ICC-ES Evaluation Report

ESR-4094

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This report also contains:

- FBC Supplement

- LABC Supplement

DIVISION: 03 00 00—CONCRETE	REPORT HOLDER:	EVALUATION SUBJECT:
Section: 03 16 00—Concrete Anchors DIVISION: 05 00 00—METALS Section: 05 05 19—Post-Installed Concrete Anchors	ADHESIVES TECHNOLOGY CORPORATION (ATC)	ADHESIVES TECHNOLOGY CORPORATION (ATC) ULTRABOND® HS-1CC ADHESIVE ANCHOR SYSTEM IN CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2021, 2018, 2015, 2012, and 2009 *International Building Code®* (IBC)
- 2021, 2018, 2015, 2012, and 2009 *International Residential Code®* (IRC)
- 2013 *Abu Dhabi International Building Code* (ADIBC)†

†The ADIBC is based on the 2009 IBC. 2009 IBC code sections referenced in this report are the same sections in the ADIBC.

For evaluation for compliance with codes adopted by the Los Angeles Department of Building and Safety (LADBS) see ESR-4094 LABC and LARC Supplement

Property evaluated:
Structural

2.0 USES

Adhesive anchors installed using the ULTRABOND HS-1CC adhesive anchor system are post-installed adhesive anchors used to resist static, wind or earthquake (IBC Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normal-weight and lightweight concrete with $^3/_8$-, $^1/_2$-, $^5/_8$-, $^3/_4$-, $^7/_8$-, 1-, and $1^1/_4$-inch-diameter threaded steel rods and No. 3 through No. 10 steel reinforcing bars in hammer-drilled holes and $^5/_8$-, $^3/_4$-, $^7/_8$-, 1-, and $1^1/_4$-inch-diameter threaded steel rods in holes drilled with the Milwaukee Vacuum-bit system. Use is limited to normal-weight and lightweight concrete with a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

Adhesive anchors with $^1/_2$-, $^5/_8$-, $^3/_4$-, $^7/_8$-, 1-, and $1^1/_4$-inch-diameter threaded steel rods and No. 4 through No. 10 steel reinforcing bars in holes drilled with diamond core bits and $^3/_8$-, $^1/_2$-, $^5/_8$-, $^3/_4$-, and 1-inch nominal diameter POWER-Sert internally threaded inserts in hammer-drilled holes are used in uncracked normal-weight and lightweight concrete only, to resist static, wind or earthquake (IBC Seismic Design Categories A and B only) tension and shear loads. Use is limited to normal-weight and lightweight concrete with a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

The anchor system complies with anchors as described in Section 1901.3 of the 2018 and 2015 IBC, Section 1909 of the 2012 IBC, and is an alternative to cast-in-place and post-installed anchors described in Section 1908 of the 2012 IBC, and Sections 1911 and 1912 of the 2009 and 2006 IBC. The anchor systems may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 General:

The ULTRABOND HS-1CC Adhesive Anchor System is comprised of ULTRABOND HS-1CC two-component adhesive filled in cartridges or bulk packaging, static mixing nozzles and manual or powered dispensing tools and equipment, hole cleaning equipment and adhesive injection accessories.

ULTRABOND HS-1CC adhesive may be used with continuously threaded steel rods, deformed steel reinforcing bars, or POWER-Sert internally threaded inserts. The primary components of the ULTRABOND HS-1CC Adhesive Anchor System, including the ULTRABOND HS-1CC adhesive cartridges or bulk containers, static mixing nozzles, nozzle extension tube, installation accessories and steel anchor elements, are shown in Figures 2, 3, 6, 7 and 8 and Tables 20 and 21 of this report.

Installation information and parameters are shown in Figures 4, 5 and 9, and Tables 17 through 22 of this report.

The manufacturer's printed installation instructions (MPII), as detailed in the product's Technical Data Sheet (TDS) is described in Figure 9 of this report. The MPII is included on each adhesive unit package.

3.2 Materials:

3.2.1 ULTRABOND **HS-1CC Adhesive:** ULTRABOND HS-1CC adhesive is an injectable two-component (resin and hardener), 1:1 mix ratio by volume epoxy adhesive. The two components are kept separate by means of a labelled dual-cylinder cartridge or in separate bulk containers. The two components combine and react when dispensed through a static mixing nozzle, supplied by ATC, which is attached to the cartridge or manifold of the bulk dispensing equipment. ULTRABOND HS-1CC is available in the packaging options depicted in Figure 3. Each cartridge or bulk container label is marked with the adhesive expiration date. The shelf life of 24 months, as indicated by the expiration date, applies to unopened containers stored at temperatures between 40°F (4°C) and 95°F (35°C). Table 22 provides working times and cure times based on the concrete and product temperatures.

3.2.2 Hole Cleaning Equipment:

3.2.2.1 Standard Equipment: Standard hole cleaning equipment is comprised of steel wire brushes supplied by ATC, which are depicted in Figure 7 of this report, and air nozzles.

3.2.2.2 Milwaukee Vacuum-bit system: The Milwaukee Vacuum-bit system is comprised of Milwaukee vacuum drill bits with carbide tips conforming to ANSI B212.15, attached to a Milwaukee vacuum model 8960-20. The system automatically cleans the hole while drilling (see Figure 8). Available sizes for the vacuum drill bits are shown in Table 21.

3.2.3 Dispensing Equipment:

3.2.3.1 Cartridges: ULTRABOND HS-1CC adhesive cartridges must be dispensed with manual dispensers, pneumatic dispensers, or electric powered dispensers shown in Table 20 and Figure 6, supplied by ATC.

3.2.3.2 Bulk: ULTRABOND HS-1CC adhesive in bulk packaging must be dispensed using pneumatic two-component delivery systems where metering of individual components, and mixing of the two components, are automatically controlled during dispensing. The mixing nozzles to be used on the manifold of the bulk dispenser wand are listed in Table 20 and shown in Figure 7 of this report. Bulk packed adhesive must be dispensed using an automatic metering controlled bulk dispensing system, Model Number RMP 6624-1717 supplied by AST.

3.2.4 Steel Anchor Elements:

3.2.4.1 Threaded Steel Rods: Threaded steel rods must be clean and continuously threaded (all-thread) in diameters described in Tables 5 through 9. Specifications for grades of threaded rod, including the mechanical properties, and corresponding nuts and washers, are included in Table 2 of this report. Carbon steel threaded rods may be furnished with a zinc electroplated coating, a mechanically deposited zinc coating, or may be uncoated. The stainless steel threaded rods must comply with ASTM F593. Steel grades and types of material (carbon, stainless) for the washers and nuts must match the threaded rods. Threaded steel rods must be clean, straight and free of indentations or other defects along their length.

3.2.4.2 Steel Reinforcing Bars: Steel reinforcing bars are deformed reinforcing bars as described in Table 3 of this report. Tables 10 through 13 summarize reinforcing bar size ranges. The embedded portions of reinforcing bars must be clean, straight, and free of mill scale, rust, mud, oil and other coatings (other than zinc) that may impair the bond with the adhesive. Reinforcing bars must not be bent after installation except as set forth in ACI 318-14 Section 26.6.3.1 (b) or ACI 318-11 Section 7.3.2, as applicable, with the additional condition that the bars must be bent cold, and heating of reinforcing bars to facilitate field bending is not permitted.

3.2.4.3 Internally Threaded Steel Inserts: Steel inserts are POWER-Sert PS2 and PS6 series internally threaded inserts as described in Table 4 of this report. Tables 14 through 16 summarize the available insert size range. Steel grades and types of material (carbon, stainless) for the bolts, threaded rods, washers and nuts must match the inserts.

3.2.4.4 Ductility: In accordance with ACI 318-14 2.3 or ACI 318-11 D.1, as applicable, in order for a steel anchor element to be considered ductile, the tested elongation must be at least 14 percent and reduction of area must be at least 30 percent. Steel elements with a tested elongation less than 14 percent or a reduction of area less than 30 percent, or both, are considered brittle. Values for various steel materials are provided in Tables 2, 3, and 4 of this report. Where values are nonconforming or unstated, the steel must be considered brittle.

3.3 Concrete:

Normal-weight concrete must comply with Sections 1903 and 1905 of the IBC. The specified compressive strength of the concrete must be from 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: The design strength of anchors under the 2018 and 2015 IBC, as well as the 2018 and 2015 IRC, must be determined in accordance with ACI 318-14 and this report. The design strength of anchors under the 2012, 2009, 2006 IBC, as well as the 2012, 2009 and 2006 IRC, must be determined in accordance with ACI 318-11 and this report.

The strength design of anchors must comply with ACI 318-14 17.3.1 or ACI 318-11 D.4.1, as applicable, except as required in ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable.

Design parameters are provided in Table 5 through Table 16 of this report. Strength reduction factors, ϕ, as given in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, must be used for load combinations calculated in accordance with Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable.

Strength reduction factors, ϕ, as given in ACI 318-11 D.4.4 must be used for load combinations calculated in accordance with ACI 318-11 Appendix C.

4.1.2 Static Steel Strength in Tension: The nominal static steel strength of a single anchor in tension, N_{sa}, in accordance with ACI 318-14 17.4.1.2 or ACI 318-11 D.5.1.2, as applicable, and the associated strength reduction factors, ϕ, in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are provided in Tables 5, 10, and 14 of this report for the corresponding anchor steel.

4.1.3 Static Concrete Breakout Strength in Tension: The nominal static concrete breakout strength of a single anchor or group of anchors in tension, N_{cb} or N_{cbg}, must be calculated in accordance with ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, with the following addition:

The basic concrete breakout strength of a single anchor in tension, N_b, must be calculated in accordance with ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2, as applicable, using the values of $k_{c,cr}$ and $k_{c,uncr}$ as provided in Tables 6, 11, and 15 of this report. Where analysis indicates no cracking in accordance with ACI 318-14 17.4.2.6 or ACI 318-11 D.5.2.6, as applicable, N_b must be calculated using $k_{c,uncr}$ and $\Psi_{c,N}$ = 1.0. For anchors in lightweight concrete, see ACI 318-14 17.2.6 or ACI 318-11 D.3.6, as applicable. The value of f'_c used for calculation must be limited to 8,000 psi (55 MPa) in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable. Additional information for the determination of nominal bond strength in tension is given in Section 4.1.4 of this report.

4.1.4 Static Bond Strength in Tension: The nominal static bond strength of a single adhesive anchor or group of adhesive anchors in tension, N_a or N_{ag}, must be calculated in accordance with ACI 318-14 17.4.5 or ACI 318-11 D.5.5, as applicable.

Bond strength values ($\tau_{k,cr}$, $\tau_{k,uncr}$) are a function of concrete state (cracked, uncracked), temperature category, hole drilling method (hammer drilling, core drilling), hole cleaning (standard, vacuum bit), installation conditions (dry concrete, water-saturated concrete, water-filled holes, underwater), and level of special inspection provided. The following table summarizes the requirements

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DRILLING/ CLEANING METHOD	CONCRETE STATE	BOND STRENGTH	PERMISSIBLE INSTALLATION CONDITIONS	ASSOCIATED STRENGTH REDUCTION FACTOR
Hammer Drilled Holes	Cracked	$\tau_{k,cr}$	Dry concrete	ϕ_d
			Water saturated concrete	ϕ_{ws}
			Water-filled hole (flooded)	$K_{wf} \cdot \phi_{wf}$
			Underwater (submerged)	ϕ_{uw}
	Uncracked	$\tau_{k,uncr}$	Dry concrete	ϕ_d
			Water saturated concrete	ϕ_{ws}
			Water-filled hole (flooded)	$K_{wf} \cdot \phi_{wf}$
			Underwater (submerged)	ϕ_{uw}
Vacuum Bit Drilled Holes	Cracked	$\tau_{k,cr}$	Dry concrete	ϕ_d
			Water saturated concrete	$K_{ws} \cdot \phi_{ws}$
	Uncracked	$\tau_{k,uncr}$	Dry concrete	ϕ_d
			Water saturated concrete	$K_{ws} \cdot \phi_{ws}$
Core Drilled Holes	Uncracked	$\tau_{k,uncr}$	Dry concrete	ϕ_d
			Water saturated concrete	$K_{ws} \cdot \phi_{ws}$

Strength reduction factors, ϕ, for determination of the bond strength are given in Tables 7, 8, 9, 12, 13, and 16 of this report. Bond strengths must also be multiplied by the factor K_{wf} where holes are water-filled at the time of anchor installation (flooded), and K_{ws} where the concrete is saturated where vacuum bit drilled holes or core drilled holes are utilized.

The bond strength values in this report correspond to concrete compressive strength f'_c equal to 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c between 2,500 psi and 8,000 psi (17.2 MPa and 55 MPa), the tabulated characteristic bond strength in uncracked concrete may be increased by a factor of $(f'_c / 2{,}500)^{0.10}$ [For **SI:** $(f'_c / 17.2)^{0.10}$] [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1]. The bond strengths in cracked concrete must not be adjusted for concrete compressive strength. Where applicable, the modified bond strength values must be used in lieu of $\tau_{k,cr}$ and $\tau_{k,uncr}$ in ACI 318-14 Equations (17.4.5.1d) and (17.4.5.2) or ACI 318-11 Equations (D-21) and (D-22), as applicable.

The resulting nominal bond strength must be multiplied by the associated strength reduction factor ϕ_d, $K_{ws} \cdot \phi_{ws}$, $K_{wf} \cdot \phi_{wf}$, or ϕ_{uw} as applicable.

4.1.5 Static Steel Strength in Shear: The nominal static steel strength of a single anchor in shear as governed by the steel, V_{sa}, in accordance with ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable, and the strength reduction factor, ϕ, in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are given in Tables 5, 10, and 14 of this report for the corresponding anchor steel.

4.1.6 Static Concrete Breakout Strength in Shear: The nominal static concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg}, must be calculated in accordance with ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, based on information given in Tables 6, 11 and 15 in this report.

The basic concrete breakout strength of a single anchor in shear, Vb, must be calculated in accordance with ACI 318-14 17.5.2.2 or ACI 318-11 D.6.2.2, as applicable, using the values of d given in Tables 5, 10 and 14 for the corresponding anchor steel in lieu of da (2018, 2015, 2012 and 2009 IBC) and do (2006 IBC). In addition, hef must be substituted for ℓe. In no case shall ℓe exceed 8d. The value of f'c shall be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

4.1.7 Static Concrete Pryout Strength in Shear: The nominal static pryout strength of a single anchor or group of anchors in shear, V_{cp} or V_{cpg}, shall be calculated in accordance with ACI 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable.

4.1.8 Interaction of Tensile and Shear Forces: For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318-14 17.6 or ACI 318-11 D.7, as applicable.

4.1.9 Minimum Member Thickness h_{min}, Anchor Spacing s_{min}, Edge Distance c_{min}: In lieu of ACI 318-14 17.7.1 and 17.7.3 or ACI 318-11 D.8.1 and D.8.3, as applicable, values of s_{min} and c_{min} described in this report must be observed for anchor design and installation. The minimum member thicknesses, h_{min}, described in this report must be observed for anchor design and installation. For adhesive anchors that will remain untorqued, see ACI 318-14 17.7.4 or ACI 318-11 D.8.4, as applicable.

4.1.10 Critical Edge Distance c_{ac} and $\psi_{cp,Na}$: The modification factor $\psi_{cp,Na}$, must be determined in accordance with ACI 318-14 17.4.5.5 or ACI 318-11 D.5.5.5, as applicable, except as noted below:

For all cases where $c_{Na}/c_{ac}<1.0$, $\psi_{cp,Na}$ determined from ACI 318-14 Eq. 17.4.5.5b or ACI 318-11 Eq. D-27, as applicable, need not be taken less than c_{Na}/c_{ac}. For all other cases, $\psi_{cp,Na}$ shall be taken as 1.0.

The critical edge distance, c_{ac} must be calculated according to Eq. 17.4.5.5c for ACI 318-14 or Eq. D-27a for ACI 318-11, in lieu of ACI 318-14 17.7.6 or ACI 318-11 D.8.6, as applicable.

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

(Eq. 17.4.5.5c for ACI 318-14 or Eq. D-27a for ACI 318-11)

where

$\left[\frac{h}{h_{ef}}\right]$ need not be taken as larger than 2.4; and

$\tau_{k,uncr}$ = the characteristic bond strength stated in the tables of this report whereby $\tau_{k,uncr}$ need not be taken as larger than:

$$\tau_{k,uncr}=\frac{k_{uncr}\sqrt{h_{ef}f_c'}}{\pi\cdot d_a}$$

Eq. (4-1)

4.1.11 Requirements for Seismic Design Categories C, D, E and F: In structures assigned to Seismic Design Category C, D, E or F under the IBC or IRC, anchors must be designed in accordance with ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable, except as described below.

The nominal steel shear strength, V_{sa}, must be adjusted by $\alpha_{V,seis}$, as given in Tables 5, 10 and 14 for the corresponding anchor steel. The nominal bond strength $\tau_{k,cr}$ must be adjusted by $\alpha_{N,seis}$, as given in Tables 7, 8, and 12.

As an exception to ACI 318-11 Section D.3.3.4.2: Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the force determined in accordance with ASCE 7 Equation 12.11-1 or 12.14-10 shall be deemed to satisfy Section ACI 318-11 D.3.3.4.3(d).

Under ACI 318-11 D.3.3.4.3(d), in lieu of requiring the anchor design tensile strength to satisfy the tensile strength requirements of ACI 318-11 D.4.1.1, the anchor design tensile strength shall be calculated from ACI 318-11 D.3.3.4.4.

The following exceptions apply to ACI 318-11 D.3.3.5.2:

1. For the calculation of the in-plane shear strength of anchor bolts attaching wood sill plates of bearing or non-bearing walls of light-frame wood structures to foundations or foundation stem walls, the in-plane shear strength in accordance with ACI 318-11 D.6.2 and D.6.3 need not be computed and ACI 318-11 D.3.3.5.3 need not apply provided all of the following are satisfied:
   1.1. The allowable in-plane shear strength of the anchor is determined in accordance with AF&PA NDS Table 11E for lateral design values parallel to grain.
   1.2. The maximum anchor nominal diameter is $^5/_8$ inch (16 mm).
   1.3. Anchor bolts are embedded into concrete a minimum of 7 inches (178 mm).
   1.4. Anchor bolts are located a minimum of $1^3/_4$ inches (45 mm) from the edge of the concrete parallel to the length of the wood sill plate.
   1.5. Anchor bolts are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the wood sill plate.
   1.6. The sill plate is 2-inch or 3-inch nominal thickness.
2. For the calculation of the in-plane shear strength of anchor bolts attaching cold-formed steel track of bearing or non-bearing walls of light-frame construction to foundations or foundation stem walls, the in-plane shear strength in accordance with ACI 318-11 D.6.2 and D.6.3 need not be computed and ACI 318-11 D.3.3.5.3 need not apply provided all of the following are satisfied:
   2.1. The maximum anchor nominal diameter is $^5/_8$ inch (16 mm).
   2.2. Anchors are embedded into concrete a minimum of 7 inches (178 mm).
   2.3. Anchors are located a minimum of $1^3/_4$ inches (45 mm) from the edge of the concrete parallel to the length of the track.
   2.4. Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.
   2.5. The track is 33 to 68 mil designation thickness.

Allowable in-plane shear strength of exempt anchors, parallel to the edge of concrete, shall be permitted to be determined in accordance with AISI S100 Section E3.3.1.

3. In light-frame construction, bearing or nonbearing walls, shear strength of concrete anchors less than or equal to 1 inch [25 mm] in diameter attaching a sill plate or track to foundation or foundation stem wall need not satisfy ACI 318-11 D.3.3.5.3(a) through (c) when the design strength of the anchors is determined in accordance with ACI 318-11 D.6.2.1(c).

4.2 Allowable Stress Design (ASD)

4.2.1 General: For anchors designed using load combinations calculated in accordance with IBC Section 1605.3 (Allowable Stress Design), allowable loads must be established using the following relationships:

$$T_{allowable,ASD} = \phi N_n/\alpha \quad \text{Eq. (4-2)}$$

$$V_{allowable,ASD} = \phi V_n/\alpha \quad \text{Eq. (4-3)}$$

where

$T_{allowable,ASD}$ = Allowable tension load (lbf or kN)

$V_{allowable,ASD}$ = Allowable shear load (lbf or kN)

ϕN_n = The lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318-14 Chapter 17 and 2018 and 2015 IBC Section 1905.1.8; ACI 318-11 Appendix D as amended in this report; ACI 318-08 Appendix D and 2009 IBC Sections 1908.1.9 and 1908.1.10; or ACI 318-05 Appendix D and 2006 IBC Section 1908.1.16, as applicable. For the 2012 IBC, Section 1905.1.9 shall be omitted.

ϕV_n = The lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318-14 Chapter 17 and 2018 and 2015 IBC Section 1905.1.8; ACI 318-11 Appendix D as amended in this report; ACI 318-08 Appendix D and 2009 IBC Sections 1908.1.9 and 1908.1.10; or ACI 318-05 Appendix D and 2006 IBC Section 1908.1.16, as applicable. For the 2012 IBC, Section 1905.1.9 shall be omitted.

α = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, α must include all applicable factors to account for non-ductile failure modes and required over-strength.

The requirements for member thickness, edge distance and spacing, as described in Tables 17, 18, and 19 of this report, must apply.

4.2.2 Interaction of Tensile and Shear Forces: In lieu of ACI 318-14 17.6.1, 17.6.2 and 17.6.3 or ACI 318-11 D.7.1, D.7.2 and D.7.3, as applicable, interaction of tension and shear loads must be calculated as follows:

For tension loads $T \leq 0.2 \cdot T_{allowable,ASD}$, the full allowable strength in shear, $V_{allowable,ASD}$, shall be permitted.

For shear loads $V \leq 0.2 \cdot V_{allowable,ASD}$, the full allowable strength in tension, $T_{allowable,ASD}$, shall be permitted.

For all other cases:

$$\frac{T}{T_{allowable,ASD}} + \frac{V}{V_{allowable,ASD}} \leq 1.2 \qquad \text{Eq. (4-4)}$$

4.3 Installation:

Installation parameters are illustrated in Figures 4 through 9, and Tables 17 through 22 of this report. Installation must be in accordance with ACI 318-14 17.8.1 and 17.8.2 or ACI 318-11 D.9.1 and D.9.2. Anchor locations must comply with this report and the plans and specifications approved by the code official. Installation of the ULTRABOND HS-1CC Adhesive Anchor System must conform to the manufacturer's printed installation instructions included in each unit package as detailed in Figure 9 of this report.

The adhesive anchor system may be used for upwardly inclined orientation applications (e.g. overhead). Upwardly inclined and horizontal orientation applications are to be installed using an appropriate piston plug size for the $^{3}/_{8}$-inch through $1^{1}/_{4}$-inch diameter threaded steel rods, No. 3 through No. 10 steel reinforcing bars, and internally threaded inserts as detailed in Tables 17, 18 and 19, installed in the specified hole diameter, and must be attached to the mixing nozzle and extension tube supplied by ATC as described in Tables 17, 18 and 19 and Figure 9 of this report. The use of extension tubing is not necessary for $^{3}/_{8}$-inch threaded rod and #3 rebar, only piston plug part number PP716 is needed in order to reach deep embedment depth installations.

Installation of anchors in horizontal or upwardly inclined orientations shall be fully restrained from movement throughout the specified curing period through the use of temporary wedges, external supports, or other methods as described in Figure 9. Where temporary restraint devices are used, their use shall not result in impairment of the anchor shear resistance.

Bulk dispensing equipment that provides automatic metering and mixing of the adhesive components requires ongoing monitoring to verify that the equipment is operating within tolerances, particularly with respect to mixture ratios and leak tightness (internal and external). Refer to the MPII in Figure 9 for additional information regarding bulk dispensing.

4.4 Special Inspection:

4.4.1 General: Installations may be made under continuous special inspection or periodic special inspection, as determined by the registered design professional. Tables 7, 8, 9, 12, 13, and 16 of this report provide strength reduction factors, ϕ, corresponding to the type of inspection provided.

Continuous special inspection of adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be performed in accordance with ACI 318-14 17.8.2.4 or ACI 318-11 D.9.2.4, as applicable.

Bulk dispensing equipment that provides automatic metering and mixing of the adhesive components requires ongoing monitoring to verify that the equipment is operating within tolerances, particularly with respect to mixture ratios and leak tightness (internal and external). Refer to the MPII in Figure 9 for additional information regarding bulk dispensing.

Under the IBC, additional requirements as set forth in Section 1705.1.1 and Table 1705.3 of the 2018, 2015 or 2012 IBC and Sections 1705, 1706 or 1707 of the 2009, and 2006 IBC must be observed, where applicable.

4.4.2 Continuous Special Inspection: Installations made under continuous special inspection with an on-site proof loading program must be performed in accordance with Section 1705.1.1 and Table 1705.3 of the 2018, 2015 and 2012 IBC, Section 1704.15 and Table 1704.4 of the 2009 IBC, or Section 1704.13 of the 2006 IBC, whereby continuous special inspection is defined in Section 1702.1 of the IBC, and this report. The special inspector must be on the jobsite continuously during anchor installation to verify anchor type, adhesive expiration date, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque, and adherence to the manufacturer's printed installation instructions.

The proof loading program must be established by the registered design professional. As a minimum, the following requirements must be addressed in the proof loading program:

1. Frequency of proof loading based on anchor type, diameter, and embedment.
2. Proof loads by anchor type, diameter, embedment, and location.
3. Acceptable displacements at proof load.
4. Remedial action in the event of a failure to achieve proof load, or excessive displacement.

Unless otherwise directed by the registered design professional, proof loads must be applied as confined tension tests. Proof load levels must not exceed the lesser of 67 percent of the load corresponding to the nominal bond strength as calculated from the characteristic bond stress for uncracked concrete modified for edge effects and concrete properties, or 80 percent of the minimum specified anchor element yield strength (Ase,N · fya). The proof load must be maintained at the required load level for a minimum of 10 seconds.

4.4.3 Periodic Special Inspection: Periodic special inspection must be performed where required in accordance with Section 1705.1.1 and Table 1705.3 of the 2018, 2015 and 2012 IBC, Section 1704.15 and Table 1704.4 of the 2009 IBC or Section 1704.13 of the 2006 IBC and this report. The special inspector must be on the jobsite initially during anchor installation to verify the anchor type, anchor dimensions, concrete type, concrete compressive strength, adhesive identification and expiration date, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque and adherence to the manufacturer's printed installation instructions. The special inspector must verify the initial installations of each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same construction personnel are permitted to be performed in the absence of the special inspector. Any change in the anchor product being installed or the personnel performing the installation requires an initial inspection. For ongoing installations over an extended period, the special inspector must make regular inspections to confirm correct handling and installation of the product

5.0 CONDITIONS OF USE:

The ULTRABOND HS-1CC Adhesive Anchor System described in this report complies with, or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 ULTRABOND HS-1CC adhesive anchors must be installed in accordance with the manufacturer's printed installation instructions included with each cartridge and bulk container, and provided in detail in Figure 9 of this report.

5.2 Anchors ($^3/_8$-, $^1/_2$-, $^5/_8$-, $^3/_4$-, $^7/_8$-, 1-, and 1$^1/_4$-inch diameter threaded steel rods and No. 3 through No. 10 steel reinforcing bars) installed in hammer drilled holes described in this report must be installed in cracked and uncracked normal-weight concrete having a specified compressive strength f'_c = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

Anchors ($^5/_8$-, $^3/_4$-, $^7/_8$-, 1-, and 1$^1/_4$-inch diameter threaded steel rods) installed with the Milwaukee vacuum bit system described in this report must be installed in cracked and uncracked normal-weight concrete having a specified compressive strength f'_c = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa). Anchors ($^1/_2$-, $^5/_8$-, $^3/_4$-, $^7/_8$-, 1-, and 1$^1/_4$-inch diameter threaded steel rods and No. 4 through No. 10 steel reinforcing bars) in core-drilled holes must be installed in uncracked normal-weight concrete having a specified compressive strength f'_c = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

Anchors ($^3/_8$-, $^1/_2$-, $^5/_8$-, $^3/_4$-, and 1-inch nominal diameter POWER-Sert inserts) in hammer-drilled holes must be installed in uncracked normal-weight concrete having a specified compressive strength f'_c = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

5.3 The values of f′c used for calculation purposes must not exceed 8,000 psi (55 MPa).

5.4 The concrete shall have attained its minimum design strength prior to installation of the adhesive anchors.

5.5 Anchors must be installed in concrete base materials in holes predrilled in accordance with the instructions provided in Figure 9 of this report.

5.6 Loads applied to the anchors must be adjusted in accordance with Section 1605.2 of the IBC for strength design.

5.7 In structures assigned to Seismic Design Categories C, D, E, and F under the IBC or IRC, anchor strength must be adjusted in accordance with Section 4.1.11 of this report.

5.8 ULTRABOND HS-1CC adhesive anchors are permitted to be installed in concrete that is cracked or that may be expected to crack during the service life of the anchor, subject to the conditions of this report. For exceptions, see Section 5.2 of this report.

5.9 Strength design values must be established in accordance with Section 4.1 of this report.

5.10 Allowable stress design values must be established in accordance with Section 4.2 of this report.

5.11 Minimum anchor spacing and edge distance as well as minimum member thickness must comply with the values described in this report.

5.12 Prior to anchor installation, calculations and details demonstrating compliance with this report must be submitted to the code official. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.13 Anchors are not permitted to support fire-resistive construction. Where not otherwise prohibited by the code, ULTRABOND HS-1CC adhesive anchors are permitted for installation in fire-resistive construction provided that at least one of the following conditions is fulfilled:

- Anchors are used to resist wind or seismic forces only.
- Anchors that support gravity load–bearing structural elements are within a fire-resistive envelope or a fire-resistive membrane, are protected by approved fire-resistive materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchors are used to support non-structural elements.

5.14 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of adhesive anchors subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under such conditions is beyond the scope of this report.

5.15 Use of zinc-plated carbon steel threaded rods or steel reinforcing bars is limited to dry, interior locations.

5.16 Use of hot-dipped galvanized carbon steel and stainless steel rods is permitted for exterior exposure or damp environments.

5.17 Steel anchoring materials in contact with preservative-treated and fire-retardant-treated wood shall be of zinc-coated steel or stainless steel. The minimum coating weights for zinc-coated steel shall be in accordance with ASTM A153.

5.18 Periodic or continuous special inspection must be provided in accordance with Section 4.4 in this report. Continuous special inspection for anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads must be provided in accordance with Section 4.4 of this report.

5.19 Installation of anchors in horizontal or upwardly inclined orientations to resist sustained tension loads must be performed by personnel certified by an applicable certification program in accordance with ACI 318-14 17.8.2.2 or 17.8.2.3 or ACI 318-11 D.9.2.2 or D.9.2.3, as applicable.

5.20 Bulk dispensing equipment that provides automatic metering and mixing of the adhesive components requires ongoing monitoring to verify that the equipment is operating within tolerances, particularly with respect to mixture ratios and leak tightness. Bulk adhesives mixed in open containers without automatically controlled metering and mixing of adhesive component is beyond the scope of this report.

5.21 Anchors shall not be used for installations where the concrete temperature can vary from 40°F (5°C) or less to 80°F (27°C) or higher within a 12-hour period. Such applications may include but are not limited to anchorage of building façade systems and other applications subject to direct sun exposure.

5.22 ULTRABOND HS-1CC anchoring system is manufactured under a quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors in Concrete (AC308), dated October 2017, revised March 2018, which incorporates requirements in ACI 355.4-11.

7.0 IDENTIFICATION

7.1 ULTRABOND HS-1CC adhesive is identified by packaging labeled with the company's name (Adhesives Technology Corporation) and address, product name, lot number, expiration date, and the evaluation report number (ESR-4094). POWER-Sert internally threaded inserts are identified by packaging labeled with the company's name (Wej-It) and address, product name, and lot number. Threaded rods, nuts, washers, and deformed reinforcing bars are standard steel anchor elements and must conform to applicable national or international specifications as set forth in Tables 2 and 3 of this report.

7.2 The report holder's contact information is the following:

ADHESIVES TECHNOLOGY CORPORATION (ATC)
450 EAST COPANS ROAD
POMPANO BEACH, FLORIDA 33064
(954) 461-2300
www.atcepoxy.com

TABLE 1—DESIGN TABLE INDEX

DESIGN STRENGTH[1]		THREADED ROD	REINFORCING BAR (REBAR)	INTERNALLY THREADED INSERTS
Steel	N_{sa}, V_{sa}	Table 5	Table 10	Table 14
Concrete	N_{pn}, N_{sb}, N_{sbg}, N_{cb}, N_{cbg}, V_{cb}, V_{cbg}, V_{cp}, V_{cpg}	Table 6	Table 11	Table 15
Bond[2]	N_a, N_{ag}	Tables 7, 8, 9	Tables 12, 13	Table 16

[1]Ref. ACI 318-14 17.3.1.1 or ACI 318-11 D.4.1.1, as applicable.
[2]See Section 4.1 of this evaluation report.

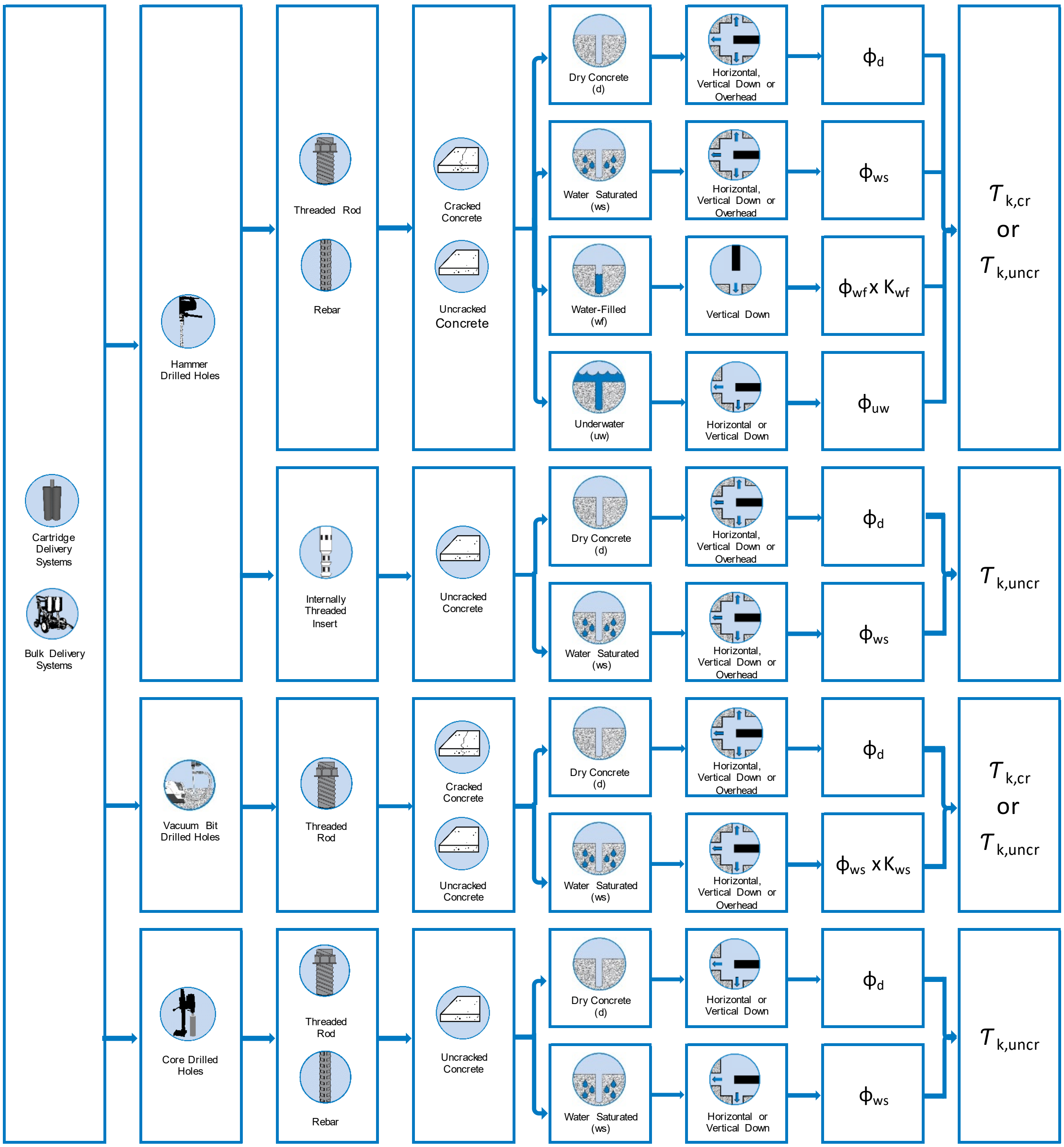


FIGURE 1—ULTRABOND HS-1CC ADHESIVE ANCHORING SYSTEM FLOW CHART FOR DETERMINATION OF BOND STRENGTH

TABLE 2—SPECIFICATIONS AND PHYSICAL PROPERTIES OF CARBON AND STAINLESS STEEL THREADED ROD MATERIALS[1]

THREADED ROD SPECIFICATION			MINIMUM SPECIFIED ULTIMATE STRENGTH, f_{uta}	MINIMUM SPECIFIED YIELD STRENGTH 0.2 PERCENT OFFSET, f_{ya}	f_{uta}/f_{ya}	ELONGATION, MIN. PERCENT[5]	REDUCTION OF AREA, MIN. PERCENT	SPECIFICATION FOR NUTS[6]	SPECIFICATION FOR WASHERS[6]
CARBON STEEL	ASTM A193[2] Gr. B7 / F1554 Gr. 105 all sizes	psi (MPa)	125,000 (862)	105,000 (724)	1.19	16	50	ASTM A563 Grade D	ASTM F436
	ASTM A36[3] / F1554, Gr. 36 all sizes	psi (MPa)	58,000 (400)	36,000 (250)	1.61	23	50	ASTM A563 Grade A	ASTM B18.22.1 Type A Plain
STAINLESS STEEL (304/316)	ASTM F593[4] CW1 3/8 to 5/8 in.	psi (MPa)	100,000 (690)	65,000 (450)	1.54	20	-[7]	ASTM F594 Alloy Group 1, 2 or 3	ASTM B18.22.1 Type A Plain
	ASTM F593[4] CW2 3/4 to 1 1/4 in.	psi (MPa)	85,000 (590)	45,000 (310)	1.89	25	-[7]		

[1]Adhesive must be used with continuously threaded carbon or stainless steel rod (all-thread) having thread characteristics complying with ANSI B1.1 UNC Coarse Thread Series.
[2]Standard Specification for Alloy-Steel and Stainless steel Bolting Materials for High temperature of High Pressure service and Other Special Purpose Applications.
[3]Standard Specification for Carbon Structural steel
[4]Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
[5]Based on 2-in. (50 mm) gauge length except for ASTM A193, which is based on a gauge length of 4d.
[6]Nuts and washers of other grades and style having specified proof load stress 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]Minimum percent reduction of area not reported in the referenced ASTM standard.

TABLE 3—SPECIFICATIONS AND PHYSICAL PROPERTIES OF CARBON STEEL REINFORCING BARS

REINFORCING BAR SPECIFICATION	UNITS	MINIMUM SPECIFIED ULTIMATE STRENGTH, f_{uta}	MINIMUM SPECIFIED YEILD STRENGTH, f_{ya}
ASTM A615[1], Grade 40	psi (MPa)	60,000 (415)	40,000 (280)
ASTM A706[2] Grade 60	psi (MPa)	80,000 (550)	60,000 (420)
ASTM A615[1] Grade 60	psi (MPa)	90,000 (620)	60,000 (420)
ASTM A615[1], Grade 75	psi (MPa)	100,000 (690)	75,000 (520)

[1]Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
[2]Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.

TABLE 4—SPECIFICATIONS AND PHYSICAL PROPERTIES OF POWER-SERT INTERNALLY THREADED INSERTS

INSERT STEEL SPECIFICATION	UNITS	MINIMUM SPECIFIED ULTIMATE STRENGTH, f_{uta}	MINIMUM SPECIFIED YEILD STRENGTH, f_{ya}
AISI 1020 all sizes	psi (MPa)	64,000 (440)	54,000 (370)
ASTM F593[1] CW1 3/8- and ½ -inch internal thread	psi (MPa)	100,000 (690)	65,000 (450)
ASTM F593[1] CW2 5/8- through 1-inch internal thread	psi (MPa)	85,000 (590)	45,000 (310)

[1]Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

TABLE 5—STEEL DESIGN INFORMATION FOR THREADED ROD[1]

DESIGN INFORMATION		Symbol	Units	Threaded Rod Diameter (inch)						
				3/8	1/2	5/8	¾	7/8	1	1 1/4
Nominal Anchor Diameter		d	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.250 (31.8)
Threaded rod cross-sectional area		A_{se}	in.² (mm²)	0.0775 (50)	0.1419 (92)	0.226 (146)	0.334 (216)	0.462 (298)	0.606 (391)	0.969 (625)
ASTM A36 Grade 36 ASTM F1554 Grade 36	Nominal Strength as Governed by Steel Strength	N_{sa}	lb (kN)	4,495 (20.0)	8,230 (36.6)	13,110 (58.3)	19,370 (86.2)	26,795 (119.2)	35,150 (156.4)	56,200 (250.0)
		V_{sa}	lb (kN)	2,695 (12.0)	4,940 (22.0)	7,865 (35.0)	11,625 (51.7)	16,080 (71.5)	21,090 (93.8)	33,720 (150.0)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	-	0.83	0.78	0.74	0.70	0.69	0.67	0.65
	Strength Reduction Factor for Tension[2]	ϕ	-	0.75						
	Strength Reduction Factor for Shear[2]	ϕ	-	0.65						
ASTM A193 Grade B7 ASTM F1554, Grade 105	Nominal Strength as Governed by Steel Strength	N_{sa}	lb (kN)	9,685 (43.1)	17,735 (78.9)	28,250 (125.7)	41,750 (185.7)	57,750 (256.9)	75,750 (337.0)	121,125 (538.8)
		V_{sa}	lb (kN)	5,815 (25.9)	10,645 (47.3)	16,950 (75.4)	25,050 (111.4)	34,650 (154.1)	45,450 (202.2)	72,675 (323.3)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	-	0.60	0.58	0.57	0.55	0.53	0.50	0.46
	Strength Reduction Factor for Tension[2]	ϕ	-	0.75						
	Strength Reduction Factor for Shear[2]	ϕ	-	0.65						
ASTM F593 CW Stainless Type 304 & 316	Nominal Strength as Governed by Steel Strength	N_{sa}	lb (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	28,390 (126.3)	39,270 (174.7)	51,510 (229.1)	82,365 (366.4)
		V_{sa}	lb (kN)	4,650 (20.7)	8,515 (37.9)	13,560 (60.3)	17,035 (75.8)	23,560 (104.8)	30,905 (137.5)	49,420 (219.8)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	-	0.65	0.62	0.60	0.58	0.57	0.55	0.53
	Strength Reduction Factor for Tension[2]	ϕ	-	0.65						
	Strength Reduction Factor for Shear[2]	ϕ	-	0.60						

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 006894 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 specified strengths and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2 b or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable. Nuts and washers must comply with requirements for the rod.
[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 6—CONCRETE BREAKOUT DESIGN INFORMATION FOR THREADED ROD[1]

DESIGN INFORMATION	Symbol	Units	Threaded Rod Diameter (inch)						
			$^{3}/_{8}$	$^{1}/_{2}$	$^{5}/_{8}$	$^{3}/_{4}$	$^{7}/_{8}$	1	$1^{1}/_{4}$
Minimum Embedment Depth	$h_{ef,min}$	in. (mm)	$2^{3}/_{8}$ (60)	$2^{3}/_{4}$ (70)	$3^{1}/_{8}$ (79)	$3^{1}/_{2}$ (89)	$3^{3}/_{4}$ (95)	4 (102)	5 (127)
Maximum Embedment Depth	$h_{ef,max}$	in. (mm)	$7^{1}/_{2}$ (191)	10 (254)	$12^{1}/_{2}$ (318)	15 (381)	$17^{1}/_{2}$ (445)	20 (508)	25 (635)
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	- (SI)	17 (7)						
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	- (SI)	24 (10)						
Minimum Spacing Distance	s_{min}	in. (mm)	$2^{3}/_{16}$ (57)	$2^{13}/_{16}$ (71)	$3^{3}/_{4}$ (95)	$4^{3}/_{8}$ (111)	5 (127)	$5^{5}/_{8}$ (143)	$6^{7}/_{8}$ (174)
Minimum Edge Distance	c_{min}	in. (mm)	$2^{3}/_{16}$ (57)	$2^{13}/_{16}$ (71)	$3^{3}/_{4}$ (95)	$4^{3}/_{8}$ (111)	5 (127)	$5^{5}/_{8}$ (143)	$6^{7}/_{8}$ (174)
Minimum Concrete Thickness	h_{min}	in. (mm)	$h_{ef} + 1^{1}/_{4}$, [$\geq$ 3.94] (h_{ef} + 30, [$\geq$ 100])		$h_{ef} + 2d_0$ where d_0 is the hole diameter				
Critical Edge Distance (Uncracked Concrete Only)	c_{ac}	-	See Section 4.1.10 of this report.						
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 = 006894 MPa.
For **pound-inch** units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

[1]Additional setting information is described in Figure 5, manufacturers printed installation instructions (MPII).
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 7—BOND STRENGTH DESIGN INFORMATION FOR THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT-MAXIMUM LONG TERM SERVICE TEMPERATURE 110 °F (43 °C)[1,2,3]

DESIGN INFORMATION			Symbol	Units	Threaded Rod Diameter (inch)						
					$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
Minimum Embedment Depth			$h_{ef,min}$	in. (mm)	$2^3/_8$ (60)	$2^3/_4$ (70)	$3^1/_8$ (79)	$3^1/_2$ (89)	$3^3/_4$ (95)	4 (102)	5 (127)
Maximum Embedment Depth			$h_{ef,max}$	in. (mm)	$7^1/_2$ (191)	10 (254)	$12^1/_2$ (318)	15 (381)	$17^1/_2$ (445)	20 (508)	25 (635)
Maximum Short Term Temperature **150 °F** (66 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,cr}$	psi (N/mm²)	1,415 (9.7)	1,250 (8.6)	1,415 (9.7)	1,415 (9.7)	1,200 (8.3)	1,330 (9.2)	1,275 (8.8)
		No Sustained Load		psi (N/mm²)	1,625 (11.2)	1,435 (9.9)	1,625 (11.2)	1,625 (11.2)	1,380 (9.5)	1,525 (10.5)	1,465 (10.1)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	2,495 (17.2)	2,400 (16.5)	2,300 (15.9)	2,205 (15.2)	2,105 (14.5)	2,010 (13.8)	1,810 (12.5)
		No Sustained Load		psi (N/mm²)	2,865 (19.8)	2,755 (19.0)	2,640 (18.2)	2,530 (17.4)	2,415 (16.7)	2,305 (15.9)	2,080 (14.3)
Maximum Short Term Temperature **180 °F** (82 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,cr}$	psi (N/mm²)	1,245 (8.6)	1,100 (7.6)	1,245 (8.6)	1,245 (8.6)	1,060 (7.3)	1,165 (8.1)	1,125 (7.8)
		No Sustained Load		psi (N/mm²)	1,430 (9.9)	1,265 (8.7)	1,430 (9.9)	1,430 (9.9)	1,215 (8.4)	1,340 (9.3)	1,290 (8.9)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	2,200 (15.2)	2,110 (14.6)	2,025 (14.0)	1,940 (13.4)	1,855 (12.8)	1,770 (12.2)	1,595 (11.0)
		No Sustained Load		psi (N/mm²)	2,525 (17.4)	2,425 (16.7)	2,325 (16.0)	2,225 (15.4)	2,130 (14.7)	2,030 (14.0)	1,830 (12.6)
Maximum Short Term Temperature **205 °F** (96 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,cr}$	psi (N/mm²)	530 (3.7)	470 (3.2)	530 (3.7)	530 (3.7)	455 (3.1)	495 (3.4)	480 (3.3)
		No Sustained Load		psi (N/mm²)	610 (4.2)	540 (3.7)	610 (4.2)	610 (4.2)	520 (3.6)	570 (3.9)	550 (3.8)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	935 (6.5)	900 (6.2)	860 (6.0)	830 (5.7)	790 (5.4)	755 (5.2)	680 (4.7)
		No Sustained Load		psi (N/mm²)	1,075 (7.4)	1,035 (7.1)	990 (6.8)	950 (6.5)	905 (6.3)	865 (6.0)	780 (5.4)
Reduction Factor for Seismic Tension[5]			$\alpha_{N,seis}$	-	1.0			0.77	1.0	0.97	0.96
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65						
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.65		0.55				
		Water-Filled Holes in Concrete	ϕ_{wf}	-	0.55					0.45	
		Modification Factor for Water-Filled Holes in Concrete	K_{wf}	-	1.0					0.96	0.88
		Underwater installation in Concrete	ϕ_{uw}	-	0.65						
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65						
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.55		0.45				
		Water-Filled Holes in Concrete	ϕ_{wf}	-	0.45						
		Modification Factor for Water-Filled Holes in Concrete	K_{wf}	-	1.0					0.92	0.75
		Underwater installation in Concrete	ϕ_{uw}	-	0.55						

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 006894 MPa.
For **pound-inch** units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

[1]Characteristic bond strength values correspond to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For uncracked concrete compressive strength, f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1], the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.10}$ (for SI: $(f'_c / 17.2)^{0.10}$). See Section 4.1.4 of this report.
[2]Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D section D.3.6 as applicable.
[3]Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[4]Characteristic bond strengths are for sustained loads (when noted) including dead and live loads.
[5]For structures assigned to Seismic Design Category C, D, E, or F, the bond strength values must be multiplied by $\alpha_{N,seis}$.

TABLE 8—BOND STRENGTH DESIGN INFORMATION FOR THREADED ROD IN HOLES DRILLED WITH THE MILWAUKEE VACUUM BIT SYSTEM- MAXIMUM LONG TERM SERVICE TEMPERATURE 110 °F (43 °C)[1,2,3]

DESIGN INFORMATION			Symbol	Units	Threaded Rod Diameter (inch)				
					$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
Minimum Embedment Depth			$h_{ef,min}$	in. (mm)	$3^1/_8$ (79)	$3^1/_2$ (89)	$3^3/_4$ (95)	4 (102)	5 (127)
Maximum Embedment Depth			$h_{ef,max}$	in. (mm)	$12^1/_2$ (318)	15 (381)	$17^1/_2$ (445)	20 (508)	25 (635)
Maximum Short Term Temperature **150 °F** (66 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,cr}$	psi (N/mm²)	1,175 (8.1)	1,005 (6.9)	1,035 (7.1)	1,185 (8.2)	1,140 (7.9)
		No Sustained Load		psi (N/mm²)	1,350 (9.3)	1,155 (8.0)	1,185 (8.2)	1,360 (9.4)	1,310 (9.0)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	2,105 (14.5)	2,030 (14.0)	1,955 (13.5)	1,880 (13.0)	1,730 (11.9)
		No Sustained Load		psi (N/mm²)	2,415 (16.7)	2,330 (16.1)	2,245 (15.5)	2,160 (14.9)	1,985 (13.7)
Maximum Short Term Temperature **180 °F** (82 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,cr}$	psi (N/mm²)	1,035 (7.1)	885 (6.1)	910 (6.3)	1,045 (7.2)	1,005 (6.9)
		No Sustained Load		psi (N/mm²)	1,190 (8.2)	1,015 (7.0)	1,045 (7.2)	1,200 (8.3)	1,155 (7.9)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	1,850 (12.8)	1,785 (12.3)	1,720 (11.9)	1,655 (11.4)	1,525 (10.5)
		No Sustained Load		psi (N/mm²)	2,125 (14.7)	2,050 (14.1)	1,975 (13.6)	1,900 (13.1)	1,750 (12.1)
Maximum Short Term Temperature **205 °F** (96 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,cr}$	psi (N/mm²)	440 (3.0)	375 (2.6)	385 (2.7)	445 (3.1)	430 (2.9)
		No Sustained Load		psi (N/mm²)	505 (3.5)	435 (3.0)	445 (3.1)	510 (3.5)	490 (3.4)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	790 (5.4)	760 (5.2)	735 (5.1)	705 (4.9)	650 (4.5)
		No Sustained Load		psi (N/mm²)	905 (6.2)	875 (6.0)	840 (5.8)	810 (5.6)	745 (5.1)
Reduction Factor for Seismic Tension[5]			$\alpha_{N,seis}$	-	1.0	0.77	1.0	0.97	0.96
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65				
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.45		0.55	0.65	
		Modification Factor for Water-Saturated Holes in Concrete	K_{ws}	-	1.0				
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65				
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.45			0.55	
		Modification Factor for Water-Saturated Holes in Concrete	K_{ws}	-	0.89	0.96	1.0		

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 006894 MPa.
For **pound-inch** units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

[1]Characteristic bond strength values correspond to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For uncracked concrete compressive strength, f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1], the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2500)^{0.10}$ (for SI: $(f'_c / 17.2)^{0.10}$). See Section 4.1.4 of this report.
[2]Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D Section D.3.6 as applicable.
[3]Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[4]Characteristic bond strengths are for sustained loads (when noted) including dead and live loads.
[5]For structures assigned to Seismic Design Category C, D, E, or F, the bond strength values must be multiplied by $\alpha_{N,seis}$.

TABLE 9—BOND STRENGTH DESIGN INFORMATION FOR THREADED ROD IN HOLES DRILLED WITH A DIAMOND CORE BIT- MAXIMUM LONG TERM SERVICE TEMPERATURE 110 °F (43 °C)[1,2,3]

DESIGN INFORMATION			Symbol	Units	Threaded Rod Diameter (inch)					
					$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
Minimum Embedment Depth			$h_{ef,min}$	in. (mm)	$2^3/_4$ (70)	$3^1/_8$ (79)	$3^1/_2$ (89)	$3^3/_4$ (95)	4 (102)	5 (127)
Maximum Embedment Depth			$h_{ef,max}$	in. (mm)	10 (254)	$12^1/_2$ (318)	15 (381)	$17^1/_2$ (445)	20 (508)	25 (635)
Maximum Short Term Temperature **150 °F** (66 °C)	Unracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	995 (7.0)					
		Without Sustained Load		psi (N/mm²)	1,145 (7.9)					
Maximum Short Term Temperature **180 °F** (82 °C)	Unracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	880 (6.1)					
		Without Sustained Load		psi (N/mm²)	1,010 (6.9)					
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65					
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.65					
		Modification Factor for Water-Saturated Holes in Concrete	K_{ws}	-	1.0					
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65					
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.55					
		Modification Factor for Water-Saturated Holes in Concrete	K_{ws}	-	1.0					

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 006894 MPa.
For **pound-inch** units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

[1]Characteristic bond strength values correspond to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For uncracked concrete compressive strength, f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1], the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.10}$ (for SI: $(f'_c / 17.2)^{0.10}$). See Section 4.1.4 of this report.
[2]Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D Section D.3.6 as applicable.
[3]Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[4]Characteristic bond strengths are for sustained loads (when noted) including dead and live loads.

TABLE 10—STEEL DESIGN INFORMATION FOR REINFORCING BAR[1]

DESIGN INFORMATION		Symbol	Units	Rebar Size							
				# 3	# 4	# 5	# 6	# 7	# 8	# 9	# 10
Nominal Bar Diameter		d	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.127 (28.6)	1.270 (32.3)
Reinforcing Bar Cross-Sectional Area		A_{se}	in.² (mm²)	0.110 (71)	0.200 (129)	0.310 (200)	0.440 (284)	0.600 (387)	0.790 (510)	1.000 (645)	1.270 (819)
ASTM A615 Grade 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)	Grade 40 bars are only available in sizes # 3 through # 6 per ASTM A615			
		V_{sa}	lb (kN)	3,960 (17.6)	7,200 (32.0)	11,160 (49.6)	15,840 (70.5)				
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	-	0.70	0.74	0.78	0.82				
	Strength Reduction Factor for Tension[2]	ϕ	-	0.75							
	Strength Reduction Factor for Shear[2]	ϕ	-	0.65							
ASTM A706 Grade 60	Nominal Strength as Governed by Steel Strength	N_{sa}	lb (kN)	8,800 (39.1)	16,000 (71.2)	24,800 (110.3)	35,200 (156.6)	48,000 (213.5)	63,200 (281.1)	80,000 (355.9)	101,600 (452.0)
		V_{sa}	lb (kN)	5,280 (23.5)	9,600 (42.7)	14,880 (66.2)	21,120 (94.0)	28,800 (128.1)	37,920 (168.7)	48,000 (213.5)	60,960 (271.2)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	--	0.70	0.74	0.78	0.82	0.73	0.63	0.53	0.42
	Strength Reduction Factor for Tension[2]	ϕ	-	0.75							
	Strength Reduction Factor for Shear[2]	ϕ	-	0.65							
ASTM A615 Grade 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 (176.1)	54,000 (240.2)	71,100 (316.3)	90,000 (400.3)	114,300 (508.4)
		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 (305.0)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	--	0.70	0.74	0.78	0.82	0.73	0.63	0.53	0.42
	Strength Reduction Factor for Tension[2]	ϕ	-	0.65							
	Strength Reduction Factor for Shear[2]	ϕ	-	0.60							
ASTM A615 Grade 75	Nominal Strength as Governed by Steel Strength	N_{sa}	lb (kN)	11,000 (48.9)	20,000 (89.0)	31,000 (137.9)	44,000 (195.7)	60,000 (266.9)	79,000 (351.4)	100,000 (444.8)	127,000 (564.9)
		V_{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 (210.8)	60,000 (266.9)	76,200 (338.9)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	--	0.70	0.74	0.78	0.82	0.73	0.63	0.54	0.42
	Strength Reduction Factor for Tension[2]	ϕ	-	0.65							
	Strength Reduction Factor for Shear[2]	ϕ	-	0.60							

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 006894 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 bar material types based on specified strengths and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2 b or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable.
[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 11—CONCRETE BREAKOUT DESIGN INFORMATION FOR REINFORCING BAR IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION	Symbol	Units	Rebar Size							
			# 3	# 4	# 5	# 6	# 7	# 8	# 9	#10
Minimum Embedment Depth	$h_{ef,min}$	in. (mm)	$2^3/_8$ (60)	$2^3/_4$ (70)	$3^1/_8$ (79)	$3^1/_2$ (89)	$3^3/_4$ (95)	4 (102)	$4^1/_2$ (114)	5 (127)
Maximum Embedment Depth	$h_{ef,max}$	in. (mm)	$7^1/_2$ (191)	10 (254)	$12^1/_2$ (318)	15 (381)	$17^1/_2$ (445)	20 (508)	$22^1/_2$ (572)	25 (635)
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	in-lb (SI)	17 (7)							
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	in.-lb. (SI)	24 (10)							
Minimum Spacing Distance	s_{min}	in. (mm)	$2^3/_{16}$ (57)	$2^{13}/_{16}$ (71)	$3^3/_4$ (95)	$4^3/_8$ (111)	5 (127)	$5^5/_8$ (143)	$6^1/_4$ (159)	$6^7/_8$ (174)
Minimum Edge Distance	c_{min}	in. (mm)	$2^3/_{16}$ (57)	$2^{13}/_{16}$ (71)	$3^3/_4$ (95)	$4^3/_8$ (111)	5 (127)	$5^5/_8$ (143)	$6^1/_4$ (159)	$6^7/_8$ (174)
Minimum Concrete Thickness	h_{min}	in. (mm)	$h_{ef} + 1^1/_4$, [$\geq$ 3.94] (h_{ef} + 30, [$\geq$ 100])		$h_{ef} + 2d_0$ where d_0 is the hole diameter					
Critical Edge Distance (Uncracked Concrete Only)[2]	c_{ac}	-	See Section 4.1.10 of this report.							
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]Additional setting information is described in Figure 3, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.ondition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11.9.2 are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 12—BOND STRENGTH DESIGN INFORMATION FOR REINFORCING BAR IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT- MAXIMUM LONG TERM SERVICE TEMPERATURE 110 °F (43 °C)[1,2,3]

DESIGN INFORMATION			Symbol	Units	Rebar Size # 3	# 4	# 5	# 6	# 7	# 8	# 9	# 10
Minimum Embedment Depth			$h_{ef,min}$	in. (mm)	$2\frac{3}{8}$ (60)	$2\frac{3}{4}$ (70)	$3\frac{1}{8}$ (79)	$3\frac{1}{2}$ (89)	$3\frac{3}{4}$ (95)	4 (102)	$4\frac{1}{2}$ (114)	5 (127)
Maximum Embedment Depth			$h_{ef,max}$	in. (mm)	$7\frac{1}{2}$ (191)	10 (254)	$12\frac{1}{2}$ (318)	15 (381)	$17\frac{1}{2}$ (445)	20 (508)	$22\frac{1}{2}$ (572)	25 (635)
Maximum Short Term Temperature **150 °F** (66 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,cr}$	psi (N/mm²)	1,450 (10.0)	1,425 (9.8)	1,400 (9.6)	1,365 (9.4)	1,295 (8.9)	1,230 (8.5)	1,160 (8.0)	1,080 (7.4)
		No Sustained Load		psi (N/mm²)	1,665 (11.5)	1,635 (11.3)	1,605 (11.1)	1,570 (10.8)	1,490 (10.3)	1,410 (9.7)	1,330 (9.2)	1,240 (8.5)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	2,180 (15.0)	2,095 (14.5)	2,010 (13.9)	1,930 (13.3)	1,845 (12.7)	1,760 (12.1)	1,675 (11.5)	1,580 (10.9)
		No Sustained Load		psi (N/mm²)	2,505 (17.3)	2,405 (16.6)	2,310 (15.9)	2,215 (15.3)	2,120 (14.6)	2,020 (13.9)	1,925 (13.3)	1,815 (12.5)
Maximum Short Term Temperature **180 °F** (82 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,cr}$	psi (N/mm²)	1,275 (8.8)	1,255 (8.7)	1,230 (8.5)	1,205 (8.3)	1,140 (7.9)	1,080 (7.5)	1,020 (7.0)	950 (6.5)
		No Sustained Load		psi (N/mm²)	1,465 (10.1)	1,440 (9.9)	1,415 (9.7)	1,380 (9.5)	1,310 (9.0)	1,240 (8.6)	1,170 (8.1)	1,090 (7.5)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	1,920 (13.2)	1,845 (12.7)	1,770 (12.2)	1,700 (11.7)	1,625 (11.2)	1,550 (10.7)	1,475 (10.2)	1,390 (9.6)
		No Sustained Load		psi (N/mm²)	2,205 (15.2)	2,120 (14.6)	2,035 (14.0)	1,950 (13.4)	1,865 (12.9)	1,780 (12.3)	1,695 (11.7)	1,595 (11.0)
Maximum Short Term Temperature **205 °F** (96 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,cr}$	psi (N/mm²)	545 (3.7)	535 (3.7)	525 (3.6)	515 (3.5)	485 (3.4)	460 (3.2)	435 (3.0)	405 (2.8)
		No Sustained Load		psi (N/mm²)	625 (4.3)	615 (4.2)	600 (4.2)	590 (4.1)	560 (3.9)	530 (3.6)	500 (3.4)	465 (3.2)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	820 (5.6)	785 (5.4)	755 (5.2)	725 (5.0)	690 (4.8)	660 (4.6)	630 (4.3)	590 (4.1)
		No Sustained Load		psi (N/mm²)	940 (6.5)	905 (6.2)	865 (6.0)	830 (5.7)	795 (5.5)	760 (5.2)	720 (5.0)	680 (4.7)
Reduction Factor for Seismic Tension[5]			$\alpha_{N,seis}$	-	1.0					0.97		0.96
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65							
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.65		0.55					
		Water-Filled Holes in Concrete	ϕ_{wf}	-	0.55					0.45		
		Modification Factor for Water-Filled Holes in Concrete	K_{wf}	-	1.0					0.96	0.92	0.88
		Underwater installation in Concrete	ϕ_{uw}	-	0.65							
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65							
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.55		0.45					
		Water-Filled Holes in Concrete	ϕ_{wf}	-	0.45							
		Modification Factor for Water-Filled Holes in Concrete	K_{wf}	-	1.0					0.92	0.83	0.75
		Underwater installation in Concrete	ϕ_{uw}	-	0.55							

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006897 MPa.
For **pound-inch** units: 1 mm = 0.03937 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

[1]Characteristic bond strength values correspond to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For uncracked concrete compressive strength, f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1], the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.10}$ (for SI: $(f'_c / 17.2)^{0.10}$). See Section 4.1.4 of this report.
[2]Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D Section D.3.6 as applicable.
[3]Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[4]Characteristic bond strengths are for sustained loads (when noted) including dead and live loads.
[5]For structures assigned to Seismic Design Category C, D, E, or F, the bond strength values must be multiplied by $\alpha_{N,seis}$.

TABLE 13—BOND STRENGTH DESIGN INFORMATION FOR REINFORCING BAR IN HOLES DRILLED WITH A DIAMOND CORE BIT- MAXIMUM LONG TERM SERVICE TEMPERATURE 110 °F (43 °C)[1,2,3]

DESIGN INFORMATION			Symbol	Units	Rebar Size						
					# 4	# 5	# 6	# 7	# 8	# 9	# 10
Minimum Embedment Depth			$h_{ef,min}$	in. (mm)	$2^3/_4$ (70)	$3^1/_8$ (79)	$3^1/_2$ (89)	$3^3/_4$ (95)	4 (102)	$4^1/_2$ (114)	5 (127)
Maximum Embedment Depth			$h_{ef,max}$	in. (mm)	10 (254)	$12^1/_2$ (318)	15 (381)	$17^1/_2$ (445)	20 (508)	$22^1/_2$ (572)	25 (635)
Maximum Short Term Temperature **150 °F** (66 °C)	Unracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	1,535 (10.6)	1,490 (10.3)	1,380 (9.5)	1,270 (8.8)	1,160 (8.0)	1,045 (7.2)	920 (6.3)
		No Sustained Load		psi (N/mm²)	1,760 (12.1)	1,715 (11.8)	1,585 (10.9)	1,460 (10.1)	1,330 (9.2)	1,200 (8.3)	1,055 (7.3)
Maximum Short Term Temperature **180 °F** (82 °C)	Unracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	1,350 (9.3)	1,315 (9.1)	1,215 (8.4)	1,120 (7.7)	1,020 (7.0)	920 (6.4)	810 (5.6)
		No Sustained Load		psi (N/mm²)	1,550 (10.7)	1,510 (10.4)	1,395 (9.6)	1,285 (8.9)	1,170 (8.1)	1,060 (7.3)	930 (6.4)
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65						
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.65						
		Modification Factor for Water-Saturated Holes in Concrete	K_{ws}	-	1.0						
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65						
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.55						
		Modification Factor for Water-Saturated Holes in Concrete	K_{ws}	-	1.0						

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]Characteristic bond strength values correspond to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For uncracked concrete compressive strength, f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1], the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.10}$ (for SI: $(f'_c / 17.2)^{0.10}$). See Section 4.1.4 of this report.
[2]Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D Section D.3.6 as applicable.
[3]Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[4]Characteristic bond strengths are for sustained loads (when noted) including dead and live loads.

TABLE 14—STEEL DESIGN INFORMATION FOR POWER-SERT INTERNALLY THREADED INSERTS[1]

DESIGN INFORMATION		Symbol	Units	Insert Designation				
				PS2-38	PS2-12	PS2-58	PS2-34	PS2-1
Internal Thread Size (UNC)		d_t	in.-TPI	$^3/_8$-16	$^1/_2$-13	$^5/_8$-11	¾-10	1-8
Nominal Anchor Diameter		d_a	in. (mm)	0.488 (12.4)	0.595 (15.1)	0.819 (20.8)	0.898 (22.8)	1.450 (36.8)
Cross-sectional area		A_{se}	in.² (mm²)	0.102 (66)	0.135 (87)	0.302 (195)	0.385 (248)	0.785 (507)
Specified Tensile Strength		f_{uta}	Psi (Mpa)	64,000 (440)				
Carbon Steel Inserts (PS2)	Nominal Strength as Governed by Steel Strength	N_{sa}	lb (kN)	6,525 (29.0)	8,670 (38.6)	19,320 (85.9)	24,630 (109.6)	50,265 (223.6)
		V_{sa}	lb (kN)	3,915 (17.4)	5,200 (23.1)	11,595 (51.6)	14,780 (65.7)	30,160 (134.2)
	Strength Reduction Factor for Tension[2]	ϕ	-	0.75				
	Strength Reduction Factor for Shear[2]	ϕ	-	0.65				
DESIGN INFORMATION		Symbol	Units	Insert Designation				
				PS6-38	PS6-12	PS6-58	PS6-34	PS6-1
Specified Tensile Strength		f_{uta}	Psi (Mpa)	100,000 (690)		85,000 (590)		
316 Stainless Steel Inserts (PS6)	Nominal Strength as Governed by Steel Strength	N_{sa}	lb (kN)	10,195 (45.3)	13,550 (60.3)	25,660 (114.1)	32,710 (145.5)	66,760 (297.0)
		V_{sa}	lb (kN)	6,115 (27.2)	8,130 (36.2)	15,395 (68.5)	19,625 (87.3)	40,055 (178.2)
	Strength Reduction Factor for Tension[2]	ϕ	-	0.65				
	Strength Reduction Factor for Shear[2]	ϕ	-	0.60				

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 006894 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 bar material types based on specified strengths and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2 b or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable.
[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 15—CONCRETE BREAKOUT DESIGN INFORMATION FOR POWER-SERT INTERNALLY THREADED INSERTS[1]

DESIGN INFORMATION	Symbol	Units	Insert Designation				
			PS2-38 PS6-38	PS2-12 PS6-12	PS2-58 PS6-58	PS2-34 PS6-34	PS2-1 PS2-1
Internal Thread Size (UNC)	d_t	in.-TPI	$^3/_8$-16	$^1/_2$-13	$^5/_8$-11	¾-10	1-8
Nominal Anchor Diameter	d_a	in. (mm)	0.488 (12.4)	0.595 (15.1)	0.819 (20.8)	0.898 (22.8)	1.450 (36.8)
Effective Embedment Depth for Concrete Breakout	h_{ef}	in. (mm)	2.5 (63.5)	3.5 (88.9)	5.5 (139.7)	6.2 (157.5)	8.2 (208.3)
Minimum Nominal Embedment Depth	h_a	in. (mm)	$2^3/_4$ (69.9)	$3^{11}/_{16}$ (93.7)	$5^3/_4$ (146.1)	$6^1/_2$ (165.1)	$8^1/_2$ (215.9)
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	in.-lb. (SI)	24 (10)				
Minimum Spacing Distance	s_{min}	in. (mm)	$2^1/_2$ (63.5)	$3^1/_8$ (79.4)	$4^3/_8$ (111)	5 (127)	$7^1/_2$ (191)
Minimum Edge Distance	c_{min}	in. (mm)	$2^1/_2$ (63.5)	$3^1/_8$ (79.4)	$4^3/_8$ (111)	5 (127)	$7^1/_2$ (191)
Minimum Concrete Thickness	h_{min}	in. (mm)	$4^1/_2$ (114)	$5^3/_8$ (137)	8 (203)	$9^1/_2$ (241)	$12^1/_2$ (318)
Critical Edge Distance (Uncracked Concrete Only)[2]	c_{ac}	-	See Section 4.1.10 of this report.				
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]Additional setting information is described in Figure 3, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.ondition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11.9.2 are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 16—BOND STRENGTH DESIGN INFORMATION FOR POWER-SERT INTERNALLY THREADED INSERTS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1,2,3]

DESIGN INFORMATION			Symbol	Units	Insert Designation				
					PS2-38 PS6-38	PS2-12 PS6-12	PS2-58 PS6-58	PS2-34 PS6-34	PS2-1 PS6-1
Internal Thread Size (UNC)			d_t	in.-TPI	3/8-16	1/2-13	5/8-11	3/4-10	1-8
Nominal Anchor Diameter			d_a	in. (mm)	0.488 (12.4)	0.595 (15.1)	0.819 (20.8)	0.898 (22.8)	1.450 (36.8)
Bond Effective Embedment Depth			h_{ef}	in. (mm)	1.55 (39.4)	2.49 (63.2)	3.75 (95.3)	3.74 (95.1)	5.00 (127.0)
Maximum Short Term Temperature **150 °F** (66 °C)	Unracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	2,410 (16.6)	2,325 (16.0)	2,150 (14.8)	2,090 (14.4)	1,655 (11.4)
		No Sustained Load		psi (N/mm²)	2,765 (19.1)	2,670 (18.4)	2,470 (17.0)	2,400 (16.5)	1,900 (13.1)
Maximum Short Term Temperature **180 °F** (82 °C)	Unracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	2,120 (14.6)	2,045 (14.1)	1,895 (13.1)	1,840 (12.7)	1,460 (10.1)
		No Sustained Load		psi (N/mm²)	2,435 (16.8)	2,350 (16.2)	2,175 (15.0)	2,110 (14.5)	1,675 (11.5)
Maximum Short Term Temperature **205 °F** (96 °C)	Unracked Concrete Characteristic Bond Strength	With Sustained Load[4]	$\tau_{k,uncr}$	psi (N/mm²)	905 (6.2)	870 (6.0)	805 (5.6)	785 (5.4)	620 (4.3)
		No Sustained Load		psi (N/mm²)	1,035 (7.1)	1,000 (6.9)	925 (6.4)	900 (6.2)	715 (4.9)
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65				
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.65	0.55			
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions	Dry Holes in Concrete	ϕ_d	-	0.65				
		Water Saturated Holes in Concrete	ϕ_{ws}	-	0.55	0.45			

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]Characteristic bond strength values correspond to concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For uncracked concrete compressive strength, f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1], the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.10}$ (for SI: $(f'_c / 17.2)^{0.10}$). See Section 4.1.4 of this report.
[2]Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 Appendix D Section D.3.6 as applicable.
[3]Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[4]Characteristic bond strengths are for sustained loads (when noted) including dead and live loads.

FIGURE 2—ULTRABOND HS-1CC ADHESIVE ANCHORING SYSTEM AND TYPICAL ANCHOR ELEMENTS (21.2 oz cartridge, manual dispensing tool, mixing nozzle, and anchor elements)

8.6 oz (254 ml) **21.2 oz (627 ml)** **53 oz. (1.6 L)** **10 gallon (38L) Bulk Kit**

FIGURE 3—ULTRABOND HS-1CC ADHESIVE ANCHORING SYSTEM AVAILABLE PACKAGING OPTIONS

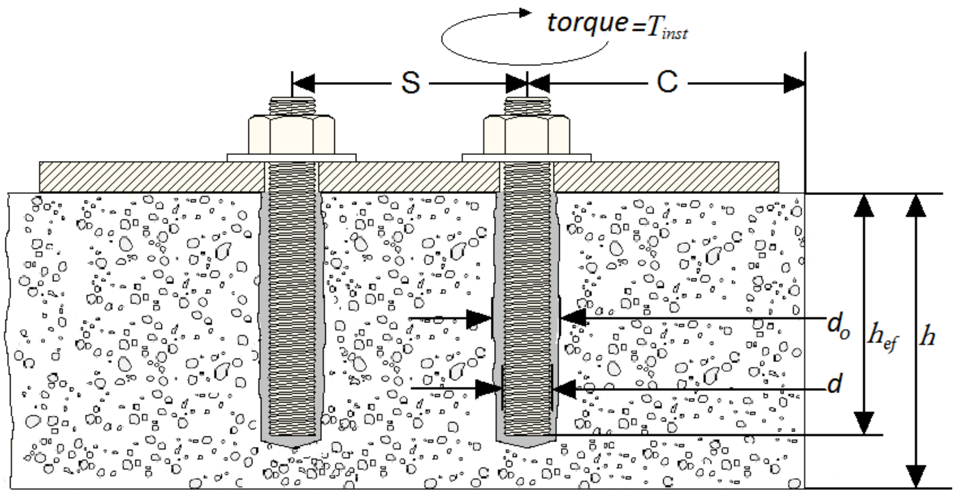


FIGURE 4—TYPICAL INSTALLATION DETAIL FOR THREADED RODS AND REINFORCING BARS

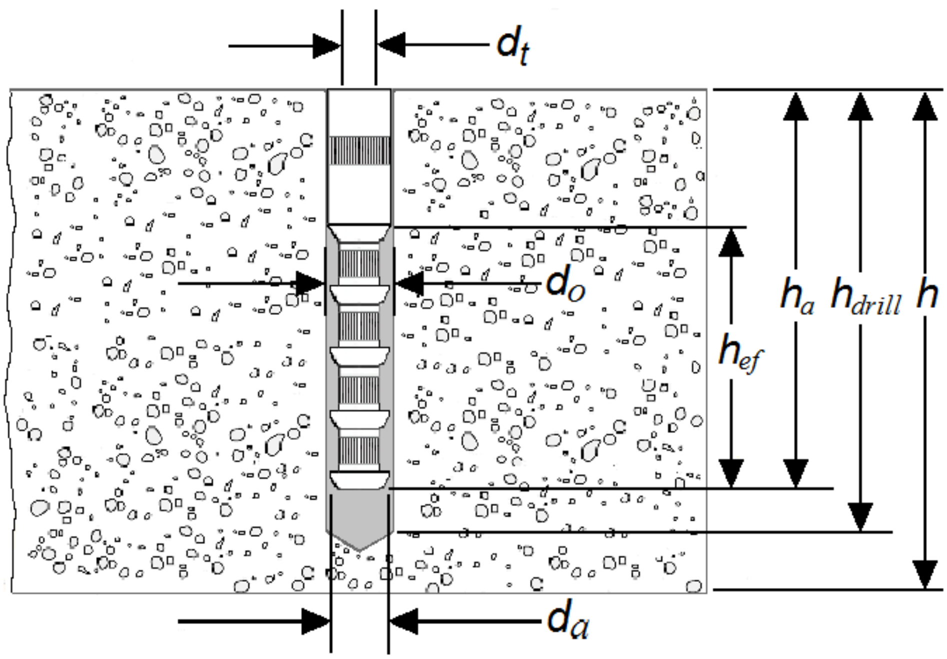


FIGURE 5—TYPICAL INSTALLATION DETAIL FOR POWER-SERT INTERNALLY THREADED INSERTS

TABLE 17—ULTRABOND HS-1CC THREADED ROD INSTALLATION PARAMETERS

Characteristic		Symbol	Units	Threaded Rod						
				3/8	1/2	5/8	3/4	7/8	1	1 1/4
Nominal Anchor Diameter		d_a	in.	0.375	0.500	0.625	0.750	0.875	1.000	1.250
Drill Size		d_o	in.	7/16	9/16	3/4	7/8	1	1 1/8	1 3/8
Maximum Tightening Torque	A36/A307 Carbon Steel	$T_{inst,max}$	ft-lb (N-m)	10 (14)	25 (34)	50 (68)	90 (122)	125 (169)	165 (224)	280 (380)
	A193 B7 Carbon Steel or F593 SS			16 (22)	33 (45)	60 (81)	105 (142)	125 (169)	165 (224)	280 (380)
Brush Part #		----	----	B716	B916	B34	B78	B100	B118	B138
Brush Length in.		----	in.	6				9		
Piston Plug Part #		----	----	PP716	PP916	PP34	PP78	PP100	PP118	PP138
Piston Plug Color		----	----	Black[1]	Blue	Yellow	Green	Black	Orange	Brown

[1]Black nozzle adaptor with extension tubing for deep embedment depths in 7/16- and 1/2-inch hole diameters.

TABLE 18—ULTRABOND HS-1CC REINFORCING BAR INSTALLATION PARAMETERS

Characteristic	Symbol	Units	Rebar							
			# 3	# 4	# 5	# 6	# 7	# 8	# 9	#10
Nominal Anchor Diameter	d_a	in.	0.375	0.500	0.625	0.750	0.875	1.000	1.127	1.270
Drill Size	d_o	in.	$^{1}/_{2}$	$^{5}/_{8}$	$^{3}/_{4}$	$^{7}/_{8}$	1	$1^{1}/_{8}$	$1^{3}/_{8}$	$1^{1}/_{2}$
Brush Part #	----	----	B12	B58	B34	B78	B100	B118	B138	B112
Brush Length in.	----	in.	6				9			
Piston Plug Part #	----	----	PP716	PP58	PP34	PP78	PP100	PP118	PP138	PP112
Piston Plug Color	----	----	Black[1]	Red	Yellow	Green	Black	Orange	Brown	Gray

[1]Black nozzle adaptor with extension tubing for deep embedment depths in $^{7}/_{16}$- and $^{1}/_{2}$-inch hole diameters.

TABLE 19—ULTRABOND HS-1CC POWER-SERT INTERNALLY THREADED INSERT INSTALLATION PARAMETERS

Characteristic		Symbol	Units	Internally Threaded Insert				
Insert Part #		----	----	PS2-38 or PS6-38	PS2-12 or PS6-12	PS2-58 or PS6-58	PS2-34 or PS6-34	PS2-1 or PS6-1
Internal Thread Size		d_t	in.-TPI	3/8 - 16	1/2 - 13	5/8 - 11	3/4 - 10	1"- 8
Drill Size		d_o	in.	1/2	5/8	7/8	1	1 1/2
Maximum Tightening Torque	A36/A307 Carbon Steel	$T_{inst,max}$	ft-lb (N-m)	10 (14)	25 (34)	50 (68)	90 (122)	165 (224)
	A193 B7 Carbon Steel or F593 SS			16 (22)	33 (45)	60 (81)	105 (142)	165 (224)
Brush Part #		----	----	B12	B58	B78	B100	B112
Brush Length in.		----	in.	6			9	
Piston Plug Part #		----	----	PP716	PP58	PP78	PP100	PP112
Piston Plug Color		----	----	Black[1]	Red	Green	Black	Gray

[1]Black nozzle adaptor with extension tubing for deep embedment depths in $^{7}/_{16}$- and $^{1}/_{2}$-inch hole diameters.

TABLE 20—ULTRABOND HS-1CC ADHESIVE, DISPENSING TOOLS AND ACCESSORIES

Package Size	8.6 fl. oz. (254 ml) Cartridge	21.2 fl. oz. (627 ml) Cartridge	53 fl. oz. (1.6 L) Cartridge	10 Gallon (38 L) Kit	
				Resin	Hardener
Part #	A9-HS1CC	A22-HS1CC	A53-HS1CC	B5G-HS1CC-A	B5G-HS1CC-B
Manual Dispensing Tool	TM9HD	TM22HD	----		
Pneumatic Dispensing Tool	----	TA22HD-A	TA53HD-A	AST Pump Model Number RMP 6624-1717	
Battery Tool		TB22HD-A	----		
Case Qty.	12		6	N/A	
Pallet Qty.	1,116	432	252	12 Kits	
Recommended Mixing Nozzle	T12 or T34HF			T34HF	
SDS Brush Adaptor	BR-SDS				
Brush Extension	BR-EXT				
Nozzle Extension Tubing	TUBE916-EXT				
Retention Wedge	WEDGE				

FIGURE 6— ULTRABOND HS-1CC ADHESIVE DISPENSING EQUIPMENT

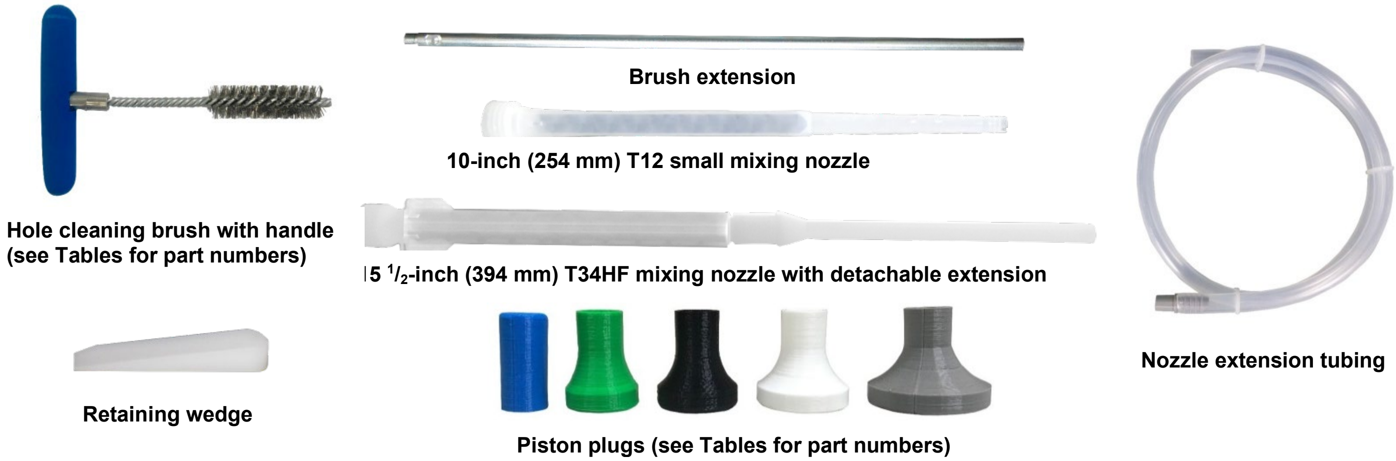


FIGURE 7— ULTRABOND HS-1CC ADHESIVE INSTALLATION ACCESSORIES

FIGURE 8— MILWAUKEE VACUUM BIT SYSTEM

TABLE 21—MILWAUKEE VACUUM BIT SYSTEM INSTALLATION INFORMATION[1]

Drill Bit Part Number[1]	Drill Type	Drill Bit Size in.	Overall Length in.	Useable Length in.
48-20-2102	SDS+	7/16	13	7 7/8
48-20-2106		1/2	13	7 7/8
48-20-2110		9/16	14	9 1/2
48-20-2114		5/8	14	9 1/2
48-20-2118		3/4	14	9 1/2
48-20-2152	SDS-Max	5/8	23	15 3/4
48-20-2156		3/4	23	15 3/4
48-20-2160		7/8	23	15 3/4
48-20-2164		1	25	17 1/2
48-20-2168		1 1/8	35	27
48-20-2172		1 3/8	35	27
8960-20	8 Gallon Dust Extractor Vacuum			

[1]Vacuum drill accessories available from Milwaukee distributors nationwide.

TABLE 22— ULTRABOND HS-1CC CURE SCHEDULE[1,2,3]

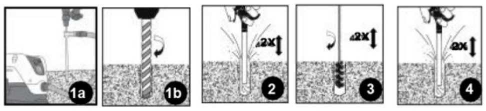
Base Material Temperature °F (°C)	Working Time min	Full Cure Time hr
43 (6)	45	144
50 (10)	35	72
75 (24)	16	7
90 (32)	12	4
110 (43)	3	2

[1]Working and full cure times are approximate, may be linearly interpolated between listed temperatures and are based on cartridge/nozzle system performance.
[2]Application Temperature: Substrate and ambient air temperature should be between 43 - 110 °F (6 - 43 °C).
[3]When ambient or base material temperature falls below 70 °F (21 °C), condition the adhesive to 70 - 75 °F (21 - 24 °C) prior to use. A high flow mixing nozzle (T34HF) may also be used to ease dispensing at colder temperatures or to increase flow rate.

ULTRABOND HS-1CC Adhesive Anchor Installation Instructions

Installation Instructions (MPII)

Drilling and Cleaning - Hammer Drilled Holes



1a. Using a rotary hammer drill & properly connected hollow vacuum bit system, ensure vacuum is on and drill hole to specified diameter and depth. No other cleaning is necessary - go to step 8.

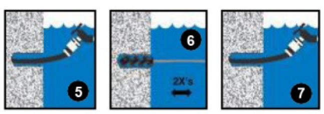
1b. If a rotary hammer drill and standard carbide bit is used, drill hole to specified diameter and depth, go to step 2. For submerged conditions, skip to step 5.

2. Remove standing water and blow out hole 2 cycles (2X) using oil free compressed air.

3. Brush for 2 cycles (2X) in up/down twisting motion.

4. Repeat step 2, then go to step 8.

Submerged Holes

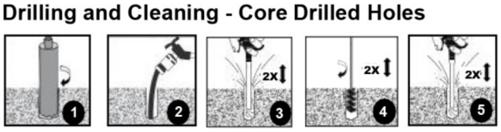


5. Flush hole with pressurized water until water flowing from hole is clean and free of debris.

6. Brush for 2 cycles (2X) in up/down twisting motion.

7. Repeat step 5, then go to step 8.

Drilling and Cleaning - Core Drilled Holes



1. Using a core drill bit, drill hole to specified diameter and depth and remove the core.

2. Flush hole with pressurized water until water flowing from hole is clean and free of debris.

3. Remove standing water & blow out hole two cycles (2X) using oil free compressed air.

4. Brush for 2 cycles (2X) in up/down twisting motion.

5. Repeat step 3, then go to step 8.

* See next page for Dispensing Preparation steps

Reference Commentary

Drilling and Cleaning - Hammer Drilled Holes

Read and follow manufacturer's operations manual for the selected rotary drill.

R1a. Recommended hollow vacuum bit systems for drilling dry & damp cracked and uncracked concrete. Drill bit should conform to ANSI B212.15. Once visual inspection confirms that hole is clean, proceed to step 8 for either Cartridge or Bulk Systems.

R1b. Traditional drilling method for drilling dry, water saturated and water-filled holes in cracked and uncracked concrete. Drill bit should conform to ANSI B212.15. **CAUTION:** Always wear appropriate personal protection equipment (PPE) for eyes, ears and skin to help avoid inhalation of dust during the drilling and cleaning process. Refer to the Safety Data Sheet (SDS) for details prior to proceeding.

R2. **BLOW (2X) – BRUSH (2X) – BLOW (2X)**. The compressed air wand should be inserted to the bottom of the hole, have a minimum pressure of 87 psi (6 bar) and be moved in an up/down motion to remove debris.

R3. Select the correct wire brush for the hole diameter, making sure it is long enough to reach the bottom of the drilled hole, using a brush extension if necessary. **CAUTION:** The brush should be clean and contact the walls of the hole. If it does not, the brush is either too worn or small and should be replaced with a new brush of the correct diameter.

R4. After final blow step is completed, visually inspect the hole to confirm it is clean. **NOTE:** If installation will be delayed for any reason, cover cleaned holes to prevent contamination. Proceed to step 8 for either Cartridge or Bulk Systems.

R5. For submerged (underwater) installations, **FLUSH – BRUSH (2X) – FLUSH**. Start at the bottom or back of the hole when flushing.

R6. Select the correct wire brush for the hole diameter, making sure it is long enough to reach the bottom of the drilled hole, using a brush extension if necessary. **CAUTION:** The brush should be clean and contact the walls of the hole. If it does not, the brush is either too worn or small and should be replaced with a new brush of the correct diameter.

R7. After final flush is completed, go to step 8 for either Cartridge or Bulk Systems.

Drilling and Cleaning - Core Drilled Holes

Read and follow manufacturer's operations manual for the selected core drill.

R1. Once hole is cored to the proper diameter and depth, remove center core and measure to ensure that specified embedment depth can be achieved. **CAUTION:** Always wear appropriate personal protection equipment (PPE) for eyes, ears and skin to help avoid inhalation of dust during the drilling and cleaning process. Refer to the Safety Data Sheet (SDS) for details prior to proceeding.

R2. **FLUSH – BLOW (2X) – BRUSH (2X) – BLOW (2X)**. Start at the bottom or back of the hole when flushing.

R3. The compressed air wand should be inserted to the bottom of the hole, have a minimum pressure of 87 psi (6 bar) and be moved in an up/down motion to remove debris.

R4. Select the correct wire brush for the hole diameter, making sure it is long enough to reach the bottom of the drilled hole, using a brush extension if necessary. **CAUTION:** The brush should be clean and contact the walls of the hole. If it does not, the brush is either too worn or small and should be replaced with a new brush of the correct diameter.

R5. After final blow step is completed, visually inspect the hole to confirm it is clean. **NOTE:** If installation will be delayed for any reason, cover cleaned holes to prevent contamination. Proceed to step 8 for either Cartridge or Bulk Systems. *

FIGURE 9—MANUFACTURERS PRINTED INSTALLATION INSTRUCTIONS (MPII) AND COMMENTARY

ULTRABOND HS-1CC Adhesive Anchor Installation Instructions

Installation Instructions (MPII)

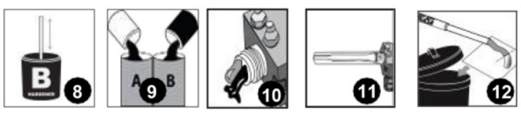
Dispensing Preparation - Cartridge Systems Only

8. Remove protective cap, insert cartridge into recommended dispensing tool and balance until both components come out evenly.

9. Screw on proper, non-modified ATC mixing nozzle to cartridge.

10. Dispense and waste enough material to ensure uniform gray color before injecting into hole. For a new cartridge (or if working time has been exceeded), ensure cartridge opening is clean, install new nozzle and repeat steps 8 & 9. Go to step 13a.

Dispensing Preparation - Bulk Systems Only



8. Epoxy materials may separate. This is normal and may be expected when stored over a period of time. Part A (Resin) should not be remixed. Part B (Hardener) should be remixed with a clean 5 gallon paint stick in a "butter churning" motion to homogenize the product.

9. Pour Resin into Side A pump reservoir then close lid on Side A. Only after separately mixing Part B, pour hardener into Side B reservoir then close lid on Side B. Follow bulk pump instructions for filling the metering pump and outlet assembly, then bleed the air from the system and fill the hose and applicator.

10. Balance the bulk pump machine following instructions in the Bulk Pump Operations Manual and test to ensure that it is dispensing the material on ratio (1:1).

11. Screw on the proper, non-modified ATC mixing nozzle onto the bulk pump wand.

12. Dispense and waste enough material to ensure uniform gray color before injecting into hole.

* See next page for Installation and Curing steps

Reference Commentary

Dispensing Preparation - Cartridge Systems Only

R8. **CAUTION:** Check the expiration date on the cartridge to ensure it is not expired. **Do not use expired product**! Before attaching mixing nozzle, balance the cartridge by dispensing a small amount of material until both components are flowing evenly. For a cleaner environment, hand mix the two components and let cure prior to disposal in accordance with local regulations.
R9. Do not modify mixing nozzle and confirm that internal mixing element is in place prior to dispensing adhesive. Take note of the air and base material temperatures and review the working/full cure time chart prior to starting the injection process.
R10. Test bead of mixed adhesive must be uniform in color and free of streaks, as adhesive must be properly mixed in order to perform as published. Dispose of the test bead according to federal, state and local regulations. **CAUTION:** When changing cartridges, never re-use nozzles and do not attempt to force adhesive out of a hardened mixing nozzle. Leave the mixing nozzle attached to the cartridge upon completion of work.

Dispensing Preparation - Bulk Systems Only

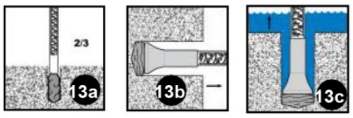
The bulk pump uses a two-component delivery system whereby metering individual components and mixing of the two components are automatically controlled during dispensing through a metering manifold and disposable mixing nozzle. The bulk pump has a minimum input air pressure requirement of 80 - 90 psi @ 15 CFM, supplied through a regulator which reduces the pressure in order to control the rate of dispensing. The two individual adhesive components stay separate throughout the system, until they reach the specified disposable mixing nozzle via a manifold at the end of the bulk pump wand. Under normal operation, the bulk pump must be capable of dispensing the individual components at a 1:1 mix ratio by volume with a tolerance of ± 2%.
R8. **CAUTION:** Check the expiration dates on the bulk containers to ensure they are not expired. **Do not use expired product**! Mix Part B carefully to avoid whipping air into product.
R9. **NOTE: Review Bulk Pump Operations Manual thoroughly before proceeding and follow all steps necessary for set-up and operation of the pump.** Fill each reservoir (hopper) to at least one-half full. Incoming air supply pressure should be maintained at approximately 100 psi (6.9 bar).
R10. Be sure to establish proper flow of both materials at the applicator tip prior to attaching mixing nozzle. A ratio check should always be performed before installation begins to confirm that equal volumes of Part A and Part B are being dispensed. This check must be completed prior to attaching the mixing nozzle.
R11. Do not modify mixing nozzle and confirm that internal mixing element is in place prior to dispensing adhesive. Take note of the air and base material temperatures and review the working/full cure time chart prior to starting the injection process.
R12. Test bead of mixed adhesive must be uniform in color and free of streaks, as adhesive must be properly mixed in order to perform as published. Dispose of the test bead according to federal, state and local regulations. **CAUTION:** Never re-use nozzles and do not attempt to force adhesive out of a hardened mixing nozzle. *

FIGURE 9—MANUFACTURERS PRINTED INSTALLATION INSTRUCTIONS (MPII) AND COMMENTARY (CONTINUED)

ULTRABOND HS-1CC Adhesive Anchor Installation Instructions

Installation Instructions (MPII)

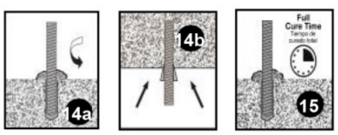
Installation and Curing



13a. Fill hole 2/3 full with adhesive starting at the bottom and withdraw as hole fills, using an extension tube as needed. Only fill hole 1/2 full when installing inserts.

13b. Use piston plugs for overhead and vertically inclined installations.

13c. If injecting in a water-filled hole, or underwater in a submerged condition, fill hole completely with adhesive as described in 13b.



14a. Fully insert clean threaded rod or rebar with slow turning motion to the bottom of the hole. For internally threaded inserts, thread a bolt into the insert and press it into the hole, finishing with hammer strikes until it is flush with the surface of the concrete.

14b. For horizontal, inclined or overhead installations, use wedges to support the anchor while curing.

15. Do not disturb, torque or apply load until full cure time has passed.

Reference Commentary

Installation and Curing

NOTE: Building Code Requirements for Structural Concrete (ACI 318-14) requires the Installer to be certified where adhesive anchors are to be installed in horizontal to vertically inclined (overhead) installations. The engineering drawings must be followed. For all applications not covered by this document, or for all installation questions, please contact Adhesives Technology Corp.

R13a. Be careful not to withdraw the mixing nozzle too quickly as this may trap air in the adhesive. Extension tubing can be connected as needed onto the outside of the tip of both the small mixing nozzle (T12) and the large mixing nozzle (T34HF). **NOTE:** When using a pneumatic dispensing tool, ensure that pressure is set at 90 psi (6.2 bar) maximum.

R13b. Select the proper piston plug for the drill hole diameter. The piston plug fits directly onto the tip of both the small and large mixing nozzle. Extension tubing may also be used if needed in order to reach the bottom of the drill hole.

R13c. Be careful not to withdraw the mixing nozzle assembly too quickly as this may trap water in the adhesive. The piston plug should push itself out of the hole from the pressure of the injected adhesive.

R14a. Prior to inserting the threaded rod or rebar into the hole, make sure it is straight, clean and free of oil/dirt and that the necessary embedment depth is marked on the anchor element. Insert the anchor elements into the hole while turning 1 - 2 rotations prior to the anchor reaching the bottom of the hole. Excess adhesive should be visible on all sides of the fully installed rod or rebar, but may not be visible on all sides of the insert. **CAUTION:** Use extra care with deep embedment or high temperature installations to ensure that the working time has not elapsed prior to the anchor being fully installed. Adjustments to the anchor alignment may only performed during the published working time for a given temperature.

R14b. For overhead, horizontal and inclined (between horizontal and overhead), wedges should be used to support the anchor while the adhesive if curing. Take appropriate steps to protect the exposed threads of the anchor element from uncured adhesive until after the full cure time has elapsed.

R15. The amount of time needed to reach full cure is base material dependent. Refer to the chart for appropriate full cure time for a given temperature.

FIGURE 9—MANUFACTURERS PRINTED INSTALLATION INSTRUCTIONS (MPII) AND COMMENTARY (CONTINUED)

ICC-ES Evaluation Report

ESR-4094 LABC and LARC Supplement

Reissued January 2024

This report is subject to renewal January 2025.

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DIVISION: 03 00 00—CONCRETE
Section: 03 16 00—Concrete Anchors

DIVISION: 05 00 00—METALS
Section: 05 05 19—Post-Installed Concrete Anchors

REPORT HOLDER:

ADHESIVES TECHNOLOGY CORPORATION (ATC)

EVALUATION SUBJECT:

ADHESIVES TECHNOLOGY CORPORATION (ATC) ULTRABOND® HS-1CC ADHESIVE ANCHOR SYSTEM IN CRACKED AND UNCRACKED CONCRETE

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the ULTRABOND HS-1CC Adhesive Anchor System in Cracked and Uncracked Concrete, described in ICC-ES evaluation report ESR-4094, has also been evaluated for compliance with the codes noted below as adopted by the Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:

- 2017 *City of Los Angeles Building Code* (LABC)
- 2017 *City of Los Angeles Residential Code* (LARC)

2.0 CONCLUSIONS

The ULTRABOND HS-1CC Adhesive Anchor System in Cracked and Uncracked Concrete, described in Sections 2.0 through 7.0 of the evaluation report ESR-4094, complies with LABC Chapter 19, and LARC, and is subjected to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The ULTRABOND HS-1CC Adhesive Anchor System in Cracked and Uncracked Concrete described in this evaluation report must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-4094.
- The design, installation, conditions of use and labeling of the ULTRABOND HS-1CC Adhesive Anchor System in Cracked and Uncracked Concrete are in accordance with the 2015 *International Building Code*® (2015 IBC) provisions noted in the evaluation report ESR-4094.
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.
- Under the LARC, an engineered design in accordance with LARC Section R301.1.3 must be submitted.
- The allowable and strength design values listed in the evaluation report and tables are for the connection of the adhesive anchors and post-installed reinforcing bars to the concrete. The connection between the adhesive anchors or post-installed reinforcing bars and the connected members shall be checked for capacity (which may govern).

This supplement expires concurrently with the evaluation report, reissued January 2024.

ICC-ES Evaluation Report

ESR-4094 FBC Supplement

Reissued January 2024

This report is subject to renewal January 2025.

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REPORT HOLDER:

ADHESIVES TECHNOLOGY CORPORATION (ATC)

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ADHESIVES TECHNOLOGY CORPORATION (ATC) ULTRABOND® HS-1CC ADHESIVE ANCHOR SYSTEM IN CRACKED AND UNCRACKED CONCRETE

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the ULTRABOND HS-1CC Adhesive Anchor System in Cracked and Uncracked Concrete, described in ICC-ES evaluation report ESR-4094, has also been evaluated for compliance with the codes noted below.

Compliance with the following codes:

- 2017 *Florida Building Code—Building*
- 2017 *Florida Building Code—Residential*

2.0 PURPOSE OF THIS SUPPLEMENT

This supplement is issued to indicate that the ULTRABOND HS-1CC Adhesive Anchor System in Cracked and Uncracked Concrete described in Sections 2.0 through 7.0 of the evaluation report, ESR-4094, complies with the *Florida Building Code—Building* and the *Florida Building Code—Residential*, when designed and installed in accordance with the 2015 *International Building Code®* provisions noted in the evaluation report.

Use of the ULTRABOND HS-1CC Adhesive Anchor System with stainless steel threaded rod and stainless steel internally threaded inserts has also been found to be in compliance with the High-Velocity Hurricane Zone provisions of the *Florida Building Code—Building* and the *Florida Building Code—Residential* with the following condition*:*

a) For connections subject to uplift, the connection must be designed for no less than 700 pounds (3114 N).

Use of the the ULTRABOND HS-1CC Adhesive Anchor System with carbon steel threaded rod, internally threaded inserts, and reinforcing bars for compliance with the High-velocity Hurricane Zone provisions of the *Florida Building Code—Building* and the *Florida Building Code—Residential* has not been evaluated and is outside the scope of this supplemental report.

For products falling under Florida Rule 9N-3, verification that the report holder's quality assurance program is audited by a quality assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official, when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the evaluation report, reissued January 2024.