Attached are page(s) from the 2008 Hilti North American Product Technical Guide. For complete details on this product, including data development, product specifications, general suitability, installation, corrosion, and spacing & edge distance guidelines, please refer to the Technical Guide, or contact Hilti.

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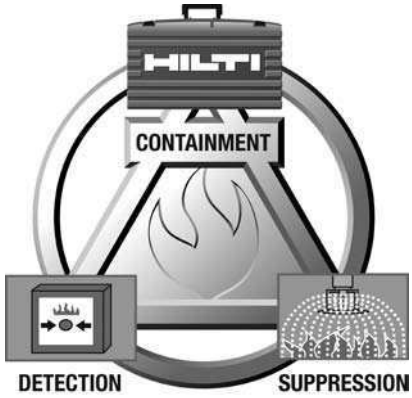

Firestop Systems

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- Firestop Systems Guides
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  - Joint Penetrations
- FACT Program
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The Hilti Diaphragm Deck Design Program allows designers to quickly and accurately design roof deck and composite floor deck diaphragms.

- Ability to design with innovative Hilti fasteners for frame and sidelap connection
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Hilti Online

- Technical Library
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- Interactive Product Advisors
- Full-line Product Catalog
- Online Ordering
- Maps to Hilti locations
- "Contact Us" program to answer your questions

MI – Industrial Pipe Support Technical Guide

A guide to specifying the Hilti modular pipe support system for medium to heavy loads without welding.

- MI System is the ideal solution for pipes up to 24 in. diameter
- Reliable fastenings without welds
- Easily installed

HIT-RE 500-SD Epoxy Adhesive Anchoring System 4.2.6

4.2.6.1 Product Description

Fastener Components

HIT RE Mixer

- HIT-RE 500-SD Refill Pack
  - Refill Pack Holder
    - ED 3500 Battery Dispenser
    - P3500 Dispenser
- HIT-RE 500-SD Medium Cartridge
  - MD2500 Dispenser
- HIT-RE 500-SD Jumbo Cartridge
  - Refill Pack Holder
    - P8000D Dispenser

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® 2006, IBC®/IRC® 2003, IBC®/IRC® 2000 and UBC® 1997 (ICC-ES AC308). 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

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

Code Compliance

IBC®/IRC® 2006 (ICC-ES AC308)
IBC®/IRC® 2003 (ICC-ES AC308)
IBC®/IRC® 2000 (ICC-ES AC308)
UBC® 1997 (ICC-ES AC308)
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.

Components

HAS Threaded Rods

HIS Internally Threaded Inserts

Rebar (supplied by contractor)

4.2.6 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Guide Specifications

Master Format Section:

03250 (Concrete accessories)

Related Sections:

03200 (Concrete Reinforcing-Reinforcing Accessories)
05050 (Metal Fabrication)
05120 (Structural Steel; Masonry Accessories)

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 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 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.

4.2.6.2 Material Specifications

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)

4.2.6.3 Strength Design

STRENGTH DESIGN

Design strengths are determined in accordance with ACI 318-05 Appendix D (ACI 318) and this report[1]. 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 ϕ 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 318-05 Appendix D (ACI 318) as required for the strength design of adhesive anchors. In conformance with ACI 318-05, 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_{cpg}.

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.5.2.8 — The limiting concrete strength of adhesive anchors in tension shall be calculated in accordance with D.5.2.1 to D.5.2.7 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) for a single anchor

$$N_a = \frac{A_{Na}}{A_{a0}} \cdot \psi_{p,Na} \cdot N_{a0} \qquad \text{(D-14a)}$$

(b) for a group of anchors

$$N_{ag} = \frac{A_{Na}}{A_{a0}} \cdot \psi_{ed,Na} \cdot \psi_{g,Na} \cdot \psi_{ec,Na} \cdot \psi_{p,Na} \cdot N_{a0} \qquad \text{(D-14b)}$$

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):

$$A_{Na0} = \left(s_{cr,Na}\right)^2 \qquad \text{(D-14c)}$$

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:

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

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

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

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

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

$$\psi_{g,Na} = \psi_{g,Na0} + \left[\left(\frac{S}{S_{cr,Na}}\right)^{0.5} \cdot (1 - \psi_{g,Na0})\right] \ge 1.0 \qquad \text{(D-14k)}$$

where

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

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

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

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

$$\psi_{ec,Na} = \frac{1}{1 + \frac{2e'_N}{S_{cr,Na}}} \le 1.0 \qquad \text{(D-14n)}$$

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

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

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

4.2.6 HIT-RE 500-SD Epoxy Adhesive Anchoring System

anchors or anchor groups loaded on tension is:

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

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

$$\psi_{ed,Na} = \left(0.7 + 3.1 \frac{c_{a,min}}{c_{cr,Na}}\right) \leq 1.0 \quad \text{(D-14p)}$$

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 $\psi_{g,Na0}$ 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).

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

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

(D-14r)

$\psi_{p,Na} = 1.0$ when $c_{a,min} \geq c_{ac}$

(D-14s)

$$\psi_{p,Na} = \frac{\max | c_{a,min}; c_{cr,Na} |}{c_{ac}} \text{ when } c_{a,min} < c_{ac}$$

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

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

(b) for a group of adhesive anchors

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

where

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

$k_{cp} = 2.0$ for $h_{ef} \geq 2.5$ 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 κ_{nn} for cases where holes are drilled in water-saturated concrete (κ_{ws}), where the holes are water-filled at the time of anchor installation (κ_{wf}), or where the application is carried out underwater (κ_{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:

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

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

where

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

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

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 $\alpha_{N,seis}$.

4.2.6.4 Technical Data

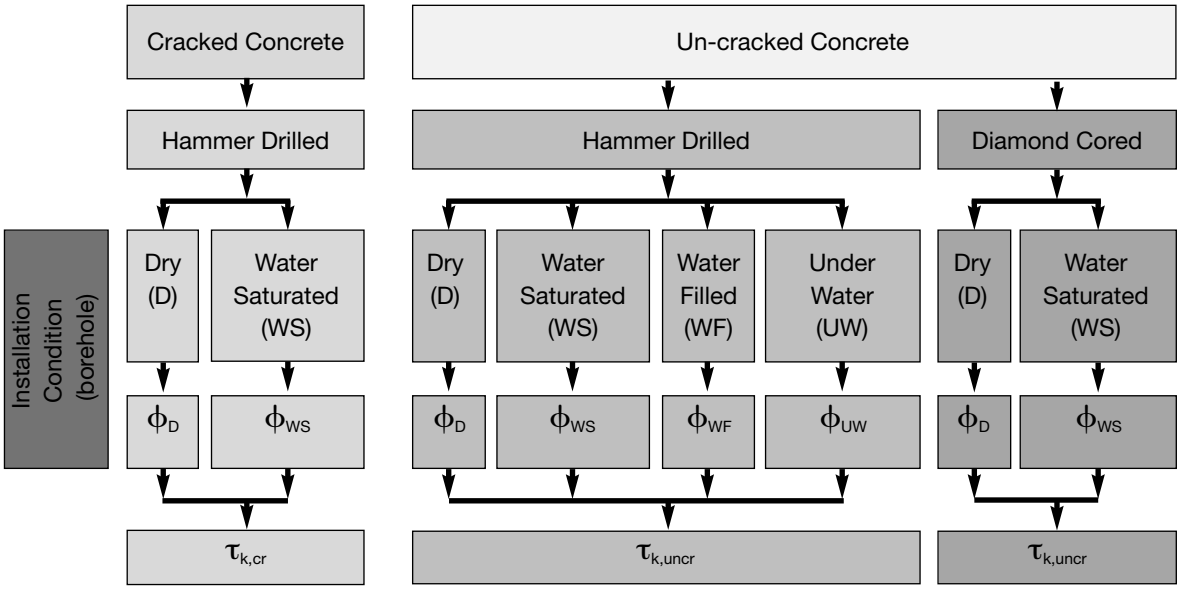
Table 1 — DESIGN TABLE INDEX

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]	Na_a, N_{ag}	hammer-drilled holes	Table 9	Table 13	Table 17	Table 21	Table 25	Table 29	Table 33
		diamond cored holes	Table 10	Table 14	Table 18	Table 22	Table 26	Table 30	Table 34

1 Ref. ACI 318 Section D.4.1.2

2 See Section 4.1

Bond strength design flowchart



4.2.6 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 2 — TENSILE PROPERTIES OF COMMON CARBON STEEL THREADED ROD MATERIALS[1]

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 MATERIALS[1]

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[4]
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.(MPa)	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.

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[6]
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 F A193[5] Grade B8M (AISI 316) for use with HIS-RN	psi (MPa)	**110,000** (759)	**95,000** (655)	1.16	15	45	F 594[7]
ASTM F A193[5] Grade B8M (AISI 316) for use with HIS-RN	psi (MPa)	**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

4.2.6 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Table 7 — STEEL DESIGN INFORMATION FOR FRACTIONAL THREADED ROD[1]

DESIGN INFORMATION		Symbol	Units	Nominal rod diameter (in.)						
				3/8	1/2	5/8	3/4	7/8	1	1-1/4
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)	**1.25** (31.8)
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)	**0.9691** (625)
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)	**70,258** (312.5)
		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)	**42,155** (187.5)
	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						
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)	**121,135** (538.8)
		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)	**72,681** (323.3)
	Reduction for seismic shear	$\alpha_{V,seis}$	-	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)	**82,372** (366.4)
		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)	**49,423** (219.8)
	Reduction for seismic shear	$\alpha_{V,seis}$	-	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 318-05 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible. 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 318-05 Section 9.2. See ACI 318-05 Section D.4.4.

Table 8 — CONCRETE BREAKOUT DESIGN INFORMATION FOR FRACTIONAL THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

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	$k_{c,uncr}$	**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)	$\boldsymbol{h_{ef}}$ **+ 1-1/4** (h_{ef} + 30)		$\boldsymbol{h_{ef} + 2d_o}$				
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.

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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	1-1/4
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)	**732** (5.0)
		$h_{ef,min}$	**in.** (mm)	**2.43** (62)	**2.81** (71)	**3.14** (80)	**3.44** (87)	**3.71** (94)	**4.0** (102)	**5.0** (127)
	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)	**1,862** (12.8)
		$h_{ef,min}$	**in.** (mm)	**2.43** (62)	**2.81** (71)	**3.14** (80)	**3.44** (87)	**3.71** (94)	**4.0** (102)	**5.0** (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)	**260** (1.8)
		$h_{ef,min}$	**in.** (mm)	**1.73** (44)	**2.20** (56)	**3.61** (66)	**3.01** (76)	**3.50** (89)	**4.0** (102)	**5.0** (127)
	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)	**643** (4.4)
		$h_{ef,min}$	**in.** (mm)	**1.73** (44)	**2.20** (56)	**3.61** (66)	**3.01** (76)	**3.50** (89)	**4.0** (102)	**5.0** (127)
Permissible installation conditions	Dry concrete	ϕ_d	-	0.65	0.65	0.65	0.65	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
		κ_{ws}	-	1.0	1.0	1.0	1.0	1.0	0.99	0.94
	Water-filled hole	ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45	0.45
		κ_{wf}	-	1.00	1.00	0.96	0.91	0.87	0.84	0.79
	Underwater application	ϕ_{uw}	-	0.45	0.45	0.45	0.45	0.45	0.45	0.45
		κ_{uw}	-	0.95	0.94	0.94	0.93	0.92	0.92	0.91

For SI: 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 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 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/mm2)	**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/mm2)	**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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond may be increased by 10%.

2 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%.

3 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.

4 Bond strength values applicable to SDC A and B only.

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Table 11 — STEEL DESIGN INFORMATION FOR METRIC THREADED ROD[1]

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}	**mm²** (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	$\alpha_{V,seis}$	-	0.70							
	Strength reduction factor ϕ for tension[2]	ϕ	-	0.65							
	Strength reduction factor ϕ for shear[2]	ϕ	-	0.60							
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	$\alpha_{V,seis}$	-	0.70							
	Strength reduction factor ϕ for tension[2]	ϕ	-	0.65							
	Strength reduction factor ϕ for shear[2]	ϕ	-	0.60							
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	$\alpha_{V,seis}$	-	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 318-05 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible. Use nuts and washers appropriate for the rod strength.

2 For use with the load combinations of ACI 318-05 Section 9.2. See ACI 318-05 Section D.4.4.

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

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Table 12 — CONCRETE BREAKOUT DESIGN INFORMATION FOR METRIC THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

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	$k_{c,uncr}$	**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.)	$\boldsymbol{h_{ef} + 30}$ (h_{ef} + 1-1/4)		$\boldsymbol{h_{ef} + 2d_o}$					
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.

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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/mm²** (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/mm²** (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/mm²** (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/mm²** (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
		κ_{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
		κ_{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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 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 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/mm²** (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/mm²** (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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 Bond strength values applicable to SDC A and B only.

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Table 15 — STEEL DESIGN INFORMATION FOR FRACTIONAL HILTI HIS-N AND HIS-RN INSERTS[1]

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** (mm²)	**0.0775** (50)	**0.1419** (92)	**0.2260** (146)	**0.3345** (216)
HIS insert effective cross-sectional area		A_{insert}	**in.²** (mm²)	**0.178** (115)	**0.243** (157)	**0.404** (260)	**0.410** (265)
ASTM A 193 B7	Nominal strength as governed by steel strength — A 193 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	$\alpha_{V,seis}$	-	0.7			
	Strength reduction factor ϕ for tension[2]	ϕ	-	0.75			
	Strength reduction factor ϕ for shear[2]	ϕ	-	0.65			
ASTM F A193 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	$\alpha_{V,seis}$	-	0.7			
	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 318-05 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible. Use nuts and washers appropriate for the rod strength.

2 For use with the load combinations of ACI 318-05 Section 9.2. See ACI 318-05 Section D.4.4. Values correspond to a ductile steel element.

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Table 16 — CONCRETE BREAKOUT DESIGN INFORMATION FOR FRACTIONAL HILTI HIS-N AND HIS-RN INSERTS [1]

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	$k_{c,uncr}$	**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.

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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
		κ_{ws}	-	1.00	1.00	0.99	0.97
	Water-filled hole	ϕ_{wf}	-	0.45	0.45	0.45	0.45
		κ_{wf}	-	0.95	0.89	0.84	0.82
	Underwater application	ϕ_{uw}	-	0.45	0.45	0.45	0.45
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 For structures assigned to SDC C, D, E or F, bond strength values shall be multiplied by $\alpha_{N,seis} = 0.65$.

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/mm2)	**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/mm2)	**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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 Bond strength values applicable to SDC A and B only.

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Table 19 — STEEL DESIGN INFORMATION FOR METRIC HILTI HIS-N AND HIS-RN INSERTS[1]

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}	**mm²** (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}	**mm²** (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** (6,582)	**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	$\alpha_{V,seis}$	-			0.7		
	Strength reduction factor ϕ for tension[2]	ϕ	-			0.65		
	Strength reduction factor ϕ for shear[2]	ϕ	-			0.60		
ISO 3506-1 Class A4-70 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** (9,127)	**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	$\alpha_{V,seis}$	-			0.7		
	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 = 0.006897MPa

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 318-05 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible. Use nuts and washers appropriate for the rod strength.

2 For use with the load combinations of ACI 318-05 Section 9.2. See ACI 318-05 Section D.4.4. Values correspond to a ductile steel element.

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Table 20 — CONCRETE BREAKOUT DESIGN INFORMATION FOR METRIC HILTI HIS-N AND HIS-RN INSERTS [1]

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	$k_{c,uncr}$	**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.

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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/mm²** (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/mm²** (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/mm²** (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/mm²** (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
		κ_{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
		κ_{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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 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 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	$\tau_{k,cr}$	**N/mm²** (psi)	**11.8** (1,712)	**10.6** (1,534)	**9.7** (1,403)	**8.8** (1,282)	**8.5** (1,235)
Temperature range B[3]	Characteristic bond strength in un-cracked concrete[2]	$\tau_{k,cr}$	**N/mm²** (psi)	**4.1** (591)	**3.7** (530)	**3.3** (484)	**3.1** (442)	**2.9** (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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 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 23 — STEEL DESIGN INFORMATION FOR FRACTIONAL REINFORCING BARS[1]

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** (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)
	Reduction for seismic shear	$\alpha_{V,seis}$	-	0.70							
	Strength reduction factor ϕ for tension[2]	ϕ	-	0.75							
	Strength reduction factor ϕ for shear[2]	ϕ	-	0.65							
ASTM 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	$\alpha_{V,seis}$	-	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 = 0.006897MPa

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 318-05 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible. Use nuts and washers appropriate for the rod strength.

2 For use with the load combinations of ACI 318-05 Section 9.2. See ACI 318-05 Section D.4.4.

Table 24 — CONCRETE BREAKOUT DESIGN INFORMATION FOR FRACTIONAL REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

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.

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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
		κ_{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
		κ_{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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 For structures assigned to SDC C, D, E or F, bond strength values shall be multiplied by $\alpha_{N,seis} = 0.65$.

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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 Bond strength values applicable to SDC A and B only.

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Table 27 — STEEL DESIGN INFORMATION FOR EU METRIC REINFORCING BARS[1]

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}	**mm²** (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** (9,711)	**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	$\alpha_{V,seis}$	-	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

1 Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318-05 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible. Use nuts and washers appropriate for the rod strength.

2 For use with the load combinations of ACI 318-05 Section 9.2. See ACI 318-05 Section D.4.4.

Table 28 — CONCRETE BREAKOUT DESIGN INFORMATION FOR EU METRIC REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

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 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.

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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	$\tau_{k,cr}$	**N/mm²** (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	$\tau_{k,uncr}$	**N/mm²** (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]	$\tau_{k,cr}$	**N/mm²** (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]	$\tau_{k,uncr}$	**N/mm²** (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
		κ_{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
		κ_{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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 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/mm²** (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/mm²** (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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 Bond strength values applicable to SDC A and B only.

Table 31 — STEEL DESIGN INFORMATION FOR CANADIAN METRIC REINFORCING BARS[1]

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}	**mm²** (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

1 Values provided for common rod material types based on published strengths and calculated in accordance with ACI 318-05 Eq. (D-3) and Eq. (D-20). Other material specifications are admissible. Use nuts and washers appropriate for the rod strength.

2 For use with the load combinations of ACI 318-05 Section 9.2. See ACI 318-05 Section D.4.4.

Table 32 — CONCRETE BREAKOUT DESIGN INFORMATION FOR CANADIAN METRIC REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

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	$k_{c,uncr}$	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.

4.2.6 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/mm²** (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	$\tau_{k,uncr}$	**N/mm²** (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/mm²** (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]	$\tau_{k,uncr}$	**N/mm²** (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
		κ_{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
		κ_{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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 For structures assigned to SDC C, D, E or F, bond strength values shall be multiplied by $\alpha_{N,seis} = 0.65$.

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/mm²** (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	$\tau_{k,uncr}$	**N/mm²** (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
		κ_{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

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 strength may be increased by 6%. For 6,500 psi ≤ f'c ≤ 8,000 psi, tabulated characteristic bond strength may be increased by 10%.

2 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%.

3 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.

4 Bond strength values applicable to SDC A and B only.

4.2.6 HIT-RE 500-SD Epoxy Adhesive Anchoring System

4.2.6.5 Installation Instructions

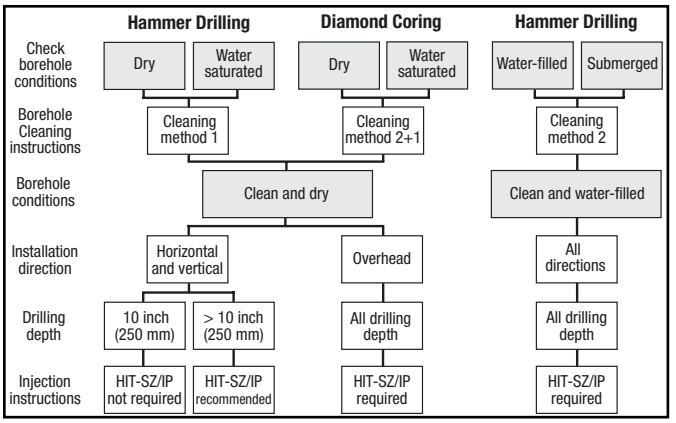
Adhesive anchoring system for fastenings in normal weight concrete

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 m^3/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 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.

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

or

*) Please refer to technical literature (approvals, setting instructions) for detail.

°F	°C	t_{work} / t_{gel}	$t_{cure, ini}$	$t_{cure, full}$	Time →
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	

4.2.6 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_0
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]	[Nm]		[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_0
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	

Table 3 — Setting Details of Hilti HIT-RE 500-SD with reinforcement bars

d	d_o	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 (30 mm)
# 4	5/8	2 – 10	51 – 254	
# 5	3/4	2-1/2 – 12-1/2	64 – 318	h_{ef} + 2 d_0
# 6	7/8	3 – 15	76 – 381	
# 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		h_{ef} + 2 d_0
14	18	56 – 280		
16	20	64 – 320		
20	25	80 – 400		
25	32	100 – 500		
28	35	112 – 560		
32	40	128 – 640		
CA rebar	[inch]	[mm]		[inch]
10 M	9/16	45 – 226		h_{ef} + 1-1/4 (30 mm)
15 M	3/4	64 – 320		h_{ef} + 2 d_0
20 M	1	78 – 390		
25 M	1-1/4	101 – 504		
30 M	1-1/2	120 – 598		

4.2.6 HIT-RE 500-SD Epoxy Adhesive Anchoring System

4.2.6.6 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

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 in³	
• Volume of HIT-RE 500-SD 16.9 fl oz/500 ml foil pack is 30.5 in³	

Gel/Full Cure Time Table (Approximate)

Base Material Temperature			
°F	°C	t_{gel}	t_{cure}
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

Item No.	Description
241382	HIT-RE 500-SD (11.1 fl oz/330 ml) – 1 pack
	Includes 1 mixer and 3/8" filler tube per package
3425973	HIT-RE 500-SD (11.1 fl oz/330 ml) MC – 25 packs
	Includes 1 mixer and 3/8" filler tube per package
3428744	HIT-RE 500-SD (11.1 fl oz/330 ml)
	Includes 1 MC and mixer and and choice of MD 2000 or MD 2500 dispenser
241383	HIT-RE 500-SD (16.9 fl oz/500 ml) MC – 20 packs
	Includes 1 mixer and 3/8" filler tube per package
3433546	HIT-RE 500-SD (16.9 fl oz/500 ml)
	Includes 2 MC and MD 2500 dispenser
3426080	HIT-RE 500-SD (16.9 fl oz/500 ml)
	Includes 5 MC and ED 3500 dispenser 2.0 Ah Kit

ED 3500 2.0 Ah Kit

Dispensers

Battery Powered

Item No.	Description
3425363	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
273676	ED 3500 Dispenser
	Includes dispenser only in cardboard box
340888	SFB 121 2.0-Ah NiCd Battery for ED 3500
378449	C 7/24 Standard Charger for ED 3500

Foil Pack Holder

Manual

Item No.	Description
338853	MD 2500 Manual Dispenser with Foil Pack Holder
	For use with HIT 11.1 fl oz/330ml and 16.9oz/500ml foil packs√
339477	Foil Pack Holder
	Replacement for MD 2500 and ED 3500

MD 2500 Manual Dispenser

Hole Cleaning/Injection Accessories

Imperial

Hole Dia. (d_0)	Round Brush		Injection Piston		Air Nozzle	
Ø [inch]	HIT-RB	Item no.	HIT-SZ (IP)	Item no.	HIT-DL	Item no.
7/16	7/16"	273203		–	–	–
1/2	1/2"	273204	1/2"	274019	1/2"	38237
9/16	9/16"	273205	9/16"	274020	9/16"	38238
5/8	5/8"	273207	5/8"	274021	9/16"	38238
11/16	11/16"	273209	11/16"	274022	11/16"	38239
3/4	3/4"	273210	3/4"	274023	3/4"	38240
7/8	7/8"	273211	7/8"	274024	7/8"	38241
1	1"	273212	1"	274025	1"	38242
1-1/8	1-1/8"	273214	1-1/8"	274026	1"	38242
1-1/4	1-1/4"	273216	1-1/4"	274027	1"	38242
1-3/8	1-3/8"	273217	1-3/8"	274028	1-3/8"	38243
1-1/2	1-1/2"	273218	1-1/2"	274029	1-3/8"	38243
1-3/4	1-3/4"	273219	1-3/4"	274030	1-3/8"	38243

Metric

Hole Dia. (d_0)	Round Brush		Injection Piston		Air Nozzle	
Ø [inch]	HIT-RB	Item no.	HIT-SZ (IP)	Item no.	HIT-DL	Item no.
10	10	380917	–	–	–	–
12	8/12	336548	8/12	351989	8/12	371715
14	10/14	336549	10/14	351990	10/14	371716
16	12/16	336550	12/16	351991	12/16	371717
18	14/18	336551	14/18	351992	14/18	371718
20	16/20	336552	16/20	351993	16/20	371719
22	18/22	370774	18/22	269618	16/20	371719
24	24	380918	24	269619	16/20 3	71719
25	20/25	336553	20/25	351994	20/25	371720
28	28	380919	28	269620	20/25	371720
30	30	380920	30	269621	20/25	371720
32	25/32	336554	25/32	351995	25/32	371721
35	35	380921	35	269622	25/32	371721
37	37	382259	37	271499	25/32	371721
40	40	382260	40	269623	25/32	371721
42	42	382261	42	269624	25/32	371721
45	45	382262	45	269625	25/32	371721
47	47	382264	47	269626	25/32	371721
52	52	382265	52	271476	25/32	371721
55	55	382266	55	271477	25/32	371721

HIT-RB (Round Brush)

HIT-SZ (IP) (Injection Piston)

HIT-DL (Air Nozzle)

Contact Hilti for

a complete listing of additional accessories and extensions for air nozzles, brushes and injection pistons to handle embedment.

Introducing

Hilti Accredited Adhesive Anchor Installer Program – call Hilti for details

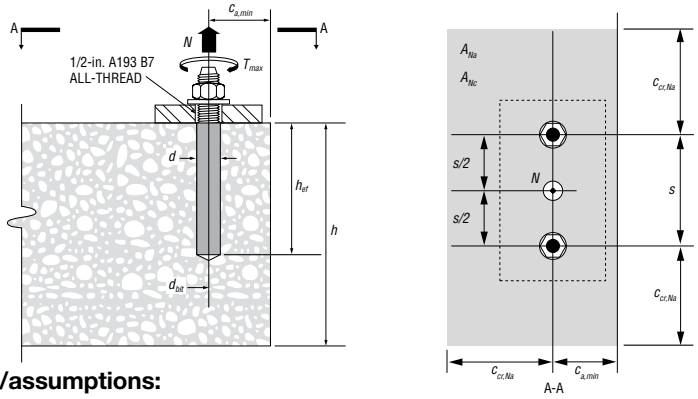
4.2.6.7 Sample Calculations

Given:

2 1/2-in. HIT RE 500-SD adhesive anchors subjected to a tension load as shown.

Design objective:

Calculate the design tension resistance for this configuration.



Dimensional parameters:

h_{ef} = 9.0 in.
s = 4.0 in.
$c_{a,min}$ = 2.5 in.
h = 12.0 in.
d = 1/2 in.

Specifications/assumptions:

ASTM A193 B7 all-thread rods, UNC thread, A 563 Grade HD hex nuts.
Normal weight concrete, f'c = 4,000 psi.
Seismic design category (SDC) B
No supplementary reinforcing per ACI 318-05 D.1.
Assume maximum short term (diurnal) base material temperature ≤ 100 0F.
Assume maximum long term base material temperature ≤ 80 0F.
Assume installation in dry concrete and hammer-drilled holes.
Assume concrete will remain uncracked for service life of anchorage.

Calculation per ACI 318-05 Appendix D and this report.	**ACI 318 Code Ref.**	
Step 1. Check minimum edge distance, anchor spacing and member thickness:	–	
c_{min} = 2.5 in. ≤ ca,min therefore ok.	–	Table 8
s_{min} = 2.5 in. ≤ s therefore ok.	–	Table 8
$h_{min} = h_{ef} + 1.25 = 9 + 1.25 = 10.25$ in. ≤ h therefore ok.	–	Table 8
Step 2. Calculate steel strength: $N_{sa} = n \times A_{se} \times f_{uta}$	D.5.1.2	–
B7 rods are considered ductile per ACI 318-05. $\therefore \Phi = 0.75$	D.1 & D.4.4a	–
$\therefore \Phi N_{sa} = \Phi \times n \times A_{se} \times f_{uta} = 0.75 \times 2 \times 0.1419 \times 125{,}000 = 26{,}606$ lb = 26.6 k		
or, using Table 7, $\therefore \Phi N_{sa} = 0.75 \times 2 \times 17{,}737 = 26.6$ k	D.5.1.2	Table 7
Step 3. Determine concrete breakout strength: $N_{cbg} = \frac{A_{Nc}}{A_{NcO}} (\Psi_{ec,N})(\Psi_{ed,N})(\Psi_{c,N})(\Psi_{cp,N})(N_b)$	D.5.2.1 & Eq. (D-5)	–
$A_{Nc} = (3h_{ef} + s)(1.5h_{ef} + c_{a,min}) = (27 + 4)(13.5 + 2.5) = 496$ in^2	–	–
$A_{NcO} = 9h_{ef}^2 = 729$ in^2	D.5.2.1 & Eq. (D-5)	–
$\Psi_{ec,N}$ = no eccentricity of tension load with respect to tension-loaded anchors	D.5.2.4	
$\Psi_{ed,N} = 0.7 + 0.3 \times \frac{c_{a,min}}{1.5\, h_{ef}}$ for $c_{a,min} \le 1.5\, h_{ef}$	D.5.2.1 & & Eq. (D-5)	–
$c_{a,min} = 2.5 < 1.5 \times 4.5$.	–	–
$\therefore \Psi_{ed,N} = 0.7 + 0.3 \times \frac{2.5}{1.5 \times 9} = 0.76$	–	–
$\Psi_{c,N}$ = 1.0 uncracked concrete assumed ($k_{c,uncr}$ = 24)	D.5.2.6	Table 8
Determine c_{ac}: $h_{ef} + 5\,(c_{a,min})^{0.75} = 9 + 5\,(2.5)^{0.75} = 18.9$ in. > 12 in. therefore, $c_{ac} = 2.5\, h_{ef}$ $c_{ac} = 2.5$ (9 in.) = 22.5 in.	D.5.12.7	Section 4.1.3
For $c_{a,min} < c_{ac}$ $\Psi_{cp,N} = \frac{\max \lvert c_{a,min};\ 1.5\, h_{ef} \rvert}{c_{ac}} = \frac{\max \lvert 2.5;\ 1.5 \times 9 \rvert}{22.5} = 0.60$	D.5.2.7 & Eq. (D-13)	–
$N_b = k_{c,uncr} \sqrt{f'_c} \times h_{ef}^{1.5} = 2.4 \sqrt{4000} \times (9)^{1.5} = 40{,}983$ lb	D.5.2.2 & Eq. (D-7)	–
$N_{cbg} = \frac{496}{729} \times 1.0 \times 0.76 \times 1.0 \times 0.60 \times 40{,}983 = 12715$ lb	–	–
$\Phi N_{cbg} = 0.65 \times 12{,}715 = 8{,}265$ lb = 8.3*k*	D.4.4c	–

4.2.6 HIT-RE 500-SD Epoxy Adhesive Anchoring System

Calculation per ACI 318-05 Appendix D and this report.	ACI 318 Code Ref.	
Step 4. Determine bond strength:		Section 4.2.6 3
$N_{ag} = \frac{A_{Na}}{A_{NaO}} (\Psi_{ed,Na}) (\Psi_{g,Na}) (\Psi_{ec,Na}) (\Psi_{p,Na}) (N_{aO})$		Eq. (D-14b)
$S_{cr,Na} = min\left(20 \text{ x } d \sqrt{\frac{\tau_{k,uncr}}{1450}} ; 3\, h_{ef}\right) = 20 \text{ x } 0.5 \sqrt{\frac{2,236}{1450}} = 12.4$ in	–	Section 4.2.6.3 Table 9
$3\, h_{ef} = 27$ in $\geq 12.4 \therefore s_{cr,Na} = 12.4$ in.		
$c_{cr,Na} = \frac{s_{cr,Na}}{2} = 6.2$ in.	–	Section 4.2.6.3 Eq. (D-14i)
$A_{Na} = (2c_{cr,Na} + s)(c_{cr,Na} + c_{a,min}) = 143.0$ in^2	–	Section 4.2.6.3 Eq. (D-14i)
$A_{NaO} = (s_{cr,Na})^2 = 154.2$ in^2	–	Section 4.2.6 3 D.5.3.7
For $c_{a,min} < c_{cr,Na}$: $\Psi_{ed,Na} = \left(0.7 + 0.3 \frac{c_{a,min}}{c_{cr,Na}}\right)$		Section 4.2.6.3
$\Psi_{ed,Na} = \left(0.7 + 0.3 \frac{2.5}{6.2}\right) = 0.82$		Section 4.2.6.3
$\tau_{k,max,uncr} = \frac{k_{k,uncr}}{\pi \text{ x } d} \sqrt{h_{ef} \text{ x } f'_c} = \frac{24}{\pi \text{ x } 0.5} \sqrt{9 \text{ x } 4000} = 2,899$ psi		Section 4.2.6.3 Table 8
$\psi_{g,NaO} = \sqrt{n} - \left[\left(\sqrt{n} - 1\right)\left(\frac{\tau_{k,uncr}}{\tau_{k,max,uncr}}\right)^{1.5}\right] = \sqrt{2} - \left[\left(\sqrt{2} - 1\right)\left(\frac{2,236}{2,899}\right)\right]^{1.5} = 1.13$		Section 4.2.6.3 Table 9
$\psi_{g,Na} = \Psi_{g,NaO} + \left[\left(\frac{s}{s_{cr,Na}}\right)^{0.5} \text{x } (1 - \Psi_{g,NaO})\right] = 1.13 + \left[\left(\frac{2.5}{12.4}\right)^{0.5} \text{x } (1\text{-}1.13)\right] = 1.06$		Section 4.2.6.3
$\psi_{ec,Na} = 1.0$ no eccentricity - loading is concentric	–	–
$\Psi_{p,Na} = \frac{\max \lvert c_{a,min} ; c_{cr,Na} \rvert}{c_{ac}} = \frac{\max \lvert 2.5 ; 6.2 \rvert}{22.5} = 0.28$	–	–
$N_{NaO} = \tau_{k,uncr}\, \pi\, d\, h_{ef} = 2,236\, \pi\, 0.5\, 9 = 31,610$ lb	–	Section 4.2.6.3 Eq. (D-14j)
$N_{ag} = \frac{A_{Na}}{A_{NaO}} (\psi_{ed,Na}) (\psi_{g,Na}) (\psi_{ec,N}) (\psi_{p,Na}) (N_{aO})$		Section 4.2.6.3
$N_{ag} = \frac{143.0}{154.2}$ (0.82) (1.06) (1.0) (0.28) (31,610) = 7,134 lb.		Eq. (D-14b)
$\therefore \phi = 0.65$	–	Table 9
$\phi N_{ag} = 0.65$ (7,134) = 4,637 lb = 4.6 k		–
Step 5. Determine controlling strength:	D.4.1.2	–

Steel strength	ϕ Nsa	= 26.6 k	
Concrete breakout strength	ϕ Ncbg	= 8.3 k	
Bond strength	ϕ Nag	= 4.6 k	controls

Step 6. Convert strength to ASD using average load factor:	Section 4.2
$N_{allow,ASD} = \frac{N_d}{\alpha} = \frac{\phi N_n}{\alpha} = \frac{4.6}{1.4} = 3.3\, k$	

In The United Sates

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. Special orders products and discontinued items are not eligible for return credit. Dated materials are only returnable in case quantity, and within 30 days after invoice date.

WARRANTY: 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.

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, or any other damages arising out of or related to the sale, use, or inability to use the product.

ACCEPTANCE OF ORDER: 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: Any non-domestic Hilti product will be so identified on shipping documents and invoices for customers who properly identify themselves as a federal government entity. All other customers may obtain such information 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.

AUTHORIZATION: HILTI LEGAL DEPARTMENT PERSONNEL ARE THE ONLY INDIVIDUALS AUTHORIZED TO MODIFY THESE TERMS AND CONDITIONS, WARRANT PRODUCT SUITABILITY FOR SPECIFIC APPLICATIONS, OR EXECUTE CUSTOMER DOCUMENTS, AND ANY SUCH ACTION IS NULL AND VOID UNLESS IN WRITTEN FORM SIGNED BY SUCH INDIVIDUAL.

In Canada

PAYMENT TERMS: Net 30 days from date of invoice. Customer agrees to pay all costs incurred by Hilti in collecting 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 order under certain limits. A fuel surcharge 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:

i) it is returned by the original purchaser

ii) it is not dated product returned more than 30 days after the original delivery date

iii) it is not discontinued, clearance or special order product

iv) it is unused, in original packaging and in unbroken quantities.

Hilti will inspect product and, if the above requirements are satisfied, will credit to customer the original purchase price. A 15% restocking fee may apply.

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: Hilti sales personnel are not authorized to modify these Terms and Conditions or modify Customer's credit terms. Terms are subject to change by Hilti with reasonable notice to Customer.

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.