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ICC-ES Evaluation Report
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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:

DEWALT

EVALUATION SUBJECT:

PURE110+® EPOXY ADHESIVE ANCHOR SYSTEM AND POST-INSTALLED REINFORCING BAR CONNECTIONS IN CRACKED AND UNCRACKED CONCRETE (DEWALT)

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 Los Angeles Department of Building and Safety (LADBS), see ESR-3298 LABC and LARC Supplement.

For evaluation for compliance with the *National Building Code of Canada*® (NBCC), see listing report ELC-3298.

Property evaluated:

Structural

2.0 USES

The Pure110+ Epoxy Adhesive Anchor System and Post-Installed Reinforcing Bar Connections are used as anchorage in cracked and uncracked normal-weight concrete or 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] to resist static, wind or earthquake (IBC Seismic Design Categories A through F) tension and shear loads.

The anchor system complies with anchors as described in Section 1901.3 of the 2021, 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 IBC. The anchor systems may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC. The post-installed reinforcing bar connections are an alternative to cast-in-place reinforcing bars governed by ACI 318 and IBC Chapter 19.

3.0 DESCRIPTION

3.1 General:

The Pure110+ Epoxy Adhesive System is comprised of a two-component epoxy adhesive filled in cartridges, static mixing nozzles, dispensing tools, hole cleaning equipment and adhesive injection accessories. The Pure110+ epoxy adhesive system may be used with continuously threaded steel rods or deformed steel reinforcing bars to form the Pure110+ Epoxy Adhesive Anchor System (see Table 1A and Figure 1 of this report) or with deformed steel reinforcing bars to form the Pure110+ Epoxy Adhesive Post-Installed Reinforcing Bar Connections (see Table 1B, Figure 1 and Figure 3 of this report). Product name for the report holder is presented in the following table.

COMPANY NAME	PRODUCT NAME
DEWALT	Pure110+®
	Pure110-PRO (outside the Americas)

The adhesive and steel anchor elements (continuously threaded steel rods or deformed steel reinforcing bars) are installed in pre-drilled holes into concrete. The primary components of the Pure110+ Epoxy Adhesive Anchor System and Post-Installed Reinforcing Bar Connections, including the epoxy adhesive cartridge, static mixing nozzle, the nozzle extension tube, dispensing tool and typical steel anchor elements, are shown in Figure 2 of this report. Manufacturer's printed installation instructions (MPII) and parameters, included with each adhesive unit package, are shown in Figure 4A and 4B.

3.2 Materials:

3.2.1 Pure110+ Epoxy Adhesive: Pure110+ epoxy adhesive is an injectable two-component epoxy. The two components are separated by means of a labelled dual-cylinder cartridge. The two components combine and react when dispensed through a static mixing nozzle, supplied by DEWALT, which is attached to the cartridge.

The Pure110+ epoxy adhesive is available in 9-ounce (265 mL), 9.5-ounce (280 mL), 13.5-ounce (400 mL), 20.5-ounce (610 mL) and 50.5-ounce (1500 mL) cartridges. Each cartridge label is marked with the adhesive expiration date. The shelf life, as indicated by the expiration date, applies to an unopened cartridge when stored in accordance with the manufacturer's printed installation instructions (MPII) as illustrated in Figure 4A and 4B of this report.

3.2.2 Hole Cleaning Equipment: Standard hole cleaning equipment and dust extraction system equipment (i.e. suction, vacuum) are available from the report holder.

3.2.2.1 Standard Hole Cleaning: Standard hole cleaning equipment used after drilling is comprised of steel wire brushes supplied by DEWALT and a compressed air nozzle (applicable for both post-installed adhesive anchor system and post-installed reinforcing bar connections). Standard hole cleaning equipment is shown in Figure 4A and 4B.

3.2.2.2 DustX+™ Extraction System: The DustX+™ extraction system automatically cleans the holes during drilling using hollow drill bits with a carbide head meeting the requirements of ANSI B212.15 and a DEWALT DWV012 / DWV902M vacuum equipped with an automatic filter cleaning system or equivalent as approved by DEWALT (applicable for post-installed adhesive anchors and post-installed reinforcing bar connections). After drilling with the DustX+™ system, no further hole cleaning is required. See Figure A for illustration of the DustX+™ extraction system.

3.2.3 Dispensers Pure110+ epoxy adhesive must be dispensed with manual dispensers, pneumatic dispensers, or electric powered dispensers supplied by DEWALT.

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 as described in Tables 4 and 8 of this report. The embedded portions of threaded rods must be clean, straight, and free of mill scale, rust and other coatings (other than zinc) that may impair the bond with the adhesive. Threaded rods, matching nuts and washers must comply with the requirements including specifications, grades, and mechanical properties prescribed in Table 2 of this report. Carbon steel threaded rods may be furnished with a 0.0002-inch-thick (0.005 mm) zinc electroplated coating complying with ASTM B633, SC1; or a minimum 0.0021-inch-thick (0.053 mm) mechanically deposited zinc coating complying with ASTM B695, Class 55; or a hot dip galvanized zinc coating complying with ASTM A153, Class C or D. Steel grades and material types (carbon, stainless) of the washers and nuts must be matched to the threaded rods. Threaded steel rods must be straight and free of indentations or other defects along their length. The embedded end may be either flat cut or cut on the bias to a chisel point.

3.2.4.2 Steel Reinforcing Bars: Steel reinforcing bars must be deformed reinforcing bars (rebars) as described in Table 3 of this report. Tables 1A, 5, 6, 7, 9, 10 and 11 summarize reinforcing bar size ranges. The embedded portions of reinforcing bars must be clean, straight, and free of mill scale, rust 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 318-19 Section 26.6.3.2 (b), ACI 318-14 26.6.3.1 (b) or ACI 318-11 7.3.2, as applicable, with the additional condition that the bars must be bent cold, and heating of the reinforcing bars to facilitate field bending is not permitted.

3.2.4.3 Ductility: In accordance with ACI 318 (-19 and -14) Section 2.3 or ACI 318-11 Appendix 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 the reduction of area must be at least 30 percent. Steel elements with a tested elongation of 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 and 3 of this report. Where values are nonconforming or unstated, the steel element must be considered brittle.

3.2.5 Steel Reinforcing Bars for Use in Post-Installed Reinforcing Bar Connections: Steel reinforcing bars used in post-installed reinforcing bar connections must be deformed bars (rebar) as depicted in Figure 3. Tables 1B and 13 summarize reinforcing bar size ranges. The embedded portions of reinforcing bars must be 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 318-19 Section 26.6.3.2 (b), ACI 318-14 26.6.3.1(b) or ACI 318-11 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.

3.3 Concrete:

Normalweight concrete and lightweight concrete must comply with Sections 1903 and 1905 of the IBC, as applicable. 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 of Pure110+ Epoxy Adhesive Post-installed Adhesive Anchor System:

4.1.1 General: The design strength of anchors under the 2021 IBC, as well as the 2021 IRC must be determined in accordance with ACI 318-19 and this report. The design strength of anchor system 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 anchor system under the 2012 and 2009 IBC, as well the 2012 and 2009 IRC, must be determined in accordance with ACI 318-11 and this report.

The strength design of anchor system must comply with ACI 318-19 17.5.1.2, ACI 318-14 17.3.1 or ACI 318-11 D.4.1, as applicable, except as required in ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable.

Design parameters are provided in Table 4 through Table 11. Strength reduction factors, ϕ, as given in ACI 318-19 17.5.3, 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 1605.1 of the 2021 IBC, Section 1605.2 of the 2018, 2015, 2012, and 2009 IBC, ACI 318 (-19 and -14) 5.3, or ACI 318-11 9.2, as applicable. Strength reduction factors, ϕ, as described 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 318-19 17.6.1.2, 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 318-19

17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are provided in Tables 4, 5, 8 and 9 of this report for the corresponding steel anchor element. See Table 1A for index of design tables.

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 318-19 17.6.2, 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 318-19 17.6.2.2, ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2, as applicable, using the selected values of $k_{c,cr}$ and $k_{c,uncr}$ as provided in the tables of this report. Where analysis indicates no cracking in accordance with ACI 318-19 17.6.2.5, 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 $\Psi_{c,N} = 1.0$. See Table 1A. For anchors in lightweight concrete see ACI 318-19 17.2.4, 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 318-19 17.3.1, 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 318-19 17.6.5, 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 the concrete service temperature, concrete state (cracked, uncracked), drilling method (hammer-drill, i.e. rotary impact drill or rock drill with a carbide bit), concrete compressive strength (f'_c) and installation conditions (dry concrete, water-saturated concrete, water-filled holes, underwater). Special inspection level is qualified as periodic for all anchors except as noted in Section 4.4 of this report. The selection of continuous special inspection level, with an onsite proof loading program, is not necessary and does not provide a benefit of a lower anchor category or an increase in the associated strength reduction factors for design. The following table summarizes the requirements.

CONCRETE STATE	DRILLING METHOD	BOND STRENGTH	CONCRETE STRENGTH	PERMISSIBLE INSTALLATION CONDITIONS	ASSOCIATED STRENGTH REDUCTION FACTOR
Cracked and Uncracked	Hammer-drill with carbide drill bit or DEWALT hollow bit	$\tau_{k,cr}$ or $\tau_{k,uncr}$	f'_c	Dry concrete	ϕ_d
				Water-saturated concrete	ϕ_{ws}
	Hammer-drill with carbide drill bit			Water-filled hole (flooded)	ϕ_{wf}
				Underwater (submerged)	ϕ_{uw}

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 55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.23}$ [For **SI:** $(f'_c / 17.2)^{0.23}$]. Where applicable, the modified bond strength values must be used in lieu of $\tau_{k,cr}$ and $\tau_{k,uncr}$ in ACI 318-19 Equations (17.6.5.1.2b) and (17.6.5.2.1), 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_{nn}.

Figure 1 of this report presents a bond strength design selection flowchart. Strength reduction factors for determination of the bond strength are given in Tables 7 and 11 of this report (see Table 1A for an index of design tables). Adjustments to the bond strength may also be taken for increased concrete compressive strength as noted in the footnotes to the corresponding tables. For anchors in lightweight concrete see ACI 318-19 17.2.4, ACI 318-14 17.2.6 or ACI 318-11 D.3.6, 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 318-19 17.7.1.2, ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable, and strength reduction factors, ϕ, in accordance with ACI 318-19 17.5.3, ACI 318-14 17.2.3 or ACI 318-11 D.4.3, as applicable, are given in Tables 4, 5, 8 and 9 of this report for the anchor element types included herein.

4.1.6 Static Concrete Breakout Strength in Shear: The nominal 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 318-19 17.7.2, ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, based on information given in Table 6 and 10 of this report. The basic concrete breakout strength in shear of a single anchor in cracked concrete, V_b, must be calculated in accordance with ACI 318-19 17.7.2.2, ACI 318-14 17.5.2.2 or ACI 318-11 D.6.2.2, as applicable, using the value of d given in Tables 4, 5, 8 and 9 of this report in lieu of d_a. In addition, h_{ef} must be substituted for ℓ_e. In no case shall ℓ_e exceed $8d$. For anchors in lightweight concrete see ACI 318-19 17.2.4, ACI 318-14 17.2.6 or ACI 318-11 D.3.6, as applicable. The value of f'_c must be limited to a maximum of 8,000 psi (55.2 MPa), in accordance with ACI 318-19 17.3.1, 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 318-19 17.7.3, 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 318-19 17.8, 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 318-19 17.9.2, 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, ACI 318-19 17.9.3, ACI 318-14 17.7.4 or ACI 318-11 D.8.4, as applicable, applies.

For anchors that will be torqued during installation, the maximum torque, T_{max}, must be reduced for edge distances of less than five anchor diameters ($5d$). T_{max} is subject to the edge distance, c_{min}, and anchor spacing, s_{min}, and must comply with the following requirements:

MAXIMUM TORQUE SUBJECT TO EDGE DISTANCE			
NOMINAL ANCHOR SIZE, *d*	**MIN. EDGE DISTANCE, c_{min}**	**MIN. ANCHOR SPACING, s_{min}**	**MAXIMUM TORQUE, T_{max}**
All sizes	5*d*	5*d*	T_{max}
$^3/_8$ in. to 1 in. (9.5 mm to 25.4 mm)	1.75 in. (45 mm)	5*d*	0.45·T_{max}
$1^1/_4$ in. (31.8 mm)	2.75 in. (70 mm)		
10 mm to 27 mm (0.39 in. to 1.06 in.)	45 mm (1.75 in.)	5*d*	0.45·T_{max}
28 mm to 32 mm (1.1 in. to 1.26 in.)	70 mm (2.75 in.)		

For values of T_{max}, see Table 12 and Figure 4A.

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 318-19 17.6.5.5, 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 318-19 Eq. 17.6.5.5.1b, 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. 17.6.5.5.1c for ACI 318-19, Eq. 17.4.5.5c for ACI 318-14 or Eq. D-27a for ACI 318-11, in lieu of ACI 318-19 17.9.5, 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. 17.6.5.5.1c for ACI 318-19, 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 where

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

$$\tau_{k,uncr}=\frac{k_{uncr}\sqrt{h_{ef}f'_c}}{\pi\cdot d_a} \qquad \text{Eq. (4-1)}$$

4.1.11 Design Strength in Seismic Design Categories C, D, E and F: In structures assigned to Seismic Design Category (SDC) C, D, E or F under the IBC or IRC, anchor system must be designed in accordance with ACI 318-19 17.10, 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 4 and 5 for the corresponding anchor steel. The nominal bond strength τ_{kcr} need not be adjusted by $\alpha_{N,seis}$ since $\alpha_{N,seis}$ = 1.0.

As an exception to ACI 318-11 D.3.3.4.2: Anchor system 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 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 nominal anchor 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 Strength Design of Pure110+ Epoxy Adhesive Post-Installed Reinforcing Bar Connections:

4.2.1 General: The design of straight post-installed deformed reinforcing bars must be determined in accordance with ACI 318 rules for cast-in place reinforcing bar development and splices and this report. Examples of typical applications for the use of post-installed reinforcing bars are illustrated in Figure 3 of this report.

4.2.2 Determination of bar development length l_d: Values of l_d must be determined in accordance with the ACI 318 development and splice length requirements for straight cast-in place reinforcing bars.

Exceptions:

1. For uncoated and zinc-coated (galvanized) post-installed reinforcing bars, the factor Ψ_e shall be taken as 1.0. For all other cases, the requirements in ACI 318-19 25.4.2.5, ACI 318-14 25.4.2.4 or ACI 318-11 12.2.4 (b) shall apply.

2. When using alternate methods to calculate the development length (e.g., anchor theory), the applicable factors for post-installed anchors generally apply.

4.2.3 Minimum Member Thickness, h_{min}, Minimum Concrete Cover, $c_{c,min}$, Minimum Concrete Edge Distance, $c_{b,min}$, Minimum Spacing, $s_{b,min}$,: For post-installed reinforcing bars, there is no limit on the minimum member thickness. In general, all requirements on concrete cover and spacing applicable to straight cast-in bars designed in accordance with ACI 318 shall be maintained.

For post-installed reinforcing bars installed at embedment depths, h_{ef}, larger than $20d_b$ ($h_{ef} > 20d_b$), the minimum concrete cover shall be as follows:

REBAR SIZE	MINIMUM CONCRETE COVER, $c_{c,min}$
$d_b \le$ No. 6 (16 mm)	1 1/8 in. (29 mm)
No. 6 < $d_b \le$ No. 11 (16 mm < $d_b \le$ 36 mm)	1 9/16 in. (40 mm)

The following requirements apply for minimum concrete edge and spacing for $h_{ef} > 20\ d_b$:

Required minimum edge distance for post-installed reinforcing bars (measured from the center of the bar):

$$c_{b,min} = d_0/2 + c_{c,min}$$

Required minimum center-to-center spacing between post-installed bars:

$$s_{b,min} = d_0 + c_{c,min}$$

Required minimum center-to-center spacing from existing (parallel) reinforcing:

$$s_{b,min} = d_b/2 \text{ (existing reinforcing)} + d_0/2 + c_{c,min}$$

All other requirements applicable to straight cast-in place bars designed in accordance with ACI 318 shall be maintained.

4.2.4 Design Strength in Seismic Design Categories C, D, E and F: In structures assigned to SDC C, D, E or F under the IBC or IRC, design of straight post-installed reinforcing bars must take into account the provisions of ACI 318 (-19 or -14) Chapter 18 or ACI 318-11 Chapter 21, as applicable.

4.3 Allowable Stress Design (ASD):

4.3.1 General: For anchor system designed using load combinations in accordance with Section 1605.1 of the 2021 IBC, or 2018, 2015, 2012, and 2009 IBC Section 1605.3 (Allowable Stress Design), allowable loads must be established using Eq. (4-2) and Eq. (4-3):

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

and

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

where

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

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

ϕN_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 (-19 and -14) Chapter 17 or ACI 318 (-11, -08) Appendix D, as applicable, and 2021, 2018 and 2015 IBC Section 1905.1.8, 2012 IBC Errata Section 1905.1.9, or 2009 IBC Section 1908.1.9, as applicable, and Section 4.1 of this report, as applicable (lbf or kN).

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 (-19 and -14 Chapter 17 or ACI 318 (-11, -08) Appendix D, as applicable, and 2021, 2018 and 2015 IBC Section 1905.1.8, 2012 IBC Errata Section 1905.1.9, or 2009 IBC Section 1908.1.9, as applicable, and Section 4.1 of this report, as applicable (lbf or kN).

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 described in this report for member thickness, edge distance and spacing, must apply.

4.3.2 Interaction of Tensile and Shear Forces: Interaction must be calculated in accordance with ACI 318-19 17.8, ACI 318-14 17.6 or ACI 318 (-11, -08) D.7, as applicable, as follows:

For shear loads $V \le 0.2\ V_{allowable,ASD}$, the full allowable load in tension shall be permitted.

For tension loads $T \le 0.2\ T_{allowable,ASD}$, the full allowable load in shear shall be permitted.

For all other cases:

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

4.4 Installation:

Installation parameters are illustrated in Table 12 of this report for post-installed adhesive anchor system and Table 14 for post-installed reinforcing bar connections. Installation must be in accordance with ACI 318-19 26.7.2, ACI 318-14 17.8.1 and 17.8.2 or ACI 318-11 D.9.1 and D.9.2, as applicable. Anchor and post-installed reinforcing bar locations must comply with this report and the plans and specifications approved by the code official. Installation of the Pure110+ Epoxy Adhesive Anchor System and Post-installed Reinforcing Bar Connections must be in accordance with the Manufacturer's printed installation instructions (MPII) included in each unit package as reproduced in Figure 4A and 4B 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 piston plugs for the 5/8-inch through 1 1/4-inch (M16 through M30) diameter threaded steel rods and No. 5 through No. 10 (14 mm through 32 mm) steel reinforcing bars, installed in the specified hole diameter, and attached to the mixing nozzle and extension tube supplied by DEWALT as described in Figure 4A and 4B in this report. Upwardly inclined and horizontal orientation installation for

the $^3/_8$-inch and $^1/_2$-inch (M10 and M12) diameter threaded steel rods, and No. 3 and No. 4 (10 mm and 12 mm) steel reinforcing bars may be injected directly to the end of the hole using extension tubing attached to the mixing nozzle with a hole depth $h_0 \leq 10$" (250 mm).

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

4.5 Special Inspection:

Periodic special inspection must be performed where required in accordance with Section 1705.1.1 and Table 1705.3 of the 2021, 2018, 2015 and 2012 IBC, Section 1704.15 and Table 1704.4 of the 2009 IBC and this report. The special inspector must be on the jobsite initially during adhesive anchor or post-installed reinforcing bar connection installation to verify anchor or post-installed reinforcing bar type and dimensions, concrete type, concrete compressive strength, adhesive identification and expiration date, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, adhesive anchor or post-installed reinforcing bar connection embedment, tightening torque and adherence to the manufacturer's printed installation instructions (MPII). The special inspector must verify the initial installations of each type and size of adhesive anchor or post-installed reinforcing bar connection by construction personnel on the 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.

Continuous special inspection of adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads must be performed in accordance with ACI 318-19 26.13.3.2(e), ACI 318-14 17.8.2.4, 26.7.1(h) and 26.13.3.2 (c) or ACI 318-11 D.9.2.4, as applicable.

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

4.6 Compliance with NSF/ANSI Standard 61:

The Pure110+ Epoxy Adhesive Anchor System and Post-installed Reinforcing Bar Connections comply with the requirements of NSF/ANSI Standard 61, as referenced in Section 605 of the 2021, 2018, 2015, 2012 and 2009 *International Plumbing Code*® (IPC), and is certified for use in water distribution systems and may have a maximum exposed surface area to volume ratio of 216 square inches per 1000 gallons (3785 L) for water treatment applications.

5.0 CONDITIONS OF USE:

The Pure110+ Epoxy Adhesive Anchor System and Post-installed Reinforcing Bar Connections described in this report comply with or is a suitable alternative to what is specified in the codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Pure110+ epoxy Adhesive Anchors System and Post-installed Reinforcing Bar Connections must be installed in accordance with the Manufacturer's printed installation instructions (MPII) as attached to each cartridge and reproduced in Figure 4A and 4B of this report.

5.2 The Adhesive Anchor System and Post-installed Reinforcing Bar Connections described in this report must be installed in cracked or uncracked normalweight concrete or lightweight concrete having a specified compressive strength, f'_c = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

5.3 The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.2 MPa). Steel anchor elements must be installed in concrete base materials in holes predrilled in accordance with the instructions provided in Figure 4A and 4B of this report.

5.4 The concrete shall have attained its minimum design strength prior to installation of the Adhesive Anchor System and Post-installed Reinforcing Bar Connections.

5.5 Loads applied to the Adhesive Anchor System and Post-installed Reinforcing Bar Connections must be adjusted in accordance with Section 1605.2 of the IBC for strength design and in accordance with Section 1605.3 of the IBC for allowable stress design.

5.6 Pure110+ epoxy Adhesive Anchors System and Post-installed Reinforcing Bar Connections are recognized for use to resist short and long-term loads, including wind and earthquake, subject to the conditions of this report.

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, and post-installed reinforcing bars must comply with Section 4.2.4 of this report.

5.8 Pure110+ epoxy Adhesive Anchors System and Post-installed Reinforcing Bar Connections are permitted to be installed in concrete that is cracked or that may be expected to crack during the service life of the anchors or post-installed reinforcing bar, subject to the conditions of this report.

5.9 Adhesive anchor strength design values must be established in accordance with Section 4.1 of this report.

5.10 Post-installed reinforcing bar connection development and splice length is established in accordance with Section 4.2 of this report.

5.11 Allowable stress design values must be established in accordance with Section 4.3 of this report.

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

5.13 Post-installed reinforcing bar connection spacing, minimum member thickness, and cover distance must be in accordance with the provisions of ACI 318 for cast-in place bars and Section 4.2.3 of this report.

5.14 Prior to 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.

5.15 Pure110+ epoxy Adhesive Anchors System and Post-installed Reinforcing Bar Connections are not

permitted to support fire-resistive construction. Where not otherwise prohibited by the code, Pure110+ epoxy adhesive anchors and post-installed reinforcing bar connections are permitted for installation in fire-resistive construction provided that at least one of the following conditions is fulfilled:

- Pure110+ epoxy Adhesive Anchors System and Post-installed Reinforcing Bar Connections are used to resist wind or seismic forces only.
- Pure110+ epoxy Adhesive Anchors System and Post-installed Reinforcing Bar Connections 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.
- Pure110+ epoxy Adhesive Anchors System and Post-installed Reinforcing Bar Connections are used to support non-structural elements.

5.16 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of adhesive anchor system and post-installed reinforcing bar connections 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.

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

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

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

5.20 Periodic special inspection must be provided in accordance with Section 4.5 of this report. Continuous special inspection of adhesive anchor system and post-installed reinforcing bar connections installed in horizontal or upwardly inclined orientations to resist sustained tension loads must be provided in accordance with Section 4.5 of this report.

5.21 Pure110+ epoxy Adhesive Anchors System and Post-installed Reinforcing Bar Connections may be used to resist tension and shear forces in floor, wall and overhead installations into concrete with a temperature between 41°F and 104°F (5°C and 40°C). For overhead and upwardly inclined applications, cartridge temperature must be between 50°F and 90°F (10°C and 32°C) Overhead and upward inclined installations require the use of piston plugs and extension tubing during injection and the adhesive anchor or post-installed reinforcing bar connection system must be supported until fully cured (e.g. wedges or other suitable means). See the MPII in Figure 4A and 4B of this report for detailed installation requirements, including required installation equipment, procedures, and temperatures.

5.22 Installation of adhesive anchor system and post-installed reinforcing bar connections 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 318-19 26.7.1(l) and 26.7.2(e), 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.

5.23 The Pure110+ epoxy adhesive is manufactured under an approved 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 June 2019 (editorially revised February 2021), which incorporates requirements in ACI 355.4-19 and ACI 355.4-11 for use in cracked and uncracked concrete; including, but not limited to, tests under freeze/thaw conditions, tests under sustained load, tests for installation including installation direction, tests at elevated temperatures, tests for resistance to alkalinity, tests for resistance to sulfur, tests for seismic tension and shear, and tests for post-installed reinforcing bar connections.

7.0 IDENTIFICATION

7.1 The ICC-ES mark of conformity, electronic labeling, or the evaluation report (ICC-ES ESR-3298) along with the name, registered trademark, or registered logo of the report holder [and/or listee] must be included in the product label.[Electronic labeling is the ICC-ES web address (www.icc-es.org); specific URL related to the report; or the ICC-ES machine-readable code placed on the aforementioned items.]

7.2 In addition,the Pure110+ epoxy adhesive described in Section 3.1 of this report is identified by packaging labeled with the lot number; expiration date; company name (DEWALT); and the evaluation report number (ESR-3298). 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.

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

DEWALT
701 EAST JOPPA ROAD
TOWSON, MARYLAND 21286
(800) 524-3244
www.DEWALT.com
anchors@DEWALT.com

TABLE 1A—DESIGN USE AND REPORT TABLE INDEX FOR POST-INSTALLED ADHESIVE ANCHORS

POST-INSTALLED ADHESIVE ANCHORS – COMMON THREADED RODS AND REINFORCING BARS (Tables 4 through 11 and Figure 1)					
DESIGN STRENGTH[1]		**THREADED ROD (FRACTIONAL)**	**DEFORMED REINFORCING BAR (FRACTIONAL)**	**THREADED ROD (METRIC)**	**DEFORMED REINFORCING BAR (METRIC)**
Steel	N_{sa}, V_{sa}	Table 4	Table 5	Table 8	Table 9
Concrete	N_{cb}, N_{cbg}, V_{cb}, V_{cbg}, V_{cp}, V_{cpg}	Table 6	Table 6	Table 10	Table 10
Bond[2]	N_a, N_{ag}	Table 7	Table 7	Table 11	Table 11

Concrete Type	**Concrete State**	**Threaded Rod Diameter (inch)**	**Reinforcing Bar Size (No.)**	**Drilling Method[3]**	**Minimum and Maximum Embedment**	**Seismic Design Categories[4]**
Normal-weight and lightweight	Cracked	$^3/_8$, $^1/_2$, $^5/_8$, $^3/_4$, $^7/_8$, 1, $1^1/_4$	3, 4, 5, 6, 7, 8, 9, 10	Hammer-drill	See Table 7	A through F
	Uncracked	$^3/_8$, $^1/_2$, $^5/_8$, $^3/_4$, $^7/_8$, 1, $1^1/_4$	3, 4, 5, 6, 7, 8, 9, 10	Hammer-drill	See Table 7	A and B
Concrete Type	**Concrete State**	**Threaded Rod Diameter (mm)**	**Reinforcing Bar Size (Ø)**	**Drilling Method[3]**	**Minimum and Maximum Embedment**	**Seismic Design Categories[4]**
Normal-weight and lightweight	Cracked	10, 12, 16, 20, 24, 27, 30	10, 12, 14, 16, 20, 25, 28, 32	Hammer-drill	See Table 11	A through F
	Uncracked	10, 12, 16, 20, 24, 27, 30	10, 12, 14, 16, 20, 25, 28, 32	Hammer-drill	See Table 11	A and B

For **SI:** 1 inch = 25.4 mm. For **pound-inch** units: 1 mm = 0.03937 inch.

[1]Reference ACI 318-19 17.5.1, ACI 318-14 17.3.1.1 or 318-11 D.4.1.1, as applicable for post-installed adhesive anchors. The controlling strength is decisive from all appropriate failure modes (i.e. steel, concrete, bond) and design assumptions.
[2]See Section 4.1.4 of this report for bond strength determination of post-installed adhesive anchors.
[3]Hammer-drill, i.e. rotary impact drills or rock drills with a carbide drill bit (including hollow drill bits).
[4]See Section 4.1.11 for requirements for seismic design of post-installed adhesive anchors, where applicable.

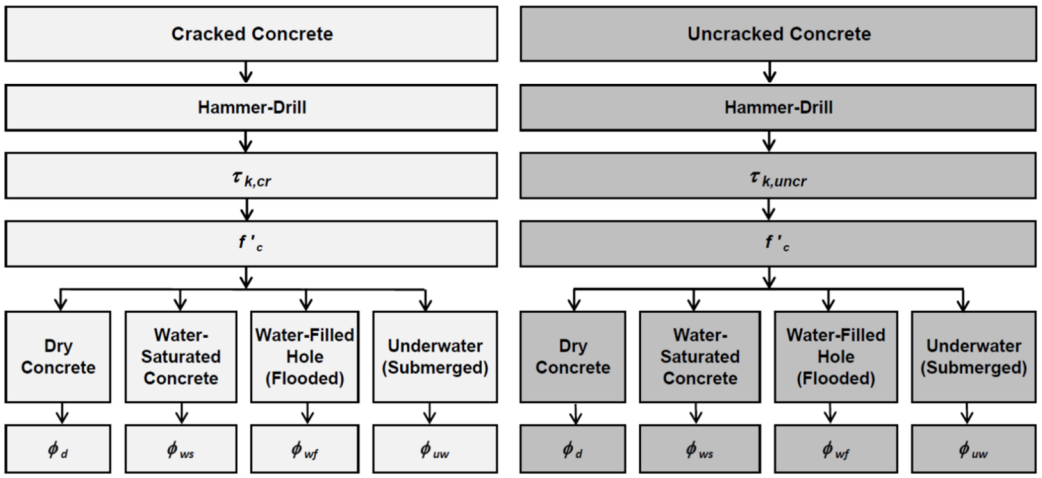


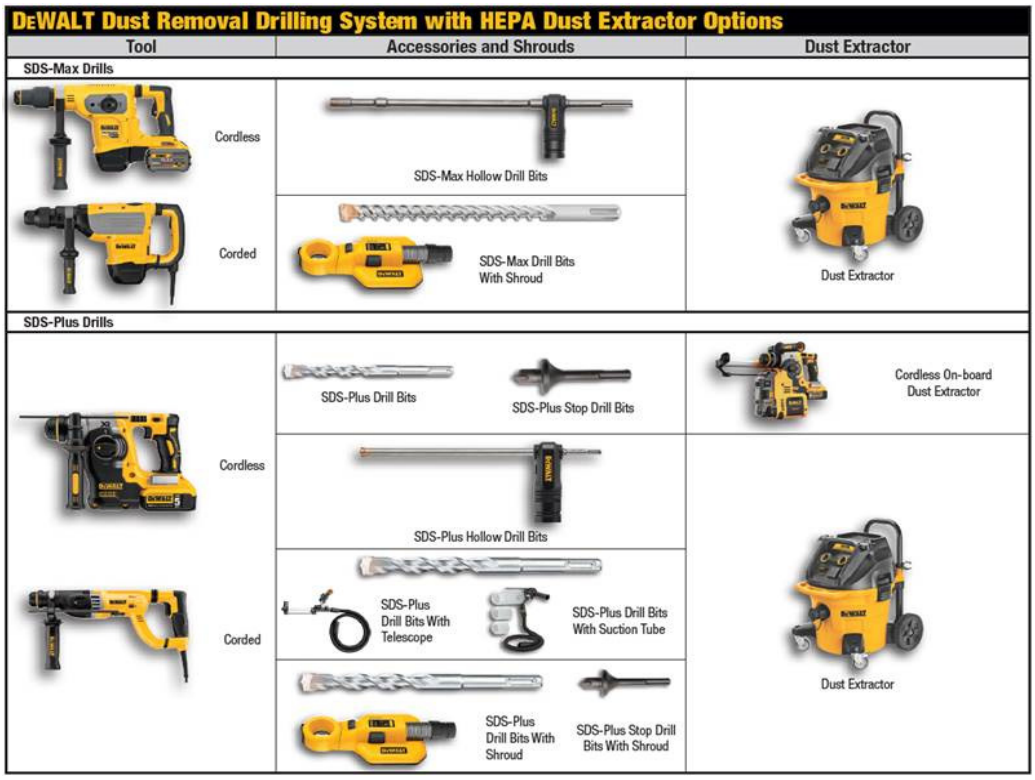
FIGURE 1—FLOWCHART FOR THE ESTABLISHMENT OF DESIGN BOND STRENGTH FOR POST-INSTALLED ADHESIVE ANCHORS

TABLE 1B—DESIGN USE AND REPORT TABLE INDEX FOR POST-INSTALLED REINFORCING BAR CONNECTIONS[1]

POST-INSTALLED REINFORCING BARS See Table 13 and Figure 3			
Concrete Type	**Reinforcing Bar Size**	**Drilling Method[2]**	**Seismic Design Categories[3]**
Normal-weight and lightweight	#3, #4, #5, #6, #7, #8, #9, #10, #11	Hammer-drill or core-drill	A through F
	Ø10, Ø12, Ø14, Ø16, Ø20, Ø25, Ø28, Ø32, Ø34, Ø36	Hammer-drill or core-drill	A through F
	10M, 15M, 20M, 25M, 30M, 35M	Hammer-drill or core-drill	A through F

For **SI:** 1 inch = 25.4 mm. For **pound-inch** units: 1 mm = 0.03937 inch.

[1]Determination of development length for post-installed reinforcing bar connections in accordance with this report.
[2]Hammer-drill, i.e. rotary impact drills or rock drills with a carbide drill bit (including hollow drill bits); core-drill, i.e. core drill with a diamond core drill bit.
[3]See Section 4.2.4 for requirements for seismic design of post-installed reinforcing bar connections, where applicable.



The DEWALT drilling systems shown above collect and remove dust with a HEPA dust extractor during the hole drilling operation in dry base materials using hammer-drills (see step 1 of the manufacturer's published installation instructions - MPII).

FIGURE A—EXAMPLES DEWALT DUST REMOVAL DRILLING SYSTEMS WITH HEPA DUST EXTRACTORS FOR ILLUSTRATION

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

THREADED ROD SPECIFICATION		UNITS	MIN. SPECIFIED ULTIMATE STRENGTH, f_{uta}	MIN. SPECIFIED YIELD STRENGTH 0.2 PERCENT OFFSET, f_{ya}	$\frac{f_{uta}}{f_{ya}}$	ELONGATION MINIMUM PERCENT[11]	REDUCTION OF AREA MIN. PERCENT	NUT SPECIFICATION[12]
Carbon Steel	ASTM A36[2] and F1554[3] Grade 36	psi (MPa)	58,000 (400)	36,000 (248)	1.61	23	40 (50 for A36)	ASTM A194 / A563 Grade A
	ASTM F1554[3] Grade 55	psi (MPa)	75,000 (517)	55,000 (380)	1.36	23	40	
	ASTM F1554[3] Grade 105	psi (MPa)	125,000 (862)	105,000 (724)	1.19	15	45	ASTM A194 / A563 Grade DH
	ASTM A193[4] Grade B7	psi (MPa)	125,000 (860)	105,000 (720)	1.19	16	50	
	ASTM A449[5] ($^3/_8$ to 1 inch dia.)	psi (MPa)	120,000 (828)	92,000 (635)	1.30	14	35	ASTM A194 / A563 Grade DH
	ASTM A449[5] ($1^1/_4$ inch dia.)	psi (MPa)	105,000 (720)	81,000 (560)	1.30	14	35	
	ASTM F568M[6] Class 5.8 (equivalent to ISO 898-1)	psi (MPa)	72,500 (500)	58,000 (400)	1.25	10	35	ASTM A563 Grade DH DIN 934 (8-A2K)[13]
	ISO 898-1[7] Class 5.8	MPa (psi)	500 (72,500)	400 (58,000)	1.25	22	-[14]	DIN 934 Grade 6
	ISO 898-1[7] Class 8.8	MPa (psi)	800 (116,000)	640 (92,800)	1.25	12	52	DIN 934 Grade 8
Stainless Steel	ASTM F593[8] CW1 ($^3/_8$ to $^5/_8$ inch dia.)	psi (MPa)	100,000 (690)	65,000 (450)	1.54	20	-[14]	ASTM F594 Alloy Group 1, 2 or 3
	ASTM F593[8] CW2 ($^3/_4$ to $1^1/_4$ inch dia.)	psi (MPa)	85,000 (590)	45,000 (310)	1.89	25	-[14]	
	ASTM A193/A193M[9] Grade B8/B8M, Class 1	psi (MPa)	75,000 (515)	30,000 (205)	2.50	30	50	ASTM A194/A194M
	ASTM A193/A193M[9] Grade B8/B8M2, Class 2B	psi (MPa)	95,000 (655)	75,000 (515)	1.27	25	40	
	ISO 3506-1[10] A4-70 and HCR-70 (M8 – M24)	MPa (psi)	700 (101,500)	450 (65,250)	1.56	40	-[14]	ISO 4032
	ISO 3506-1[10] A4-50 and HCR-50 (M27 – M30)	MPa (psi)	500 (72,500)	210 (30,450)	2.38	40	-[14]	

For **SI:** 1 inch = 25.4 mm, 1 psi = 0.006897 MPa. For **pound-inch** units: 1 mm = 0.03937 inch, 1 MPa = 145.0 psi.

See Table 2 Notes on the Following Page

Table 2 Notes (Continued)

[1]Pure110+ epoxy adhesive may be used in conjunction with all grades of continuously threaded carbon or stainless steels (all-thread) that comply with this table and that have thread characteristics comparable with ANSI B1.1 UNC Coarse Thread Series or ANSI B1.13M M Profile Metric Thread Series. Tabulated values correspond to anchor diameters included in this report. See Section 3.2.4.3 of this report for ductility of steel anchor elements.

[2]*Standard Specification for Carbon Structural Steel.*

[3]*Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.*

[4]*Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.*

[5]*Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.*

[6]*Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.*

[7]*Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs*

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

[9]*Standard Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*.

[10] *Mechanical properties of fasteners made of corrosion-resistant stainless steel fasteners – Part 1: Bolts, screws and studs*

[11]Based on 2-inch (50 mm) gauge length except ASTM A193, which are based on a gauge length of 4*d* and ISO 898, which is based on 5*d*; *d* = nominal diameter.

[12]Nuts 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. Material types of the nuts and washers must be matched to the threaded rods.

[13]Nuts for metric rods.

[14]Minimum percent reduction of area not reported in the referenced standard.

TABLE 3—SPECIFICATIONS AND PROPERTIES OF COMMON STEEL REINFORCING BARS[1]

REINFORCING SPECIFICATION	UNITS	MINIMUM SPECIFIED ULTIMATE STRENGTH, f_{uta}	MINIMUM SPECIFIED YIELD STRENGTH, f_{ya}
ASTM A615[2], A767[4], Grade 75	psi (MPa)	100,000 (690)	75,000 (520)
ASTM A615[2], A767[4], Grade 60	psi (MPa)	90,000 (620)	60,000 (420)
ASTM A706[3], A767[4], Grade 60	psi (MPa)	80,000 (550)	60,000 (420)
ASTM A615[2], A767[4], Grade 40	psi (MPa)	60,000 (420)	40,000 (280)
DIN 488[5] BSt 500	MPa (psi)	550 (80,000)	500 (72,500)
CAN/CSA G30.18[6], Grade 400	MPa (psi)	540 (78,300)	400 (58,000)

For **SI:** 1 psi = 0.006897 MPa. For **pound-inch** units: 1 MPa = 145.0 psi.

[1]Adhesive must be used with specified deformed reinforcing bars. Tabulated values correspond to bar sizes included in this report.

[2]*Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.* Grade 40 and Grade 60 bars furnished to specification are considered ductile elements. In accordance with ACI 318-19 17.10.5.3(a)(vi), ACI 318-14 17.2.3.4.3(a)(vi) or ACI 318-11 D.3.3.4.3(a)6, as applicable, deformed reinforcing bars meeting this specification used as ductile steel elements to resist earthquake effects shall be limited to reinforcing bars satisfying the requirements of ACI 318 (-19 or -14) 20.2.2.4 and 20.2.2.5 or ACI 318-11 21.1.5.2(a) and (b), as applicable. Grade 75 bars furnished to specification are considered brittle elements unless evidence is otherwise shown to the satisfaction of the registered design professional and code official in accordance with Section 3.2.4.3 of this report.

[3]*Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.* Bars furnished to specification are considered ductile elements.

[4]*Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.* Bars furnished to specification are considered brittle elements unless evidence is otherwise shown to the satisfaction of the registered design professional and code official in accordance with Section 3.2.4.3 of this report.

[5]*Reinforcing steel; reinforcing steel bars; dimensions and masses*. Bars furnished to this specification are considered brittle elements unless evidence is otherwise shown to the satisfaction of the registered design professional and code official in accordance with Section 3.2.4.3 of this report.

[6]*Billet bars for Concrete Reinforcement.*

TABLE 4—STEEL DESIGN INFORMATION FOR FRACTIONAL THREADED ROD

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL ROD DIAMETER[1] (inch)						
				3/8	1/2	5/8	3/4	7/8	1	1 1/4
Threaded rod nominal outside diameter		d	inch (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 effective cross-sectional area		A_{se}	inch² (mm²)	0.0775 (50)	0.1419 (92)	0.2260 (146)	0.3345 (216)	0.4617 (298)	0.6057 (391)	0.9691 (625)
ASTM A36 and ASTM F1554 Grade 36	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (kN)	4,495 (20.0)	8,230 (36.6)	13,110 (58.3)	19,400 (86.3)	26,780 (119.1)	35,130 (156.3)	56,210 (250.0)
		V_{sa}	lbf (kN)	2,695 (12.0)	4,940 (22.0)	7,860 (35.0)	11,640 (51.8)	16,070 (71.4)	21,080 (93.8)	33,725 (150.0)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.80						
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ASTM F1554 Grade 55	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (kN)	5,810 (25.9)	10,640 (47.3)	16,950 (75.4)	25,085 (111.6)	34,625 (154.0)	45,425 (202.0)	72,680 (323.3)
		V_{sa}	lbf (kN)	3,485 (15.5)	6,385 (28.4)	10,170 (45.2)	15,050 (67.0)	20,775 (92.4)	27,255 (121.2)	43,610 (194.0)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.80						
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ASTM A193 Grade B7 and ASTM F1554 Grade 105	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (kN)	9,685 (43.1)	17,735 (78.9)	28,250 (125.7)	41,810 (186.0)	57,710 (256.7)	75,710 (336.8)	121,135 (538.8)
		V_{sa}	lbf (kN)	5,815 (25.9)	10,640 (7.3)	16,950 (75.4)	25,085 (111.6)	34,625 (154.0)	45,425 (202.1)	72,680 (323.3)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.80						
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ASTM A449	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (kN)	9,300 (41.4)	17,025 (75.7)	27,120 (120.6)	40,140 (178.5)	55,905 (248.7)	72,685 (323.3)	101,755 (452.6)
		V_{sa}	lbf (kN)	5,580 (24.8)	10,215 (45.4)	16,270 (72.4)	24,085 (107.1)	33,540 (149.2)	43,610 (194.0)	61,050 (271.6)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.80						
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ISO 898-1 Class 5.8	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (kN)	5,620 (25.0)	10,290 (45.8)	16,385 (72.9)	24,250 (107.9)	33,475 (148.9)	43,915 (195.4)	[5]
		V_{sa}	lbf (kN)	3,370 (15.0)	6,175 (27.5)	9,830 (43.7)	14,550 (64.7)	20,085 (89.3)	26,350 (117.2)	[5]
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.80						[5]
	Strength reduction factor for tension[3]	ϕ	-	0.65						
	Strength reduction factor for shear[3]	ϕ	-	0.60						
ASTM F593 CW Stainless (Types 304 and 316)	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	28,430 (126.5)	39,245 (174.6)	51,485 (229.0)	82,370 (366.4)
		V_{sa}	lbf (kN)	4,650 (20.7)	8,515 (37.9)	13,560 (60.3)	17,060 (75.9)	23,545 (104.7)	30,890 (137.4)	49,425 (219.8)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.70		0.80				
	Strength reduction factor for tension[3]	ϕ	-	0.65						
	Strength reduction factor for shear[3]	ϕ	-	0.60						
ASTM A193 Grade B8/B8M, Class 1 Stainless (Types 304 and 316)	Nominal strength as governed by steel strength (for a single anchor)[4]	N_{sa}	lbf (kN)	4,420 (19.7)	8,090 (36.0)	12,880 (57.3)	19,065 (84.8)	26,315 (117.1)	34,525 (153.6)	55,240 (245.7)
		V_{sa}	lbf (kN)	2,650 (11.8)	4,855 (21.6)	7,730 (34.4)	11,440 (50.9)	15,790 (70.2)	20715 (92.1)	33,145 (147.4)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.70		0.80				
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ASTM A193 Grade B8/B8M2, Class 2B Stainless (Types 304 and 316)	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (kN)	7,365 (32.8)	13,480 (60.0)	21,470 (95.5)	31,775 (141.3)	43,860 (195.1)	57,545 (256.0)	92,065 (409.5)
		V_{sa}	lbf (kN)	4,420 (19.7)	8,085 (36.0)	12,880 (57.3)	19,065 (84.8)	26,315 (117.1)	34,525 (153.6)	55,240 (245.7)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.70		0.80				
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						

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

[1]Values provided for steel element material types are based on minimum specified strengths and calculated in accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2(b), 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, except where noted. Nuts and washers must be appropriate for the rod. See Table 2 for nut specifications.

[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable are used in accordance with ACI 318-19 17.5.3, 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. Values correspond to ductile steel elements.

[3]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable are used in accordance with ACI 318-19 17.5.3, 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. Values correspond to brittle steel elements.

[4]In accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2, ACI 318-14 17.4.1.2 and 17.5.1.2 or ACI 318-11 D.5.1.2 and D.6.1.2, as applicable, the calculated values for nominal tension and shear strength for ASTM A193 Grade B8/B8M Class 1 stainless steel threaded rods are based on limiting the specified tensile strength of the anchor steel to $1.9f_y$ or 57,000 psi (393 MPa).

[5]The referenced standard includes rod diameters up to and including 1-inch (24 mm).

TABLE 5—STEEL DESIGN INFORMATION FOR FRACTIONAL REINFORCING BARS

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL REINFORCING BAR SIZE (REBAR)[1]							
				#3	#4	#5	#6	#7	#8	#9	#10
Rebar nominal outside diameter		d	inch (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)	1.125 (28.7)	1.250 (32.3)
Rebar effective cross-sectional area		A_{se}	inch^2 (mm^2)	0.110 (71.0)	0.200 (129.0)	0.310 (200.0)	0.440 (283.9)	0.600 (387.1)	0.790 (509.7)	1.000 (645.2)	1.270 (819.4)
ASTM A615 Grade 75	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (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}	lbf (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		0.80					
	Strength reduction factor for tension[3]	ϕ	-	0.65							
	Strength reduction factor for shear[3]	ϕ	-	0.60							
ASTM A615 Grade 60	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (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}	lbf (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		0.80					
	Strength reduction factor for tension[3]	ϕ	-	0.65							
	Strength reduction factor for shear[3]	ϕ	-	0.60							
ASTM A706 Grade 60	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (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}	lbf (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		0.80					
	Strength reduction factor for tension[2]	ϕ	-	0.75							
	Strength reduction factor for shear[2]	ϕ	-	0.65							
ASTM A615 Grade 40	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	Lbf (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	In accordance with ASTM A615, Grade 40 bars are furnished only in sizes No. 3 through No. 6			
		V_{sa}	Lbf (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		0.80					
	Strength reduction factor for tension[3]	ϕ	-	0.65							
	Strength reduction factor for shear[3]	ϕ	-	0.60							

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

[1]Values provided for reinforcing bar material types based on minimum specified strengths and calculated in accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2(b), ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b 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 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-19 17.5.3, 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. Values correspond to ductile steel elements. In accordance with ACI 318-19 17.10.5.3(a)(vi), ACI 318-14 17.2.3.4.3(a)(vi) or ACI 318-11 D.3.3.4.3 (a) 6, as applicable, deformed reinforcing bars meeting this specification used as ductile steel elements to resist earthquake effects shall be limited to reinforcing bars satisfying the requirements of ACI 318 (-19 or -14) 20.2.2.4 and 20.2.2.5 or ACI 318-11 21.1.5.2 (a) and (b) as applicable.

[3]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-19 17.5.3, 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. Values correspond to brittle steel elements.

TABLE 6—CONCRETE BREAKOUT DESIGN INFORMATION FOR FRACTIONAL THREADED ROD AND REINFORCING BARS[1]

DESIGN INFORMATION	SYMBOL	UNITS	NOMINAL ROD DIAMETER (inch) / REINFORCING BAR SIZE							
			3/8 or #3	1/2 or #4	5/8 or #5	3/4 or #6	7/8 or #7	1 or #8	#9	1 1/4 or #10
Effectiveness factor for cracked concrete	$k_{c,cr}$	- (SI)	17 (7.1)							
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	- (SI)	24 (10.0)							
Minimum embedment	$h_{ef,min}$	inch (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 1/2 (89)	4 (102)	4 1/2 (114)	5 (127)
Maximum embedment	$h_{ef,max}$	inch (mm)	7 1/2 (191)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	22 1/2 (572)	25 (635)
Minimum anchor spacing	s_{min}	inch (mm)	1 7/8 (48)	2 1/2 (64)	3 1/8 (79)	3 3/4 (95)	4 3/8 (111)	5 (127)	5 5/8 (143)	6 1/4 (159)
Minimum edge distance	c_{min}	inch (mm)	5*d* where *d* is nominal outside diameter of the anchor; or see Section 4.1.9 of this report for design with reduced minimum edge distances down to the following values:							
			1 3/4 (45)						2 3/4 (70)	
Minimum member thickness	h_{min}	inch (mm)	h_{ef} + 1 1/4 (h_{ef} + 30)	h_{ef} + 2d_o where d_o is hole diameter; for installation parameters see Table 12 of this report						
Critical edge distance—splitting (for uncracked concrete only)	c_{ac}	nch (mm)	See Section 4.1.10 of this report							
Strength reduction factor for tension, concrete failure modes, Condition B, (supplemental reinforcement not present)[2] [concrete breakout]	ϕ	-	0.65							
Strength reduction factor for shear, concrete failure modes, Condition B, (supplemental reinforcement not present)[2] [concrete breakout and pryout]	ϕ	-	0.70							

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.448 N. For **pound-inch** units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf.

[1]Additional setting information is described in Table 12 and in the installation instructions, Figure 4A of this report.

[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pryout governs, as set forth in ACI 318-19 17.5.3, 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 or ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-19 17.5.3, 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 FRACTIONAL THREADED RODS AND REINFORCING BARS[1]

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL ROD DIAMETER (inch)						
				3/8	1/2	5/8	3/4	7/8	1	1 1/4
Minimum embedment		$h_{ef,min}$	inch (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 1/2 (89)	4 (102)	5 (127)
Maximum embedment		$h_{ef,max}$	inch (mm)	7 1/2 (191)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	25 (635)
110°F (43°C) Maximum long-term service temperature; 140°F (60°C) maximum short-term service temperature[3,5] with Threaded Rods	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	psi (N/mm²)	1,206 (8.3)	1,206 (8.3)	1,206 (8.3)	1,206 (8.3)	1,206 (8.3)	1,206 (8.3)	1,206 (8.3)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		psi (N/mm²)	1,206 (8.3)	1,206 (8.3)	1,206 (8.3)	1,206 (8.3)	1,206 (8.3)	1,206 (8.3)	1,206 (8.3)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	psi (N/mm²)	1,829 (12.6)	1,738 (12.0)	1,671 (11.5)	1,617 (11.1)	1,567 (10.8)	1,538 (10.6)	1,479 (10.2)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		psi (N/mm²)	1,829 (12.6)	1,738 (12.0)	1,671 (11.5)	1,617 (11.1)	1,567 (10.8)	1,538 (10.6)	1,479 (10.2)
110°F (43°C) Maximum long-term service temperature; 176°F (80°C) maximum short-term service temperature[4,5] with Threaded Rods	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	psi (N/mm²)	882 (6.1)	882 (6.1)	882 (6.1)	882 (6.1)	882 (6.1)	882 (6.1)	882 (6.1)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		psi (N/mm²)	882 (6.1)	882 (6.1)	882 (6.1)	882 (6.1)	882 (6.1)	882 (6.1)	882 (6.1)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	psi (N/mm²)	1,334 (9.2)	1,262 (8.7)	1,218 (8.4)	1,175 (8.1)	1,146 (7.9)	1,117 (7.7)	1,073 (7.4)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		psi (N/mm²)	1,334 (9.2)	1,262 (8.7)	1,218 (8.4)	1,175 (8.1)	1,146 (7.9)	1,117 (7.7)	1,073 (7.4)

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL REINFORCING BAR SIZE							
				#3	#4	#5	#6	#7	#8	#9	#10
Minimum embedment		$h_{ef,min}$	inch (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 1/2 (89)	4 (102)	4 1/2 (114)	5 (127)
Maximum embedment		$h_{ef,max}$	inch (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)
110°F (43°C) Maximum long-term service temperature; 140°F (60°C) maximum short-term service temperature[3,5] with Rebars	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	psi (N/mm²)	1,206 (8.3)	1,170 (8.1)	1,122 (7.7)	1,122 (7.7)	1,122 (7.7)	1,122 (7.7)	1,122 (7.7)	1,122 (7.7)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		psi (N/mm²)	1,206 (8.3)	1,170 (8.1)	1,122 (7.7)	1,122 (7.7)	1,122 (7.7)	1,122 (7.7)	1,122 (7.7)	1,122 (7.7)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	psi (N/mm²)	1,829 (12.6)	1,738 (12.0)	1,671 (11.5)	1,617 (11.1)	1,567 (10.8)	1,538 (10.6)	1,507 (10.4)	1,479 (10.2)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		psi (N/mm²)	1,829 (12.6)	1,738 (12.0)	1,671 (11.5)	1,617 (11.1)	1,567 (10.8)	1,538 (10.6)	1,507 (10.4)	1,479 (10.2)
110°F (43°C) Maximum long-term service temperature; 176°F (80°C) maximum short-term service temperature[4,5] with Rebars	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	psi (N/mm²)	882 (6.1)	848 (5.8)	814 (5.6)	814 (5.6)	814 (5.6)	814 (5.6)	814 (5.6)	814 (5.6)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		psi (N/mm²)	882 (6.1)	848 (5.8)	814 (5.6)	814 (5.6)	814 (5.6)	814 (5.6)	814 (5.6)	814 (5.6)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	psi (N/mm²)	1,334 (9.2)	1,262 (8.7)	1,218 (8.4)	1,175 (8.1)	1,146 (7.9)	1,117 (7.7)	1,102 (7.6)	1,073 (7.4)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		psi (N/mm²)	1,334 (9.2)	1,262 (8.7)	1,218 (8.4)	1,175 (8.1)	1,146 (7.9)	1,117 (7.7)	1,102 (7.6)	1,073 (7.4)

Permissible installation conditions[7]	Dry concrete	Anchor Category		1							
		ϕ_d		0.65							
	Water-saturated concrete, Water-filled hole (flooded)	Anchor Category		2							
		ϕ_{ws}, ϕ_{wf},		0.55							
	Underwater (submerged)	Anchor Category		2					3		
		ϕ_{uw}		0.55					0.45		
Reduction factor for seismic tension[9]		$\alpha_{N,seis}$		1.0							

For **SI:** 1 inch = 25.4 mm, 1 psi = 0.006894 MPa. For **pound-inch** units: 1 mm = 0.03937 inch, 1 MPa = 145.0 psi.

[1]Bond strength values correspond to a normal-weight concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c between 2,500 psi and 8,000 psi (17.2 MPa and 55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.23}$ [For **SI:** $(f'_c / 17.2)^{0.23}$]. See Section 4.1.4 of this report for bond strength determination.

[2]The modification factor for bond strength of adhesive anchors in lightweight concrete shall be taken as given in ACI 318-19 17.2.4, ACI 318-14 17.2.6 or ACI 318-11 D.3.6, as applicable, where applicable.

[3]The maximum short-term service temperature may be increased to 162°F (72°C) provided characteristic bond strengths are reduced by 3 percent. Long-term and short-term temperatures meet the requirements of Section 8.5 of ACI 355.4 and Table 8.1, Temperature Category B.

[4]Long-term and short-term temperatures meet the requirements of Section 8.5 of ACI 355.4 and Table 8.1, Temperature Category A.

[5]Short-term base material service temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling. Long-term base material service temperatures are roughly constant over significant periods of time.

[6]Characteristic bond strengths are for sustained loads including dead and live loads.

[7]Permissible installation conditions include dry concrete, water-saturated concrete, water-filled holes and underwater. Water-filled holes include applications in dry or water-saturated concrete where the drilled holes contain standing water during anchor installation. For installation instructions see Figure 4A of this report.

[8]Bond strength values for uncracked concrete are applicable for structures assigned to Seismic Design Categories A and B only.

[9]For structures assigned to Seismic Design Categories C, D, E or F, the tabulated bond strength values for cracked concrete do not require an additional reduction factor applied for seismic tension ($\alpha_{N,seis}$ = 1.0), where seismic design is applicable. See Section 4.1.11 of this report for requirements for seismic design.

TABLE 8—STEEL DESIGN INFORMATION FOR METRIC THREADED RODS

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL ROD DIAMETER[1] (mm)						
				10	12	16	20	24	27	30
Threaded rod nominal outside diameter		d	mm (inch)	10 (0.39)	12 (0.47)	16 (0.63)	20 (0.79)	24 (0.94)	27 (1.06)	30 (1.18)
Threaded rod effective cross-sectional area		A_{se}	mm² (inch²)	58.0 (0.090)	84.3 (0.131)	157 (0.243)	245 (0.380)	353 (0.547)	459 (0.711)	561 (0.870)
ISO 898-1 Class 5.8	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	kN (lbf)	29.0 (6,520)	42.0 (9,475)	78.5 (17,645)	122.5 (27,540)	176.5 (39,680)	229.5 (51,595)	280.5 (63,060)
		V_{sa}	kN (lbf)	17.4 (3,910)	25.5 (5,685)	47.0 (10,590)	73.5 (16,525)	106.0 (23,805)	137.5 (30,956)	168.5 (37,835)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.80						
	Strength reduction factor for tension[3]	ϕ	-	0.65						
	Strength reduction factor for shear[3]	ϕ	-	0.60						
ISO 898-1 Class 8.8	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	kN (lbf)	46.5 (10,430)	67.5 (15,160)	125.5 (28,235)	196.0 (44,065)	282.5 (63,485)	367.0 (82,550)	449.0 (100,895)
		V_{sa}	kN (lbf)	27.9 (6,270)	40.5 (9,095)	75.5 (16,940)	117.5 (26,440)	169.5 (38,090)	220.5 (49,530)	269.5 (60,535)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.80						
	Strength reduction factor for tension[3]	ϕ	-	0.65						
	Strength reduction factor for shear[3]	ϕ	-	0.60						
ISO 3506-1 Stainless Grades A4 and HCR	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	kN (lbf)	40.6 (9,125)	59.0 (13,265)	109.9 (24,705)	171.5 (38,555)	247.1 (55,550)	229.5 (51,595)	280.5 (63,060)
		V_{sa}	kN (lbf)	24.4 (5,475)	35.4 (7,960)	65.9 (14,825)	102.9 (23,135)	148.3 (33,330)	137.7 (30,955)	168.3 (37,835)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.80						
	Strength reduction factor for tension[3]	ϕ	-	0.65						
	Strength reduction factor for shear[3]	ϕ	-	0.60						
ASTM A193M Grade B8/B8M, Class 1 Stainless (Types 304 and 316)	Nominal strength as governed by steel strength (for a single anchor)[4]	N_{sa}	kN (lbf)	22.8 (5,125)	33.1 (7,450)	61.7 (13,870)	96.3 (21,645)	138.7 (21,645)	180.4 (40,455)	220.5 (49,465)
		V_{sa}	kN (lbf)	13.7 (3,075)	19.9 (4,470)	37.0 (8,325)	57.8 (12,990)	83.2 (18,715)	108.2 (24,335)	132.3 (29,740)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.80						
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ASTM A193M Grade B8/B8M2, Class 2B Stainless (Types 304 and 316)	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	kN (lbf)	38.0 (8,540)	55.2 (12,415)	102.8 (23,120)	160.5 (36,080)	231.2 (51,980)	300.6 (67,590)	367.5 (82,610)
		V_{sa}	kN (lbf)	22.8 (5,125)	33.1 (7,450)	61.7 (13,870)	96.3 (21,645)	138.7 (21,645)	180.4 (40,455)	220.5 (49,465)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.80						
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						

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

[1]Values provided for steel element material types are based on minimum specified strengths and calculated in accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2(b), ACI 318-11 Eq. (D-2) and Eq. (D-29) except where noted. Nuts and washers must be appropriate for the rod. See Table 2 for nut specifications.

[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-19 17.5.3, 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. Values correspond to ductile steel elements.

[3]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable are used in accordance with ACI 318-19 17.5.3, 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. Values correspond to brittle steel elements.

[4]In accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2, ACI 318 D.5.1.2 and D.6.1.2 the calculated values for nominal tension and shear strength for ASTM A193 Grade B8/B8M Class 1 stainless steel threaded rods are based on limiting the specified tensile strength of the anchor steel to $1.9f_y$ or 393 MPa (57,000 psi).

TABLE 9—STEEL DESIGN INFORMATION FOR METRIC REINFORCING BARS[1]

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL REINFORCING BAR SIZE (Ø)							
				Ø10	Ø12	Ø14	Ø16	Ø20	Ø25	Ø28	Ø32
Rebar nominal outside diameter		d	mm (inch)	10.0 (0.394)	12.0 (0.472)	14.0 (0.551)	16.0 (0.630)	20.0 (0.787)	25.0 (0.984)	28.0 (1.102)	32.0 (1.260)
Rebar effective cross-sectional area		A_{se}	mm² (inch²)	78.5 (0.122)	113.1 (0.175)	153.9 (0.239)	201.1 (0.312)	314.2 (0.487)	490.9 (0.761)	615.8 (0.954)	804.2 (1.247)
DIN 488 BSt 500	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	kN (lbf)	43.0 (9,710)	62.0 (13,985)	84.5 (19,035)	110.5 (24,860)	173.0 (38,845)	270.0 (60,695)	338.5 (76,135)	442.5 (99,440)
		V_{sa}	kN (lbf)	26.0 (5,825)	37.5 (8,390)	51.0 (11,420)	66.5 (14,915)	103.0 (23,305)	162.0 (36,415)	203.0 (45,680)	265.5 (59,665)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.70		0.80					
	Strength reduction factor for tension[2]	ϕ	-	0.65							
	Strength reduction factor for shear[2]	ϕ	-	0.60							

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

[1]Values provided for reinforcing bar material types based on minimum specified strengths and calculated in accordance with ACI 318-19 Eq. 17.6.1.2 and Eq. 17.7.1.2(b), ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b 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 or ACI 318 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-19 17.5.3, 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. Values correspond to brittle steel elements.

TABLE 10—CONCRETE BREAKOUT DESIGN INFORMATION FOR METRIC THREADED ROD AND REINFORCING BARS[1]

DESIGN INFORMATION	SYMBOL	UNITS	NOMINAL ROD DIAMETER / REINFORCING BAR SIZE											
			M10 or Ø10	M12	Ø12	Ø14	M16 or Ø16	M20 or Ø20	M24	Ø25	M27	Ø28	M30	Ø32
Effectiveness factor for cracked concrete	$k_{c,cr}$	SI -	17 (7.1)											
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	SI -	24 (10.0)											
Minimum embedment	$h_{ef,min}$	mm (inch)	60 (2.4)	70 (2.8)	70 (2.8)	70 (2.8)	80 (3.2)	90 (3.6)	96 (3.8)	100 (3.9)	108 (4.3)	112 (4.4)	120 (4.7)	128 (5.0)
Maximum embedment	$h_{ef,max}$	mm (inch)	200 (7.8)	240 (14.8)	240 (14.8)	280 (11.0)	320 (12.6)	400 (15.8)	480 (18.8)	500 (19.6)	540 (21.4)	560 (22.0)	600 (23.6)	640 (25.2)
Minimum anchor spacing	s_{min}	mm (inch)	50 (2.0)	60 (2.4)	60 (2.4)	70 (3.7)	80 (3.2)	100 (4.0)	120 (4.8)	125 (4.9)	135 (5.3)	140 (5.5)	150 (5.9)	160 (6.3)
Minimum edge distance	c_{min}	mm (inch)	5d where d is nominal outside diameter of the anchor; or see Section 4.1.9 of this report for design with reduced minimum edge distances down to the following values:											
			45 (1.75)								70 (2.75)			
Minimum member thickness	h_{min}	mm (inch)	h_{ef} + 30 (h_{ef} + 1 1/4)	h_{ef} + 2d_o where d_o is hole diameter; for installation parameters see Table 12 of this report										
Critical edge distance—splitting (for uncracked concrete only)	c_{ac}	mm (inch)	See Section 4.1.10 of this report											
Strength reduction factor for tension, concrete failure modes, Condition B, (supplemental reinforcement not present)[2] [concrete breakout]	ϕ	-	0.65											
Strength reduction factor for shear, concrete failure modes, Condition B, (supplemental reinforcement not present)[2] [concrete breakout and pryout]	ϕ	-	0.70											

For **pound-inch** units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf. For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.448 N.

[1]Additional setting information is described in Table 12 and the installation instructions, Figure 4A of this report.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pryout governs, as set forth in ACI 318-19 17.5.3, 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 (-19 or -14) 5.3 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-19 17.5.3, 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.4.5.

TABLE 11—BOND STRENGTH DESIGN INFORMATION FOR METRIC THREADED RODS AND REINFORCING BARS[1]

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL ROD DIAMETER						
				M10	M12	M16	M20	M24	M27	M30
Minimum embedment		$h_{ef,min}$	mm (inch)	60 (2.4)	70 (2.8)	80 (3.2)	90 (3.6)	96 (3.8)	108 (4.3)	120 (4.7)
Maximum embedment		$h_{ef,max}$	mm (inch)	200 (7.8)	240 (14.8)	320 (12.6)	400 (15.8)	480 (18.8)	540 (21.4)	600 (23.6)
110°F (43°C) Maximum long-term service temperature; 140°F (60°C) maximum short-term service temperature[3,5] with Threaded Rods	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	N/mm² (psi)	8.3 (1205)	8.3 (1205)	8.3 (1205)	8.3 (1205)	8.3 (1205)	8.3 (1205)	8.3 (1205)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		N/mm² (psi)	8.3 (1205)	8.3 (1205)	8.3 (1205)	8.3 (1205)	8.3 (1205)	8.3 (1205)	8.3 (1205)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	N/mm² (psi)	12.5 (1813)	12.1 (1755)	11.5 (1668)	11.1 (1610)	10.7 (1552)	10.5 (1523)	10.3 (1494)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		N/mm² (psi)	12.5 (1813)	12.1 (1755)	11.5 (1668)	11.1 (1610)	10.7 (1552)	10.5 (1523)	10.3 (1494)
110°F (43°C) Maximum long-term service temperature; 176°F (80°C) maximum short-term service temperature[4,5] with Threaded Rods	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	N/mm² (psi)	6.1 (882)	6.1 (882)	6.1 (882)	6.1 (882)	6.1 (882)	6.1 (882)	6.1 (882)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		N/mm² (psi)	6.1 (882)	6.1 (882)	6.1 (882)	6.1 (882)	6.1 (882)	6.1 (882)	6.1 (882)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	N/mm² (psi)	9.1 (1320)	8.8 (1276)	8.4 (1218)	8.1 (1175)	7.8 (1131)	7.7 (1117)	7.5 (1088)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		N/mm² (psi)	9.1 (1320)	8.8 (1276)	8.4 (1218)	8.1 (1175)	7.8 (1131)	7.7 (1117)	7.5 (1088)

DESIGN INFORMATION		SYMBOL	UNITS	REINFORCING BAR SIZE							
				Ø10	Ø12	Ø14	Ø16	Ø20	Ø25	Ø28	Ø32
Minimum embedment		$h_{ef,min}$	mm (inch)	60 (2.4)	70 (2.8)	70 (2.8)	80 (3.2)	90 (3.6)	100 (3.9)	112 (4.4)	128 (5.0)
Maximum embedment		$h_{ef,max}$	mm (inch)	200 (7.8)	240 (14.8)	280 (11.0)	320 (12.6)	400 (15.8)	500 (19.6)	560 (22.0)	640 (25.2)
110°F (43°C) Maximum long-term service temperature; 140°F (60°C) maximum short-term service temperature[3,5] with Rebars	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	N/mm² (psi)	8.3 (1205)	8.1 (1171)	7.7 (1120)	7.7 (1120)	7.7 (1120)	7.7 (1120)	7.7 (1120)	7.7 (1120)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		N/mm² (psi)	8.3 (1205)	8.1 (1171)	7.7 (1120)	7.7 (1120)	7.7 (1120)	7.7 (1120)	7.7 (1120)	7.7 (1120)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	N/mm² (psi)	12.5 (1813)	12.1 (1755)	11.8 (1711)	11.5 (1668)	11.1 (1610)	10.6 (1537)	10.4 (1508)	10.2 (1479)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		N/mm² (psi)	12.5 (1813)	12.1 (1755)	11.8 (1711)	11.5 (1668)	11.1 (1610)	10.6 (1537)	10.4 (1508)	10.2 (1479)
110°F (43°C) Maximum long-term service temperature; 176°F (80°C) maximum short-term service temperature[4,5] with Rebars	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	N/mm² (psi)	6.1 (882)	5.9 (848)	5.6 (814)	5.6 (814)	5.6 (814)	5.6 (814)	5.6 (814)	5.6 (814)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		N/mm² (psi)	6.1 (882)	5.9 (848)	5.6 (814)	5.6 (814)	5.6 (814)	5.6 (814)	5.6 (814)	5.6 (814)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	N/mm² (psi)	9.1 (1320)	8.8 (1276)	8.6 (1247)	8.4 (1218)	8.1 (1175)	7.8 (1131)	7.6 (1102)	7.4 (1073)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		N/mm² (psi)	9.1 (1320)	8.8 (1276)	8.6 (1247)	8.4 (1218)	8.1 (1175)	7.8 (1131)	7.6 (1102)	7.4 (1073)
Permissible installation conditions[7]	Dry concrete	Anchor Category		1							
		ϕ_d		0.65							
	Water-saturated concrete, Water-filled hole (flooded)	Anchor Category		2							
		ϕ_{ws}, ϕ_{wf},		0.55							
	Underwater (submerged)	Anchor Category		2					3		
		ϕ_{uw}		0.55					0.45		
Reduction factor for seismic tension		$\alpha_{N,seis}$		1.0							

For **pound-inch** units: 1 mm = 0.03937 inch, 1 MPa = 145.0 psi. For **SI:** 1 inch = 25.4 mm, 1 psi = 0.006894 MPa.

[1]Bond strength values correspond to normal-weight concrete compressive strength f'_c = 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c between 2,500 psi and 8,000 psi (17.2 MPa and 55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.23}$ [For **SI:** $(f'_c / 17.2)^{0.23}$]. See Section 4.1.8 of this report for bond strength determination.

[2]The modification factor for bond strength of adhesive anchors in lightweight concrete shall be taken as given in ACI 318-19 17.2.4, ACI 318-14 17.2.6 or ACI 318-11 D.3.6, as applicable.

[3]The maximum short-term service temperature may be increased to 162°F (72°C) provided characteristic bond strengths are reduced by 3 percent. Long-term and short-term temperatures meet the requirements of Section 8.5 of ACI 355.4 and Table 8.1, Temperature Category B.

[4]Long-term and short-term temperatures meet the requirements of Section 8.5 of ACI 355.4 and Table 8.1, Temperature Category A.

[5]Short-term elevated concrete temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.

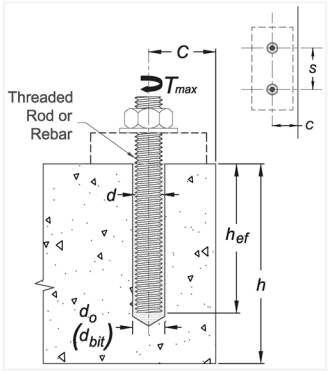
[6]Characteristic bond strengths are for sustained loads including dead and live loads.

[7]Permissible installation conditions include dry concrete, water-saturated concrete, water-filled holes and underwater. Water-filled holes include applications in dry or water-saturated concrete where the drilled holes contain standing water during anchor installation. For installation instructions see Figure 4A of this report.

[8]Bond strength values for uncracked concrete are applicable for structures assigned to Seismic Design Categories A and B only.

[9]For structures assigned to Seismic Design Categories C, D, E or F, the tabulated bond strength values for cracked concrete do not require an additional reduction factor applied for seismic tension ($\alpha_{N,seis}$ = 1.0), where seismic design is applicable. See Section 4.1.11 of this report for requirements for seismic design.

TABLE 12—INSTALLATION PARAMETERS FOR THREADED RODS AND REINFORCING BARS FOR POST-INSTALLED ADHESIVE ANCHORS[7]



PARAMETER	SYMBOL	UNITS	FRACTIONAL NOMINAL ROD DIAMETER (inch) / REINFORCING BAR SIZE								
			3/8 or #3	1/2 #4	5/8 or #5	3/4 or #6	7/8 or #7	1 or #8	#9	1 1/4	#10
Threaded rod outside diameter	d	inch (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)	-
Rebar nominal outside diameter	d	inch (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)	1.125 (28.7)	-	1.250 (31.8)
Carbide drill bit nominal size[6]	d_{bit} (d_o)	inch	7/16	9/16 5/8	11/16 or 3/4[5]	7/8	1	1 1/8	1 3/8	1 3/8	1 1/2
Minimum embedment	$h_{ef,min}$	inch (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 1/2 (89)	4 (102)	4 1/2 (114)	5 (127)	5 (127)
Maximum embedment	$h_{ef,max}$	inch (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)	25 (635)
Minimum member thickness	h_{min}	inch (mm)	h_{ef} + 1 1/4 (h_{ef} + 30)		h_{ef} + $2d_o$						
Minimum anchor spacing	s_{min}	inch (mm)	1 7/8 (48)	2 1/2 (64)	3 1/8 (79)	3 3/4 (95)	4 3/8 (111)	5 (127)	5 5/8 (143)	6 1/4 (159)	6 1/4 (159)
Minimum edge distance	c_{min}	inch (mm)	1 7/8 (48)	2 1/2 (64)	3 1/8 (79)	3 3/4 (95)	4 3/8 (111)	5 (127)	5 5/8 (143)	6 1/4 (159)	6 1/4 (159)
Max. torque[1]	T_{max}	ft-lbs	15	30	60	105	125	165	200	280	280
Max. torque[1,2] (low strength rods)	T_{max}	ft-lbs	5	20	40	60	100	165	-	280	-
Minimum edge distance, reduced[4]	$c_{min,red}$	inch (mm)	1 3/4 (45)	1 3/4 (45)	1 3/4 (45)	1 3/4 (45)	1 3/4 (45)	1 3/4 (45)	2 3/4 (70)	2 3/4 (70)	2 3/4 (70)
Max. torque, reduced[1]	$T_{max,red}$	ft-lbs	7 [5][3]	14	27	47	56	74	90	126	126

PARAMETER	SYMBOL	UNITS	METRIC NOMINAL ROD DIAMETER / REINFORCING BAR SIZE											
			M10 Ø10	M12 Ø12	Ø14	M16 Ø16	M20 Ø20	M24	Ø25	M27	Ø28	M30	Ø32	
Threaded rod outside diameter	d	mm (inch)	10 (0.39)	12 (0.47)	-	16 (0.63)	20 (0.79)	24 (0.94)	-	27 (1.06)	-	30 (1.18)	-	
Rebar nominal outside diameter	d	mm (inch)	10.0 (0.394)	12.0 (0.472)	14.0 (0.551)	16.0 (0.630)	20.0 (0.787)	-	25.0 (0.984)	-	28.0 (1.102)	-	32.0 (1.260)	
Carbide drill bit nominal size[6]	d_{bit} (d_o)	mm	12 14	14 16	18	18 20	24 25	28	32	32	35	35	38	
Minimum embedment	$h_{ef,min}$	mm (inch)	60 (2.4)	70 (2.8)	70 (2.8)	80 (3.2)	90 (3.6)	96 (3.8)	100 (3.9)	108 (4.3)	112 (4.4)	120 (4.7)	128 (5.0)	
Maximum embedment	$h_{ef,max}$	mm (inch)	200 (7.8)	240 (14.8)	280 (11.0)	320 (12.6)	400 (15.8)	480 (18.8)	500 (19.6)	540 (21.4)	560 (22.0)	600 (23.6)	640 (25.2)	
Minimum member thickness	h_{min}	mm (inch)	h_{ef} + 30 (h_{ef} + 1 1/4)		h_{ef} + $2d_o$									
Minimum anchor spacing	s_{min}	mm (inch)	50 (2.0)	60 (2.4)	70 (3.7)	80 (3.2)	100 (4.0)	120 (4.8)	125 (4.9)	135 (5.3)	140 (5.5)	150 (5.9)	160 (6.3)	
Minimum edge distance	c_{min}	mm (inch)	50 (2.0)	60 (2.4)	70 (3.7)	80 (3.2)	100 (4.0)	120 (4.8)	125 (4.9)	135 (5.3)	140 (5.5)	150 (5.9)	160 (6.3)	
Max. torque[1]	T_{max}	N-m	20	40	60	80	120	160	160	180	180	200	300	
Max. torque[1,3] (low strength rod)	T_{max}	N-m	7	20	-	40	100	160	-	180	-	200	-	
Minimum edge distance, reduced[4]	$c_{min,red}$	mm (inch)	45 (1 3/4)	45 (1 3/4)	45 (1 3/4)	45 (1 3/4)	45 (1 3/4)	45 (1 3/4)	45 (1 3/4)	45 (1 3/4)	70 (2 3/4)	70 (2 3/4)	70 (2 3/4)	
Max. torque, reduced[1]	$T_{max,red}$	N-m	9 [7][3]	18	27	36	54	72	72	81	81	90	135	

For **pound-inch** units: 1 mm = 0.03937 inch, 1 N-m = 0.7375 ft-lbf. For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m.

[1]Torque may not be applied to the anchors until the full cure time of the adhesive has been achieved.
[2]These torque values apply to ASTM A36 / F1554 Grade 36 carbon steel threaded rods; ASTM F1554 Grade 55 carbon steel threaded rods; and ASTM A193 Grade B8/B8M (Class 1) stainless steel threaded rods.
[3]These torque values apply to ASTM A193 Grade B8/B8M (Class 1) stainless steel threaded rod only.
[4]See Section 4.1.9 of this report for requirements of anchors installed at reduced edge distances.
[5]Either drill bit size listed is acceptable for threaded rod 5/8-inch diameter and rebar size No. 5.
[6]For any case, it must be possible for the steel anchor element to be inserted into the cleaned drill hole without resistance.
[7]The DEWALT DustX+ extraction system can be used to automatically clean holes drilled in concrete with a hammer-drill. See Figure A for an illustration of the DustX+ extraction system. The DustX+ extraction system is qualified for use in dry concrete and water saturated concrete, however, drilling in dry concrete is recommended by DEWALT when using hollow drill bits.

FIGURE 2—PURE110+ EPOXY ADHESIVE ANCHOR SYSTEM INCLUDING TYPICAL STEEL ANCHOR ELEMENTS

Pure110+ Instruction Card

DESCRIPTION:
Pure110+ is a high strength, 100% solids epoxy adhesive which is formulated for use in anchoring and rebar connection applications by trained professionals. Refer to installation instructions and SDS for additional detailed information.

PRECAUTION:
Safety glasses and dust masks should be used when drilling holes into concrete, stone and masonry. Wear gloves and safety glasses when handling and dispensing adhesive. Do not sand the adhesive and create silica dust which could be inhaled. Avoid skin and eye contact. Use a NIOSH-approved chemical mask to avoid respiratory discomfort if working indoors or in a confined area, or if sensitive to adhesive odors. Wash hands or other affected body parts with soap and water if skin contact occurs. Flush eyes with plenty of water and seek immediate medical attention if eye contact occurs. Move to fresh air if adhesive odor begins to cause discomfort.

IMPORTANT! Before using, read and review Safety Data Sheet (SDS).
This product contains crystalline silica and as supplied does not pose a dust hazard. IARC classifies crystalline silica (quartz sand) as a Group I carcinogen based upon evidence among workers in industries where there has been long-term and chronic exposure (via inhalation) to silica dust; e.g. mining, quarry, stone crushing, refractory brick and pottery workers. This product does not pose a dust hazard; therefore, this classification is not relevant. However, if reacted (fully cured) product is further processed (e.g. sanded, drilled) be sure to wear proper respiratory and eye protection to avoid health risk.

HANDLING AND STORAGE:
Store in a cool, dry, well ventilated area at temperatures between 41°F (5°C) and 86°F (30°C). Do not freeze. Store and keep away from flame, heat and light. Keep partially used containers closed when not in use. Protect from damage.

Note expiration date on product label before use. Do not use expired product. Partially used cartridges may be stored with hardened adhesive in the attached mixing nozzle. If the cartridge is reused, attach a new mixing nozzle and discard initial quantity of anchor adhesive as described in installation instructions.

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[I.] Pure110+ epoxy system selection table

Dispensers			Cartridges		Mixing nozzles
Tool	Size	Cat.#	Type	Size	Cat.#
Manual	Heavy Duty Caulk Gun	08437-PWR	Quik-shot (coaxial)	9 fl.oz. or 9.5 fl.oz.	PFC16406000 or 8609-PWR
Cordless		DCE560D1			
Manual	13.5 fl.oz.	DFC1610275	Dual tube	13.5 fl.oz	
Manual	20.5 fl.oz.	08409-PWR	Dual tube	20.5 fl.oz.	08609-PWR
Pneumatic		08413-PWR			
Cordless		DCE591D1			
Pneumatic	50.5 fl.oz.	08438-PWR	Dual tube	50.5 fl.oz.	08609-PWR

[II.] Gel (working) times and curing times for adhesive

Temperature of base material		Gel (working) time	Full curing time
41°F	5°C	120 minutes	48 hours
50°F	10°C	90 minutes	24 hours
68°F	20°C	25 minutes	8 hours
86°F	30°C	20 minutes	6 hours
95°F	35°C	15 minutes	6 hours
104°F	40°C	12 minutes	4 hours
110°F	43°C	10 minutes	4 hours

Linear interpolation for intermediate base material temperatures is possible.

[III.] Hole cleaning tools and accessories for Adhesive Anchors[1,2,3,4,5,6,7]

Fractional anchor sizes								Tools	Metric anchor sizes							
Rod dia. (inch)	Rebar size (No.)	Drill bit size (inch)	Brush size (inch)	Brush length (inches)	Wire brush (Cat. #)	Plug size (inch)	Piston plug (Cat. #)		Rod dia. (mm)	Rebar size (Ø)	Drill bit size (inch)	Brush size (mm)	Brush length (mm)	Wire brush (Cat. #)	Plug size (mm)	Piston plug (Cat. #)
3/8	3	7/16	7/16	6 3/4	08284	N/A	N/A	Wire brush	10	-	12	12	170	DFC1670100	N/A	N/A
1/2	-	9/16	9/16	6 3/4	08285	N/A	N/A	Brush extension	12	10	14	14	170	DFC1670150	N/A	N/A
-	4	5/8	5/8	6 3/4	08275	N/A	N/A	Drill chuck adaptor	-	12	16	16	200	DFC1670200	N/A	N/A
5/8	5	11/16	11/16	7 7/8	08286	11/16	08258		16	14	18	18	200	DFC1670250	18	08259
		3/4	3/4	7 7/8	08278	3/4	08259	SDS adaptor	-	16	20	20	300	DFC1670300	20	08259
3/4	6	7/8	7/8	7 7/8	08287	7/8	08300	Compressed air nozzle	20	20	25	25	300	DFC1670400	25	08301
7/8	7	1	1	11 7/8	08288	1	08301		24	-	28	28	300	DFC1670450	28	08303
1	8	1 1/8	1 1/8	11 7/8	08289	1 1/8	08303		27	25	32	32	300	DFC1670500	32	08307
1 1/4	9	1 3/8	1 3/8	11 7/8	08290	1 3/8	08305	Std. piston plug	30	28	35	35	300	DFC1670550	35	08305
-	10	1 1/2	1 1/2	11 7/8	08291	1 1/2	08309		-	32	38	38	300	DFC1670600	38	08309

[1]If the DEWALT DustX+ extraction system is used to automatically clean the holes during drilling, standard hole cleaning (brushing and blowing following drilling) is not required.
[2]Holes are drilled with hammer-drill (i.e. rotary impact drills or rock drills with a carbide drill bit, including the use of hollow drill bits).
[3]For any case, it must be possible for the anchor to be inserted into the cleaned drill hole without resistance.
[4]A brush extension (Cat. #08282) must be used with a steel wire brush for holes drilled deeper than the listed brush length.
[5]Brush adaptors for power tool connections are available for drill chuck (Cat.# 08296) and SDS (Cat.# 08283).
[6]A plastic extension tube (Cat# 08281 or 8297) or flexible extension hose (Cat.# PFC1640600) or equivalent approved by DEWALT must be used if the bottom or back of the anchor hole is not reached with the mixing nozzle only.
[7]All overhead (i.e upwardly inclined) installations require the use of piston plugs where one is tabulated together with the anchor size (see table). N/A = Not applicable.
All horizontal installations require the use of piston plugs where one is tabulated together with the anchor size and where the embedment depth is greater than 8 inches.
A plastic extension tube (Cat# 08281 or 08297) or equivalent approved by DEWALT must be used with piston plugs.
The use of piston plugs is also recommended for underwater installations where one is tabulated together with the anchor size.

[IV.] Installation parameters - Specifications for installation of threaded rods and reinforcing bars for Adhesive Anchors

Anchor property / Setting information	Nominal threaded rod / reinforcing bar size									
	3/8" or #3	1/2"	#4	5/8" or #5	3/4" or #6	7/8" or #7	1" or #8	#9	1 1/4"	#10
d = Threaded rod outside diameter (in.)	0.375	0.500		0.625	0.750	0.875	1.000	-	1.250	-
d = Nominal rebar diameter (in.)	0.375	0.500		0.625	0.750	0.875	1.000	1.125	-	1.250
d_{bit} (d_b) = Nominal ANSI drill bit size (in.)	7/16	9/16	5/8	11/16 or 3/4	7/8	1	1 1/8	1 3/8	1 3/8	1 1/2
$h_{ef,min}$ = Minimum embedment (inches)	2 3/8	2 3/4		3 1/8	3 1/2	3 1/2	4	4 1/2	5	5
$h_{ef,max}$ = Maximum embedment (inches)	4 1/2	10		12 1/2	15	17 1/2	20	22 1/2	25	25
h_{min} = Minimum member thickness (inches)	h_{ef} + 1 1/4			h_{ef} + $2d_o$, where d_o is hole diameter						
s_{min} = Minimum spacing (inches)	1 7/8	2 1/2		3 1/8	3 3/4	4 3/8	5	5 5/8	6 1/4	6 1/4
c_{min} = Minimum edge distance (inches)	1 7/8	2 1/2		3 1/8	3 3/4	4 3/8	5	5 5/8	6 1/4	6 1/4
T_{max} = Maximum torque (ft.-lb.)[1]	15	33		60	105	125	165	165	280	280
T_{max} = Maximum torque (ft.-lb.) for A36/Grade 36 and Grade 55 carbon steel rods and Grade B8/B8M (Class 1) stainless rods[2]	5	20		40	60	100	165	-	280	-
$c_{min,red}$ = Minimum edge distance, reduced (inches)	1 3/4	1 3/4		1 3/4	1 3/4	1 3/4	1 3/4	2 3/4	2 3/4	2 3/4
$T_{max,red}$ = Maximum torque (ft.-lb.), reduced edge[1]	7 [5][3]	14		27	47	56	74	90	126	126

Anchor property / Setting information	Nominal threaded rod / reinforcing bar size													
	M10	Ø10	M12	Ø12	Ø14	M16	Ø16	M20	Ø20	M24	Ø25	M27	Ø28	M30	Ø32
d = Threaded rod outside diameter (mm)	10		12		-	16		20		24	-	27	-	30	-
d = Nominal rebar diameter (mm)	10		12		14	16		20		-	25	-	28	-	32
d_{bit} (d_b) = Nominal ISO drill bit size (mm)	12	14	14	16	18	18	20	24	25	28	32	32	35	35	38
$h_{ef,min}$ = Minimum embedment (mm)	60		70		70	80		90		96	100	108	112	120	128
$h_{ef,max}$ = Maximum embedment (mm)	200		240		280	320		400		480	500	540	560	600	640
h_{min} = Minimum member thickness (mm)	h_{ef} + 1 1/4		h_{ef} + $2d_o$, where d_o is hole diameter												
s_{min} = Minimum spacing (mm)	50		60		70	80		100		120	125	135	140	150	160
c_{min} = Minimum edge distance (mm)	50		60		70	80		100		120	125	135	140	150	160
T_{max} = Maximum torque (N-m)[1]	20		40		60	80		120		160	160	180	180	200	300
T_{max} = Maximum torque (N-m), Grade B8/B8M SS[1,3]	7		20		-	40		100		160	-	180	-	200	-
$c_{min,red}$ = Minimum edge distance (mm), reduced	45		45		45	45		45		45	45	45	70	70	70
$T_{max,red}$ = Maximum torque (N-m), reduced edge[1]	9 [7][3]		18		27	36		54		72	72	81	81	90	135

[1]Torque may not be applied to the anchors until the full cure time of the adhesive has been achieved.
[2]These torque values apply to ASTM A 36 / F 1554 Grade 36 carbon steel threaded rods; ASTM F 1554 Grade 55 carbon steel threaded rods; and ASTM A 193 Grade B8/B8M (Class 1) stainless steel threaded rods or equivalent. Torque may not be applied to the anchors until the full cure time of the adhesive has been achieved.
[3]These torque values apply to ASTM A 193 Grade B8/B8M (Class 1) stainless steel threaded rod only.

FIGURE 4A—PURE110+® EPOXY ADHESIVE ANCHOR SYSTEM MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII)

Pure110+ Instruction Card (continued)

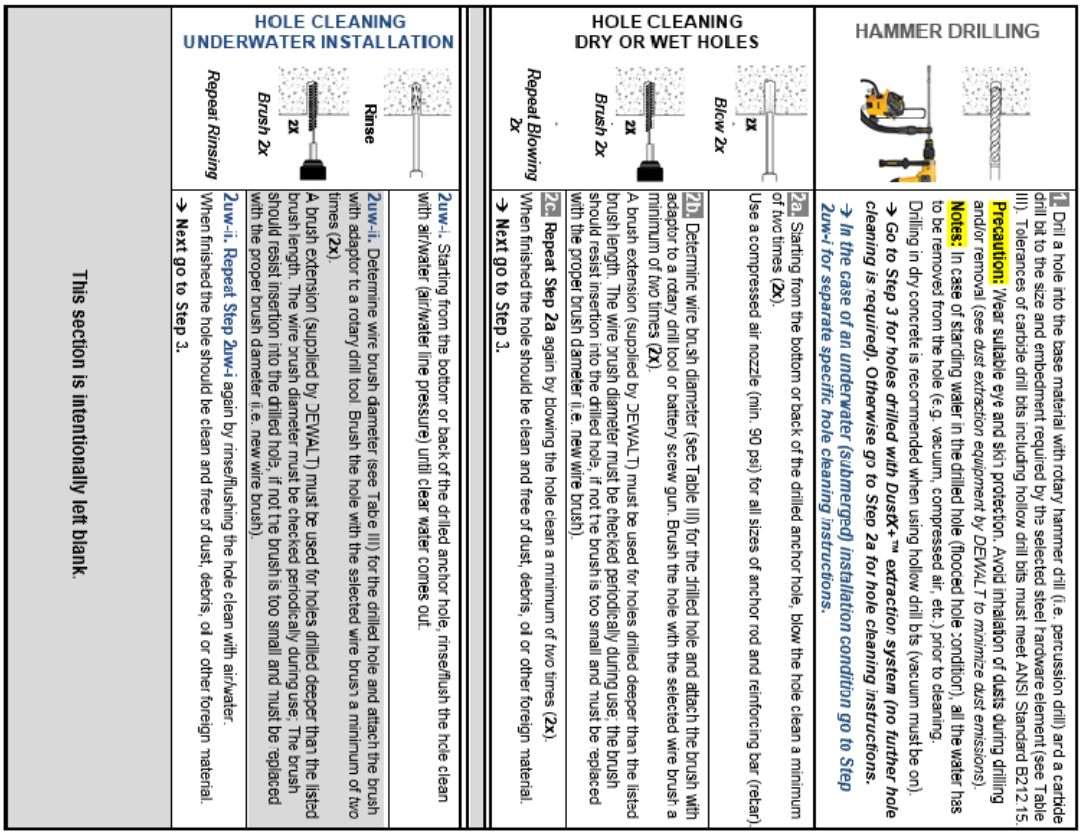


FIGURE 4A—PURE110+® EPOXY ADHESIVE ANCHOR SYSTEM MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII) (Continued)

TABLE 13—DEVELOPMENT LENGTHS FOR COMMON REINFORCING BAR CONNECTIONS PROVIDED FOR ILLUSTRATION[1,2,3,7,8]

FRACTIONAL REINFORCING BARS											
DESIGN INFORMATION	**SYMBOL**	**REFERENCE STANDARD**	**UNITS**	**NOMINAL REBAR SIZE (US)**								
				#3	**#4**	**#5**	**#6**	**#7**	**#8**	**#9**	**#10**	**#11**
Nominal rebar diameter	d_b	ASTM A615/A706, Grade 60 (f_y = **60 ksi**)	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)	1.128 (28.6)	1.270 (32.3)	1.410 (35.8)
Nominal rebar area	A_b		in^2 (mm^2)	0.11 (71)	0.20 (127)	0.31 (198)	0.44 (285)	0.60 (388)	0.79 (507)	1.00 (645)	1.27 (817)	1.56 (1006)
Development length in f'_c = **2,500 psi** concrete[4,5]	l_d	ACI 318-19 25.4.2.4, ACI 318-14 25.4.2.3 or ACI 318-11 12.2.3 as applicable	in. (mm)	12.0 (305)	14.4 (366)	18.0 (457)	21.6 (549)	31.5 (800)	36.0 (914)	40.6 (1031)	45.7 (1161)	50.8 (1290)
Development length in f'_c = **3,000 psi** concrete[4,5]			in. (mm)	12.0 (305)	13.1 (334)	16.4 (417)	19.7 (501)	28.8 (730)	32.9 (835)	37.1 (942)	41.7 (1060)	46.3 (1177)
Development length in f'_c = **4,000 psi** concrete[4,5]			in. (mm)	12.0 (305)	12.0 (305)	14.2 (361)	17.1 (434)	24.9 (633)	28.5 (723)	32.1 (815)	36.2 (920)	40.1 (1019)
Development length in f'_c = **6,000 psi** concrete[4,5]			in. (mm)	12.0 (305)	12.0 (305)	12.0 (305)	13.9 (354)	20.3 (516)	23.2 (590)	26.2 (666)	29.5 (750)	32.8 (832)
Development length in f'_c = **8,000 psi** concrete[4,5]			in. (mm)	12.0 (305)	12.0 (305)	12.0 (305)	12.1 (307)	17.6 (443)	20.1 (511)	22.7 (577)	25.6 (649)	28.4 (721)

METRIC REINFORCING BARS												
DESIGN INFORMATION	**SYMBOL**	**REFERENCE STANDARD**	**UNITS**	**NOMINAL REBAR SIZE (EU)**								
				Ø10	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø24**	**Ø25**	**Ø28**	**Ø32**	**Ø34**	**Ø36**
Nominal rebar diameter	d_b	DIN 488, BSt 500 (BS 4449: 2005) (f_y = **72.5 ksi**)	mm (in)	10 (0.394)	12 (0.472)	14.0 (0.551)	16 (0.630)	20 (0.787)	24 (0.945)	25 (0.984)	28 (1.102)	32 (1.260)	34 (1.339)	36 (1.417)
Nominal rebar area	A_b		mm^2 (in^2)	78.5 (0.12)	113 (0.18)	154 (0.23)	201 (0.31)	314 (0.49)	452 (0.70)	491 (0.76)	616 (0.96)	804 (1.25)	908 (1.41)	1018 (1.58)
Development length in f'_c = **2,500 psi** concrete[4,6]	l_d	ACI 318-19 25.4.2.4, ACI 318-14 25.4.2.3 or ACI 318-11 12.2.3 as applicable	mm (in)	348 (13.7)	417 (16.4)	487 (19.2)	556 (21.9)	870 (34.2)	1044 (41.1)	1087 (42.8)	1217 (47.9)	1392 (54.8)	1479 (58.2)	1566 (61.6)
Development length in f'_c = **3,000 psi** concrete[4,6]			mm (in)	318 (12.5)	381 (15.0)	445 (17.5)	508 (20.0)	794 (31.3)	953 (37.5)	992 (39.1)	1112 (43.8)	1271 (50.0)	1351 (53.2)	1429 (56.3)
Development length in f'_c = **4,000 psi** concrete[4,6]			mm (in)	305 (12.0)	330 (13.0)	385 (15.2)	439 (17.3)	688 (27.1)	825 (32.5)	859 (33.8)	963 (37.9)	1100 (43.3)	1170 (46.0)	1238 (48.7)
Development length in f'_c = **6,000 psi** concrete[4,6]			mm (in)	305 (12.0)	305 (12.0)	314 (12.4)	359 (14.2)	562 (22.1)	674 (26.4)	702 (27.6)	786 (30.9)	899 (35.4)	955 (37.6)	1011 (39.8)
Development length in f'_c = **8,000 psi** concrete[4,6]			mm (in)	305 (12.0)	305 (12.0)	305 (12.0)	311 (12.3)	486 (29.1)	584 (23.0)	608 (23.9)	681 (26.8)	778 (30.6)	827 (32.6)	875 (34.5)

DESIGN INFORMATION	**SYMBOL**	**REFERENCE STANDARD**	**UNITS**	**NOMINAL REBAR SIZE (CA)**					
				10M	**15M**	**20M**	**25M**	**30M**	**35M**
Nominal rebar diameter	d_b	CAN/CSA G30.18, Grade 400 (f_y = **58 ksi**)	mm (in)	11.3 (0.445)	16.0 (0.630)	19.5 (0.768)	25.2 (0.992)	29.9 (1.177)	35.7 (1.406)
Nominal rebar area	A_b		mm^2 (in^2)	100 (0.16)	200 (0.31)	300 (0.46)	500 (0.77)	700 (1.09)	1000 (1.56)
Development length in f'_c = **2,500 psi** concrete[4,6]	l_d	ACI 318-19 25.4.2.4, ACI 318-14 25.4.2.3 or ACI 318-11 12.2.3 as applicable	mm (in)	315 (12.4)	445 (17.5)	678 (26.7)	876 (34.5)	1041 (41.0)	1242 (48.9)
Development length in f'_c = **3,000 psi** concrete[4,6]			mm (in)	305 (12.0)	407 (16.0)	620 (24.4)	800 (31.5)	950 (37.4)	1135 (44.7)
Development length in f'_c = **4,000** psi concrete[4,6]			mm (in)	305 (12.0)	353 (13.9)	536 (21.1)	693 (27.3)	823 (32.4)	983 (38.7)
Development length in f'_c = **6,000 psi** concrete[4,6]			mm (in)	305 (12.0)	305 (12.0)	438 (17.3)	566 (22.3)	672 (26.4)	802 (31.6)
Development length in f'_c = **8,000 psi** concrete[4,6]			mm (in)	305 (12.0)	305 (12.0)	379 (14.9)	490 (19.3)	582 (22.9)	695 (27.4)

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]Calculated development lengths in accordance with Section 4.2.2 of this report and ACI 318-19 25.4.2.4, ACI 318-14 25.4.2.3 or ACI 318-11 12.2.3, as applicable, for reinforcing bars are valid for static, wind, and earthquake loads.

[2]Calculated development lengths in SDC C through F must comply with ACI 318 (-19 or -14) Chapter 18 or ACI 318-11 Chapter 21, as applicable, and Section 4.2.4 of this report. Post-installed reinforcing bars may be installed into holes drilled with a hammer-drill (i.e. rotary impact drills or rock drills with a carbide drill bit, including hollow drill bits) or a core-drill (i.e. core drill with a diamond core drill bit).

[3]For Class B splices, minimum length of lap for tension lap splices is 1.3l_d in accordance with ACI 318 (-19 or -14) 25.5.2 and ACI 318-11 12.15.1, as applicable.

[4]For lightweight concrete, λ = 0.75; therefore multiply development lengths by 1.33 (increase development length by 33 percent), unless the provisions of ACI 318-19 25.4.2.5, ACI 318-14 25.4.2.4 or ACI 318-11 12.2.4 (d), as applicable, are met to permit alternate values of λ (e.g for sand-lightweight concrete, λ = 0.85; therefore multiply development lengths by 1.18). Refer to ACI 318 (-19 or -14) 19.2.4 or ACI 318-11 8.6.1, as applicable.

[5] $\left(\frac{c_b+K_{tr}}{d_b}\right) = 2.5$, ψ_t=1.0, ψ_e=1.0, ψ_s=0.8 for $d_b \le$ #6,1.0 for $d_b >$ #6. Refer to ACI 318-19 25.4.2.5, ACI 318-14 25.4.2.4 or ACI 318-11 12.2.4, as applicable.

[6] $\left(\frac{c_b+K_{tr}}{d_b}\right) = 2.5$, ψ_t=1.0, ψ_e=1.0, ψ_s=0.8 for $d_b \le$ 19 mm, 1.0 for $d_b >$ 19 mm. Refer to ACI 318-19 25.4.2.5, ACI 318-14 25.4.2.4 or ACI 318-11 12.2.4, as applicable.

[7]Minimum f'_c of 24 MPa is required under ADIBC Appendix L, Section 5.1.1.

[8]Calculations may be performed for other steel grades and concrete compressive strengths per ACI 318 (-19 or -14) Chapter 25 or ACI 318-11 Chapter 12, as applicable.

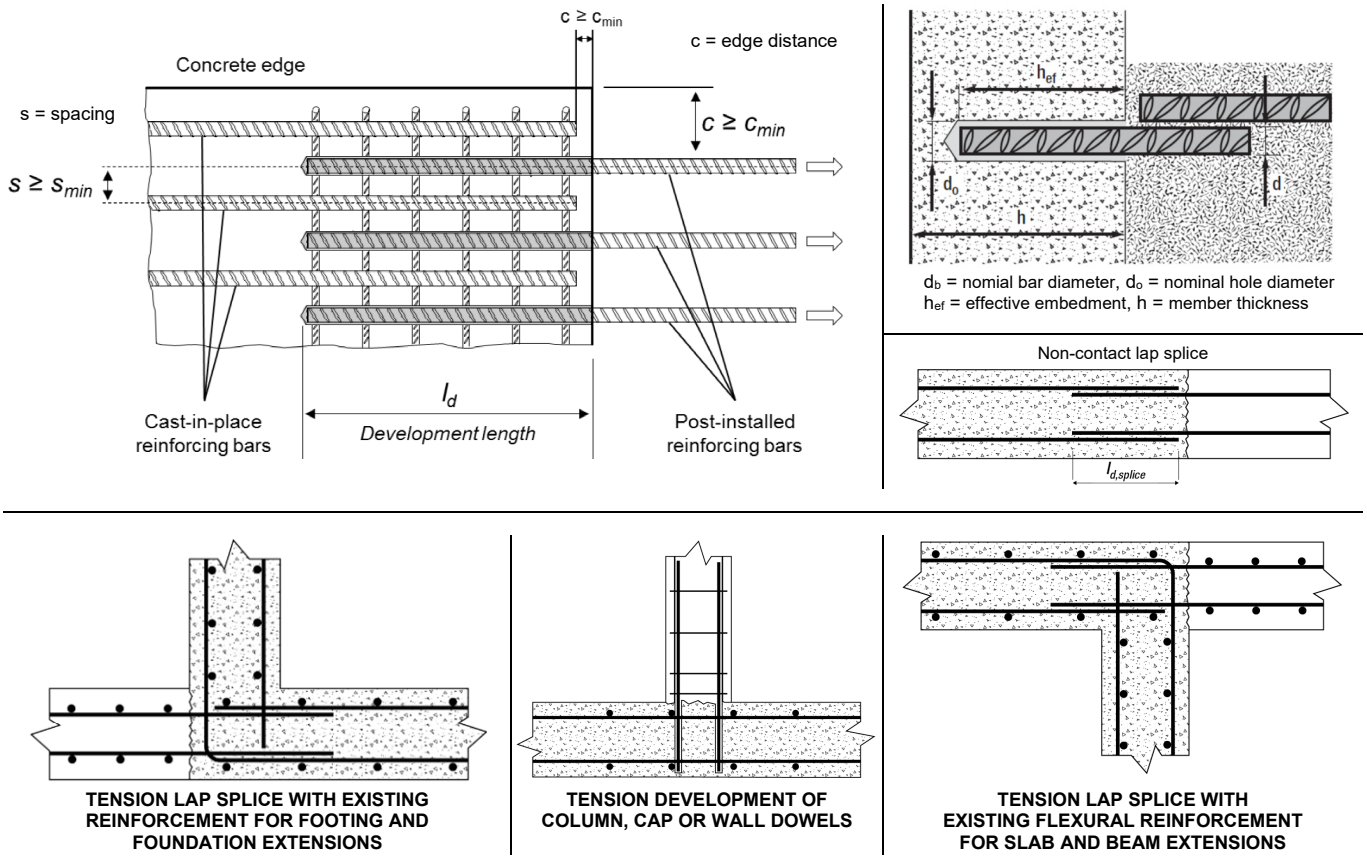


FIGURE 3—INSTALLATION DETAIL FOR POST-INSTALLED REINFORCING BAR CONNECTIONS (Top Pictures), EXAMPLES OF DEVELOPMENT LENGTH APPLICATION DETAILS FOR POST-INSTALLED REINFORCING BAR CONNECTIONS PROVIDED FOR ILLUSTRATION (Bottom Pictures)

TABLE 14—INSTALLATION PARAMETERS FOR COMMON POST-INSTALLED REINFORCING BAR CONNECTIONS[4]

FRACTIONAL REINFORCING BARS											
PARAMETER	SYMBOL	UNITS	NOMINAL REBAR SIZE (US)								
			#3	#4	#5	#6	#7	#8	#9	#10	#11
Nominal hole diameter[1,3]	d_o	in.	$^7/_{16}$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_8$	$1^3/_8$	$1^1/_2$	$1^3/_4$
Effective embedment[2,3]	h_{ef}	in.	Up to $7^1/_2$	Up to 10	Up to $12^1/_2$	Up to 15	Up to $17^1/_2$	Up to 20	Up to $22^1/_2$	Up to 25	Up to $27^1/_2$
Nominal hole diameter[1,3]	d_o	in.	$^1/_2$	$^5/_8$	$^3/_4$	1	$1^1/_8$	$1^1/_4$	$1^3/_8$	$1^1/_2$	$1^3/_4$
Effective embedment[2,3]	h_{ef}	in.	Up to $22^1/_2$	Up to 30	Up to $37^1/_2$	Up to 45	Up to $52^1/_2$	Up to 60	Up to $67^1/_2$	Up to 75	Up to $82^1/_2$

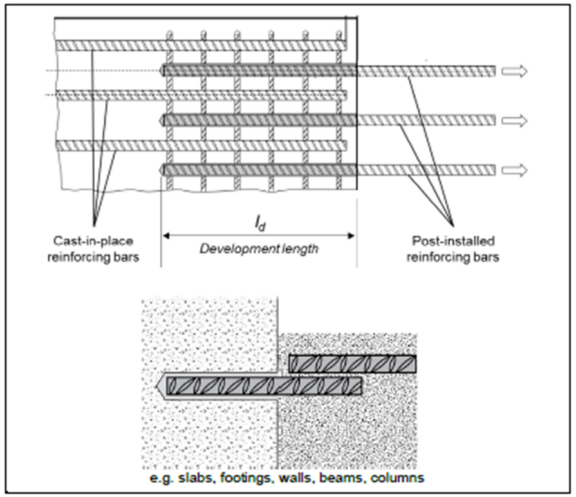
METRIC REINFORCING BARS												
PARAMETER	SYMBOL	UNITS	NOMINAL REBAR SIZE (EU)									
			Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø32	Ø34	Ø36
Nominal hole diameter[1]	d_o	mm	14	16	18	20	25	32	32	35	40	42	45
Effective embedment[2]	h_{ef}	mm	Up to 600	Up to 720	Up to 840	Up to 1200	Up to 1440	Up to 1500	Up to 1500	Up to 1680	Up to 1920	Up to 2040	Up to 2160

PARAMETER	SYMBOL	UNITS	NOMINAL REBAR SIZE (CA)					
			10M	15M	20M	25M	30M	35M
Nominal hole diameter[1]	d_o	in.	$^9/_{16}$	$^3/_4$	1	$1^1/_4$	$1^1/_2$	$1^3/_4$
Effective embedment[2]	h_{ef}	mm	Up to 678	Up to 960	Up to 1170	Up to 1512	Up to 1794	Up to 2100

For **SI**: 1 inch ≡ 25.4 mm,; for **pound-inch** units: 1 mm = 0.03937 inches.

[1]For any case, it must be possible for the reinforcing bar (rebar) to be inserted into the cleaned drill hole without resistance.
[2]Consideration should be given regarding the commercial availability of carbide drill bits (including hollow bits) and diamond core drill bits, as applicable, with lengths necessary to achieve the effective embedments for post-installed reinforcing bar connections.
[3]For fractional reinforcing bars where the effective embedment is listed for two nominal hole diameters, either nominal hole diameter may be used.
[4]The DEWALT DustX+ extraction system can be used to automatically clean holes drilled in concrete with a hammer-drill. See Figure A for an illustration of the DustX+ extraction system. The DustX+ extraction system is qualified for use in dry concrete and water saturated concrete, however, drilling in dry concrete is recommended by DEWALT when using hollow drill bits.

Pure110+ Post-installed Rebar Connections



[V.] Pure110+ epoxy system selection table

Dispensers			Cartridges		Mixing nozzles
Tool	Size	Cat.#	Type	Size	Cat.#
Manual Cordless	Heavy Duty Caulk Gun	08437-PWR DCE560D1	Quik-shot (coaxial)	9 fl.oz. or 9.5 fl.oz	PFC1640600 or 08609-PWR
Manual	13.5 fl.oz.	08298-PWR	Dual tube	13.5 fl.oz.	
Manual Pneumatic Cordless	 20.5 fl.oz.	08409-PWR 08413-PWR DCE591D1	Dual tube	20.5 fl.oz.	08609-PWR
Pneumatic	50.5 fl.oz.	08438-PWR	Dual tube	50.5 fl.oz.	08609-PWR

[VI.] Gel (working) times and curing times for adhesive

Temperature of base material		Gel (working) time	Full curing time
41°F	5°C	120 minutes	48 hours
50°F	10°C	90 minutes	24 hours
68°F	20°C	25 minutes	8 hours
86°F	30°C	20 minutes	6 hours
95°F	35°C	15 minutes	6 hours
104°F	40°C	12 minutes	4 hours
110°F	43°C	10 minutes	4 hours

Linear interpolation for intermediate base material temperatures is possible.

[VII.] Hole cleaning tools and accessories for Post-installed Rebar Connections[1,2,3,4,5,6,7]

Fractional reinforcing bar sizes							Wire brush / Brush extension / Drill chuck adaptor / SDS adaptor / Rebar connection premium piston plug / Compressed air nozzle / DustX+™ system	Metric reinforcing bar sizes										
Rebar size (No.)	Drill bit size (inch)	Brush size (inch)	Brush length (inches)	Wire brush (Cat.#)	Plug size (inch)	Piston plug (Cat.#)		Rebar size (Ø)	Rebar size (M)	Drill bit size (mm)	Drill bit size (inch)	Brush size (mm)	Brush size (inch)	Brush length (mm)	Wire brush (Cat.#)		Plug size (mm)	Plug size (inch)	Piston plug (Cat.#)
3	7/16	7/16	6 3/4	08284	N/A	N/A		10	10	14	9/16	14	9/16	170	DFC1670150	08285	N/A		N/A
	1/2	1/2	6 3/4	08285	N/A	N/A		12	-	16	-	16	-	200	DFC1670200	-	16	-	N/A
4	5/8	5/8	6 3/4	08275	5/8	N/A		14	-	18	-	18	-	200	DFC1670250	-	18	-	N/A
5	3/4	3/4	7 7/8	08278	3/4	PFC1691520		-	15	-	3/4	-	3/4	200	-	08278	-	3/4	PFC1691520
6	7/8	7/8	7 7/8	08287	7/8	PFC1691530		16	-	20	-	20	-	300	DFC1670300	-	20	-	PFC1691520
	1	1	11 7/8	08288	1	PFC1691540		20	20	25	1	25	1	300	DFC1670400	08288	25	1	PFC1691540
7	1	1	11 7/8	08288	1	PFC1691540		24	-	32	-	32	-	300	DFC1670500	-	32	-	PFC1691555
	1 1/8	1 1/16	11 7/8	08289	1 1/8	PFC1691550		25	25	32	1 1/4	32	1 1/4	300	DFC1670500	08290	32	1 1/4	PFC1691555
8	1 1/8	1 1/16	11 7/8	08289	1 1/8	PFC1691550		28	-	35	-	35	-	300	DFC1670550	-	35	-	PFC1691560
	1 1/4	1 1/4	11 7/8	08276	1 1/4	PFC1691555		-	30	-	1 1/2	-	1 1/2	300	-	08291	-	1 1/2	PFC1691570
9	1 3/8	1 3/8	11 7/8	08290	1 3/8	PFC1691560		32	-	40	-	40	-	300	DFC1670600	-	40	-	PFC1691570
10	1 1/2	1 1/2	11 7/8	08291	1 1/2	PFC1691570		34	-	42	-	42	-	300	DFC1670605	-	42	-	PFC1691575
11	1 3/4	1 3/4	11 7/8	08299	1 3/4	PFC1691580		-	35	-	1 3/4	-	1 3/4	300	-	08299	-	1 3/4	PFC1691580
								36	-	45	-	45	-	300	DFC1670610	-	45	-	PFC1691580

[1]If the DEWALT DustX+ extraction system is used to automatically clean the holes during drilling, standard hole cleaning (brushing and blowing following drilling) is not required.

[2]Holes are drilled with hammer-drilling (i.e. rotary impact drills or rock drills with a carbide drill bit, including the use of hollow drill bits) or core-drilling (i.e. core drill with a diamond core drill bit).

[3]For any case, it must be possible for the reinforcing bar to be inserted into the cleaned hole without resistance.

[4]A brush extension (Cat.# 08282) must be used with a steel wire brush for holes drilled deeper than the listed brush length.

[5]Brush adaptors for power tool connections are available for drill chuck (Cat.# 08296) and SDS (Cat.# 08283).

[6]A flexible extension tube (Cat.# 08297) or flexible extension hose (Cat.# PFC1640600) or equivalent approved by DEWALT must be used with the mixing nozzle if the bottom or back of the anchor hole is not reached with the mixing nozzle only.

[7]All overhead (i.e upwardly inclined) installations require the use of piston plugs during where one is tabulated together with the anchor size (see table). N/A = Not applicable. All horizontal installations require the use of piston plugs where one is tabulated together with the anchor size and where the embedment depth is greater than 8 inches. A flexible extension tube (Cat.# 08297) or flexible extension hose (Cat.# PFC1640600) or equivalent approved by DEWALT must be used with piston plugs.

[VIII.] Installation parameters - Specifications for installation of reinforcing bars for Post-installed Rebar Connections

FRACTIONAL REINFORCING BARS

PARAMETER	SYMBOL	UNITS	NOMINAL REBAR SIZE (US)								
			#3	#4	#5	#6	#7	#8	#9	#10	#11
Nominal hole diameter[1,3]	d_o	in.	7/16	5/8	3/4	7/8	1	1 1/8	1 3/8	1 1/2	1 3/4
Effective embedment[2,3]	h_{ef}	in.	Up to 7 1/2	Up to 10	Up to 12 1/2	Up to 15	Up to 17 1/2	Up to 20	Up to 22 1/2	Up to 25	Up to 27 1/2
Nominal hole diameter[1,3]	d_o	in.	1/2	5/8	3/4	1	1 1/8	1 1/4	1 3/8	1 1/2	1 3/4
Effective embedment[2,3]	h_{ef}	in.	Up to 22 1/2	Up to 30	Up to 37 1/2	Up to 45	Up to 52 1/2	Up to 60	Up to 67 1/2	Up to 75	Up to 82 1/2

METRIC REINFORCING BARS

PARAMETER	SYMBOL	UNITS	NOMINAL REBAR SIZE (EU)										
			Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø32	Ø34	Ø36
Nominal hole diameter[1]	d_o	mm	14	16	18	20	25	32	32	35	40	42	45
Effective embedment[2]	h_{ef}	mm	Up to 600	Up to 720	Up to 840	Up to 1200	Up to 1440	Up to 1500	Up to 1500	Up to 1680	Up to 1920	Up to 2040	Up to 2160

PARAMETER	SYMBOL	UNITS	NOMINAL REBAR SIZE (CA)					
			10M	15M	20M	25M	30M	35M
Nominal hole diameter[1]	d_o	in.	9/16	3/4	1	1 1/4	1 1/2	1 3/4
Effective embedment[2]	h_{ef}	mm	Up to 678	Up to 960	Up to 1170	Up to 1512	Up to 1794	Up to 2100

For **SI**: 1 inch ≡ 25.4 mm,; for **pound-inch** units: 1 mm = 0.03937 inches.

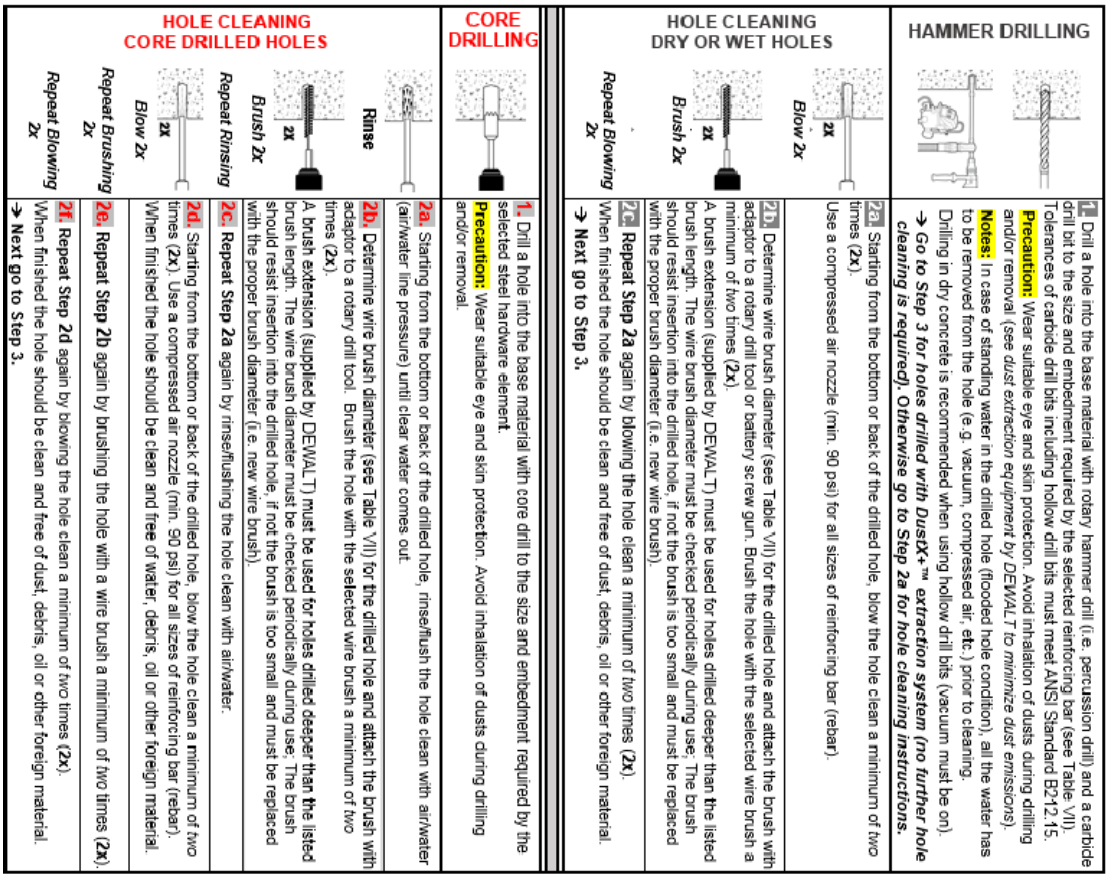
[1]For any case, it must be possible for the reinforcing bar (rebar) to be inserted into the cleaned drill hole without resistance.

[2]Consideration should be given regarding the commercial availability of carbide drill bits (including hollow bits) and diamond core drill bits, as applicable, with lengths necessary to achieve the effective embedments for post-installed reinforcing bar connections.

[3]For fractional reinforcing bars where the effective embedment is listed for two nominal hole diameters, either nominal hole diameter may be used.

FIGURE 4B—PURE110+® EPOXY ADHESIVE POST-INSTALLED REINFORCING BAR CONNECTIONS MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII)

Pure110+ Post-installed Rebar Connections (cont.)



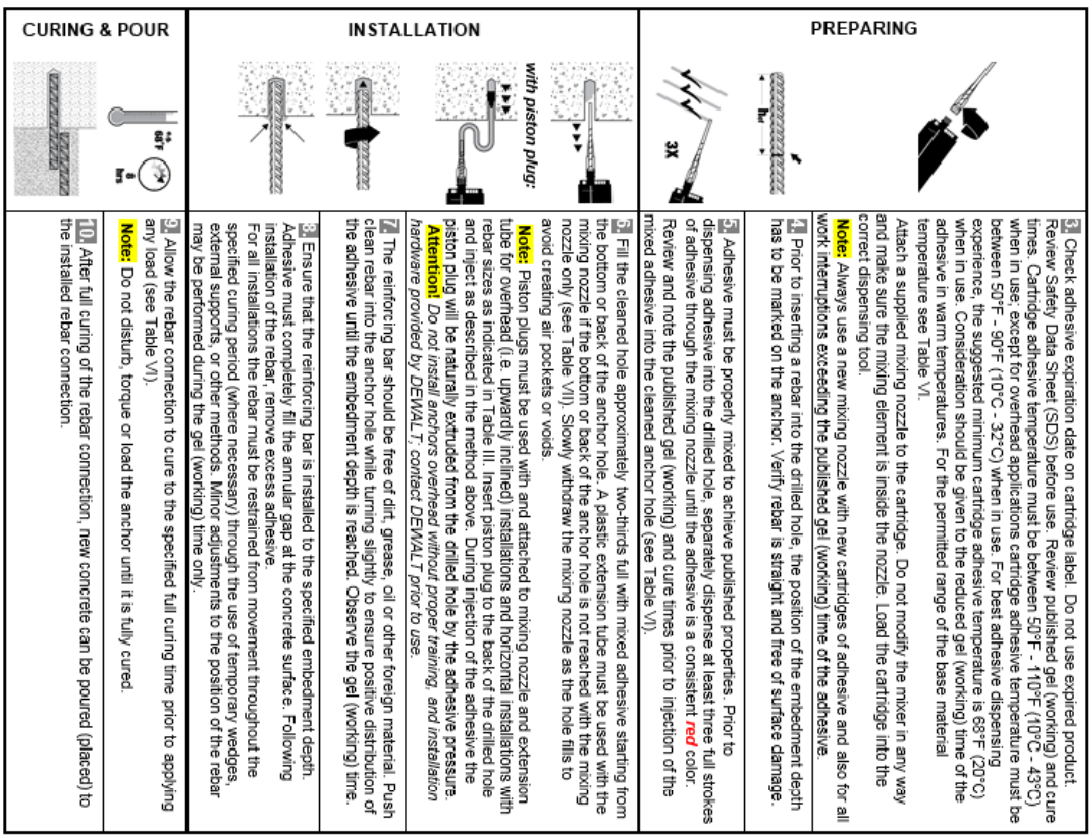


FIGURE 4B—PURE110+® EPOXY ADHESIVE POST-INSTALLED REINFORCING BAR CONNECTIONS MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII) (Continued)

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:

DEWALT

EVALUATION SUBJECT:

PURE110+® EPOXY ADHESIVE ANCHOR SYSTEM AND POST-INSTALLED REINFORCING BAR CONNECTIONS IN CRACKED AND UNCRACKED CONCRETE

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the Pure110+ Epoxy Adhesive Anchor System and Post-Installed Reinforcing Bar Connections in cracked and uncracked concrete, described in ICC-ES evaluation report ESR-3298, have also been evaluated for compliance with the codes noted below as adopted by Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:

- 2020 *City of Los Angeles Building Code* (LABC)
- 2020 *City of Los Angeles Residential Code* (LARC)

2.0 CONCLUSIONS

The Pure110+ Epoxy Adhesive Anchor System and Post-Installed Reinforcing Bar Connections in cracked and uncracked concrete, described in Sections 2.0 through 7.0 of the evaluation report ESR-3298, comply with LABC Chapter 19, and the LARC, and are subjected to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The Pure110+ Epoxy Adhesive Anchor System and Post-Installed Reinforcing Bar Connections described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-3298.
- The design, installation, conditions of use and labeling of the Pure110+ Epoxy Adhesive Anchor System and Post-Installed Reinforcing Bar Connections are in accordance with the 2018 *International Building Code®* (IBC) provisions noted in the evaluation report ESR-3298.
- 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 steel anchors and post-installed reinforcing bars to the concrete. The connection between the steel anchors or post-installed reinforcing bars and the connected members shall be checked for capacity (which may govern).
- For use in wall anchorage assemblies to flexible diaphragm applications, anchors shall be designed per the requirements of City of Los Angeles information Bulletin P/BC 2020-071.

This supplement expires concurrently with the evaluation report, reissued July 2023.

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:

DEWALT

EVALUATION SUBJECT:

PURE110+® EPOXY ADHESIVE ANCHOR SYSTEM AND POST-INSTALLED REINFORCING BAR CONNECTIONS IN CRACKED AND UNCRACKED CONCRETE (DEWALT)

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the Pure110+ Epoxy Adhesive Anchor System and Post-Installed Reinforcing Bar Connections in Cracked and Uncracked Concrete, described in ICC-ES evaluation report ESR-3298, has also been evaluated for compliance with the codes noted below.

Applicable code editions:

- 2020 *Florida Building Code—Building*
- 2020 *Florida Building Code—Residential*

2.0 CONCLUSIONS

The Pure110+ Epoxy Adhesive Anchor System and Post-Installed Reinforcing Bar Connections in Cracked and Uncracked Concrete**,** described in Sections 2.0 through 7.0 of the evaluation report ESR-3298, comply with the *Florida Building Code—Building* and the *Florida Building Code—Residential*, provided the design requirements are determined in accordance with the *Florida Building Code—Building* or the *Florida Building Code—Residential,* as applicable. The installation requirements noted in ICC-ES evaluation report ESR-3298 for the 2018 *International Building Code®* meet the requirements of the *Florida Building Code—Building* or the *Florida Building Code—Residential*, as applicable.

Use of the Pure110+ epoxy adhesive anchors and Post-Installed Reinforcing Bar Connections 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).

For products falling under Florida Rule 61G20-3, 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 July 2023.