on credit are subject to Credit Department approval.
Return Policy:	Product may be returned (prepaid, unless otherwise authorized) to Hilti provided: <ul style="list-style-type: none"> i) it is returned by the original purchaser, with proof of purchase ii) it is not dated product returned more than 30 days after original delivery date (dated items only returnable in case quantities) iii) it is not discontinued, clearance, or special order product iv) it is unused, in original packaging and in unbroken quantities, in as-new condition v) it is not older than 1 year from invoice date
Warranty:	Other than the manufacturer's published warranty, no warranties or conditions, express or implied, written or oral, statutory or otherwise are implied. Any and all conditions and warranties implied by law or by the Sale of Goods Act or any similar statutes of any Province are hereby expressly waived.
Title to Product:	Title to product remains with Hilti until the total purchase price of product is paid.
Prices:	Customer agrees to Pay Hilti prices set out on invoice. Customer agrees to pay taxes as indicated on invoice unless Hilti receives acceptable exemption certificates.
Indemnification:	Customer agrees to use product at own risk and to indemnify Hilti against all liabilities, including legal fees, to third parties arising out of the use or possession thereof. Hilti shall in no event be liable for special, incidental, or consequential damages.
Changes:	Only Hilti legal department personnel are authorized to modify these Terms and Conditions or modify credit terms. Terms are subject to change by Hilti without notice.
Cash Sales:	Payment in full is due prior to goods being released.
Quotations:	All terms and conditions apply once customer agrees to purchase product. Quotations on special promotion products are only valid until end of promotion period. Quotations based on purchasing all items listed – pricing for individual products may vary for purchases of different quantities or item combinations.
Convert check to ETF:	When you provide a check as payment, you authorize Hilti to use information from your check to make a one time electronic fund transfer from your checking account or to process the payment as a check transaction. When we use information from your check to make an electronic fund transfer, funds may be withdrawn from your account as soon as the same day we receive payment and you will not receive your check back from your financial institution.

Conditions de Vente

Délai de règlement:	Net dans 30 jours suivant la date de facturation. Le Client accepte de payer tous les frais, y compris les frais juridiques, engagés par Hilti pour recouvrer des montants en souffrance.
Transport:	Toutes les commandes sont expédiées franco départ par un transporteur à la discrétion de Hilti. Des frais sont imposés pour la livraison accélérée, les exigences particulières de manutention et les commandes d'un montant inférieur à une certaine limite. Un supplément pour carburant est également imposé lorsque les conditions du marché l'exigent.
Crédit:	Toutes les commandes vendues à crédit le sont sous réserve de l'approbation de notre service du Crédit.
Retours:	Hilti accepte le retour des produits, port payé (à moins d'une autorisation contraire), aux conditions suivantes: <ul style="list-style-type: none"> i) l'acheteur initial effectue le retour et présente une preuve d'achat; ii) les produits portant une date d'expiration ne sont pas retournés plus de 30 jours après la date initiale de leur livraison (seules les caisses de ces produits sont acceptées); iii) les produits ne sont pas en fin de série, en écoulement ou commandés spécialement; iv) les produits sont inutilisés, dans leur emballage d'origine, en lots complets et encore neufs. v) retourné dans 1 an suivant la date de facturation.
Garantie:	Mise à part la garantie publiée par le fabricant, aucune garantie ou condition, qu'elle soit explicite ou implicite, écrite ou orale, statutaire ou autrement, n'est consentie. Toute condition ou garantie implicite à la loi, à la Loi sur la vente d'objets ou à tout autre acte législatif similaire d'une province fait par la présente l'objet d'une renonciation formelle.
Titre du produit:	Hilti conserve le titre du produit jusqu'à ce que son prix d'achat soit réglé en totalité.
Prix:	Le client accepte de payer le prix facturé par Hilti. Le client accepte de payer les taxes figurant sur la facture, à moins d'avoir fait parvenir à Hilti un certificat d'exemption acceptable.
Indemnisation:	Le client accepte d'utiliser le produit à ses propres risques et de garantir Hilti contre toutes les responsabilités envers un tiers, y compris les frais d'avocat, découlant de l'utilisation ou de la possession du produit. Hilti n'accepte sous aucun prétexte d'être tenue responsable de dommages indirects ou fortuits.
Modifications:	Seul le personnel du service des Affaires juridiques de Hilti a l'autorisation de modifier les présentes conditions ou de modifier les modalités de crédit. Hilti se réserve le droit de modifier les conditions sans préavis.
Ventes au comptant:	Paiement échu au total avant la livraison des marchandises.
Soumissions:	Toutes les conditions entrent en vigueur lorsque le client accepte d'acheter les produits. Une soumission sur un produit en réclame cesse d'être en vigueur à la fin de la réclame. Le prix d'une soumission vaut pour l'achat de tous les produits qu'elle contient; le prix de produits individuels achetés séparément varie en fonction des quantités et des combinaisons d'articles.
Convertir le chèque TFE:	Lorsque vous fournissez un chèque en guise de paiement, vous autorisez Hilti à utiliser l'information sur celui-ci pour effectuer un transfert de fonds unique de votre compte chèque où pour effectuer la transaction avec le chèque tel quel. Lorsque nous utilisons l'information de votre chèque pour effectuer un transfert de fonds électronique, les fonds pourront être retirés de votre compte le jour même de la réception de votre paiement et vous ne pourrez récupérer celui-ci de votre institution financière.

Hilti Technical Service

We are committed to developing and maintaining the trust of our customers within the professional design and construction communities who recommend, specify, or use Hilti products.

We do this by providing technical assistance for the safe, appropriate use of Hilti products based on sound engineering judgement.

Field Engineering and Fire Protection Specialists

- Product application design and detail assistance
- Specification consultation
- Design software support, i.e.: PROFIS
- AIA/CES & NCSEA continuing education seminars
- Project site involvement
- Installation and safety training
- Site specific product support

Corporate Engineering

- Technical reports and approvals
- Online technical design center
- Technical software programs, i.e. PROFIS
- Product application consultation
- Firestop Engineering Judgements
- Project specific CAD support
- Decking submittal support

Corporate Testing Capabilities

- Concrete anchor and power driven fastener test facility
- Full-scale Diaphragm Test Frame
- U.L. certified firestop assembly furnaces
- Independent witness by accredited organization

LEED Documentation

- Provide LEED documentation for all Hilti products
- Online download of LEED documents

Hilti. Outperform. Outlast.

Hilti. Outperform. Outlast.

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