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ESR-3298

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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:

POWERS FASTENERS, INC.

701 EAST JOPPA ROAD
TOWSON, MARYLAND 21286

EVALUATION SUBJECT:

POWERS PURE110+ EPOXY ADHESIVE ANCHOR SYSTEM IN CRACKED AND UNCRACKED CONCRETE

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

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EVALUATION SUBJECT:

POWERS PURE110+ EPOXY ADHESIVE ANCHOR SYSTEM IN CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2012 *International Building Code*® (IBC)
- 2012 *International Residential Code*® (IRC)

Property evaluated:

Structural

2.0 USES

The Powers Pure110+ epoxy adhesive anchors are used to resist static, wind or earthquake (IBC Seismic Design Categories A through F) tension and shear loads 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).

The anchor system complies with anchors as described in Section 1909 of the 2012 IBC and is an alternative to cast-in-place anchors described in Sections 1908 of the 2012 IBC. The anchor systems may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 General:

The Powers Pure110+ Epoxy Adhesive Anchor System is comprised of a two-component epoxy adhesive filled in cartridges, static mixing nozzles, dispensing tools, hole cleaning equipment and adhesive injection accessories.

Product names for the report holder and the additional listee are presented in Table A of this report. Powers Pure110+ epoxy adhesive may be used with continuously threaded steel rods or deformed steel reinforcing bars. The adhesive and steel anchor elements are installed in pre-drilled holes into concrete. The primary components of the Powers Pure110+ Epoxy Adhesive Anchor System, 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 3.

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 labeled dual-cylinder cartridge. The two components combine and react when dispensed through a static mixing nozzle, supplied by Powers Fasteners, which is attached to the cartridge. A nozzle extension tube is also packaged with the cartridge. The Pure110+ epoxy adhesive is available in 9-ounce (265 mL), 21-ounce (620 mL) and 51-ounce (1510 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 MPII, as illustrated in Figure 3 of this report.

3.2.2 Hole Cleaning Equipment: Hole cleaning equipment is comprised of steel wire brushes supplied by Powers Fasteners, Inc., and a compressed air nozzle. The equipment is shown in Figure 3.

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

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 and Figure 3 of this report. Specifications for grades of threaded rod, including the mechanical properties and corresponding nuts and washers, are provided in Table 2. Carbon steel threaded rods must be furnished with a minimum 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. The stainless steel threaded rods must comply with Table 2 of this report. 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 are deformed reinforcing bars (rebars) as described in Table 1 of this report. Tables 5 and 9 and Figure 3 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 Section 7.3.2 of ACI 318, 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 D.1, 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.

3.3 Concrete:

Normal-weight 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).

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

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

The strength design of anchors must comply with ACI 318 D.4.1, except as required in ACI 318 D.3.3.

Design parameters are provided in Tables 4 through 11. Strength reduction factors, ϕ, as given in ACI 318 D.4.3, must be used for load combinations calculated in accordance with Section 1605.2 of the IBC or Section 9.2 of ACI 318. Strength reduction factors, ϕ, as described in ACI 318 D.4.4 must be used for load combinations calculated in accordance with ACI 318 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 D.5.1.2 and the associated strength reduction factors, ϕ, in accordance with ACI 318 D.4.3 are provided in Tables 4, 5, 8 and 9 of this report for the corresponding steel anchor element. See Table 1 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 D.5.2 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 D.5.2.2 using the 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 D.5.2.6, N_b must be calculated using $k_{c,uncr}$ and $\Psi_{c,N}$ = 1.0. See Table 1. For anchors in lightweight concrete see ACI 318-11 D.3.6. The value of f'_c used for calculation must be limited to 8,000 psi (55 MPa) in accordance with ACI 318 D.3.7. 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 318-11 D.5.5. Bond strength values ($\tau_{k,cr}$, $\tau_{k,uncr}$)are a function of the concrete state (cracked, uncracked), concrete type (normal weight, lightweight), drilling method (hammer-drill), 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 does not provide an increase in anchor category or associated strength reduction factors for design). The following table summarizes the requirements.

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

Figure 1 of this report presents a flowchart for the establishment of the bond strength. 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 Equations (D-21) and (D-22). 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 1. Adjustments to the bond strength may also be taken for increased concrete compressive strength as noted in the footnotes to the corresponding tables.

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 D.6.1.2, and strength reduction factors, ϕ, in accordance with ACI 318 D.4.3 are given in Tables 4, 5, 8 and 9 of this report for the anchor element types included in this report. See Table 1 for index of design tables.

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 D.6.2 based on information given in Tables 6 and 10 of this report. The basic concrete breakout strength of a single anchor in shear, V_b, must be calculated in accordance with ACI 318 D.6.2.2 using the values of d given in Tables 4, 5, 8 and 9 for the corresponding anchor steel in lieu of d_a. In addition, h_{ef} must be substituted for ℓ_e. In no case shall ℓ_e exceed 8d. The value of f'_c must be limited to a maximum of 8,000 psi (55 MPa), in accordance with ACI 318 D.3.7.

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 D.6.3.

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 D.7.

4.1.9 Minimum Member Thickness h_{min}, Anchor Spacing s_{min}, Edge Distance c_{min}: In lieu of ACI 318 D.8.1 and D.8.3, 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 D.8.4 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	5d	5d	$1.0 \cdot T_{max}$
$^3/_8$ in. to $1^1/_4$ in. (9.5 mm to 31.8 mm)	1.75 in. (45 mm)	5d	$0.45 \cdot T_{max}$
10 mm to 32 mm (0.39 in to 1.18 in)	45 mm (1.75 in.)	5d	$0.45 \cdot T_{max}$

For values of T_{max}, see Table 12 and Figure 3.

4.1.10 Critical Edge Distance c_{ac}: In lieu of ACI 318 D.8.6, c_{ac} must be determined as follows:

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

where

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

τ_{uncr} = characteristic bond strength stated in the table of this report where by τ_{uncr} need not be taken as larger than:

$$\tau_{uncr}=\frac{k_{uncr}\sqrt{h_{ef}f'_c}}{\pi\cdot d_a}$$

4.1.11 Design Strength in Seismic Design Categories C, D, E and F: In structures assigned to Seismic Design Category C, D, E or F under the IBC or IRC, design anchors in accordance with ACI 318 Section D.3.3.

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 $\tau_{k,cr}$ need not be adjusted by $\alpha_{N,seis}$ since $\alpha_{N,seis}$ = 1.0.

Modify ACI 318 Sections D.3.3.4.2, D.3.3.4.3(d) and D.3.3.5.2 to read as follows:

D.3.3.4.2 - Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments shall be designed in accordance with D.3.3.4.3. The anchor design tensile strength shall be determined in accordance with D.3.3.4.4

Exception:

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

D.3.3.4.3(d) – The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include E, with E increased by Ω_0. The anchor design tensile strength shall be calculated from D.3.3.4.4.

D.3.3.5.2 – Where the shear component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor shear force associated with the same load combination, anchors and their attachments shall be designed in accordance with D.3.3.5.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with D.6.

Exceptions:

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 D.6.2 and D.6.3 need not be computed and 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 $^5/_8$ inches (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 D.6.2 and D.6.3 need not be computed and D.3.3.5.3 need not apply provided all of the following are satisfied:

2.1. The maximum anchor nominal diameter is $^5/_8$ inches (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 D.3.3.5.3(a) through (c) when the design strength of the anchors is determined in accordance with D.6.2.1(c).

4.2 Allowable Stress Design (ASD):

4.2.1 General: For anchors designed using load combinations in accordance with IBC Section 1605.3 (Allowable Stress Design), allowable loads must be established using Eq. (4-2) and Eq. (4-3):

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

and

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

where

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

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

ϕN_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 Appendix D with amendments in this report.

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 Appendix D with amendments in this report.

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. An example of allowable stress design values for various diameters, for illustrative purposes, is shown in Table 13 of this report.

4.2.2 Interaction of Tensile and Shear Forces: Interaction must be calculated in accordance with ACI 318 D.7 as follows:

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

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

For all other cases:

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

4.3 Installation:

Installation parameters are illustrated in Table 12 of this report. Installation must be in accordance with ACI 318-11 D.9.1 and D.9.2. Anchor locations must comply with this report and the plans and specifications approved by the code official. Installation of the Powers Pure110+ Epoxy Adhesive Anchor System must be in accordance with the Manufacturer's printed installation instructions (MPII) included in each unit package as reproduced in Figure 3 of this report.

4.4 Special Inspection:

Periodic special inspection must be performed where required in accordance with Section Section 1705.1.1 and Table 1705.3 of the 2012 IBC, and this report. The special inspector must be on the jobsite initially during anchor installation to verify the anchor type, anchor dimensions, concrete type, concrete compressive strength, adhesive identification and expiration date, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque and adherence to the manufacturer's published installation instructions (MPII). The special inspector must verify the initial installations of each type and size of adhesive anchor 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 D.9.2.4.

Under the IBC, additional requirements as set forth in Sections 1705, 1706 or 1707 must be observed, where applicable.

4.5 Compliance with NSF/ANSI Standard 61:

The Powers Pure110+ Epoxy Adhesive Anchor System complies with the requirements of NSF/ANSI Standard 61, as referenced in Section 605 of the 2012 *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 Powers Pure110+ Epoxy Adhesive Anchor System described in this report complies 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 Powers Pure110+ epoxy adhesive anchors must be installed in accordance with the Manufacturer's printed installation instructions (MPII) as attached to each cartridge and reproduced in Figure 3 of this report.

5.2 The anchors described in this report must be installed in cracked or uncracked normal-weight 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).Anchors must be installed in concrete base materials in holes predrilled in accordance with the instructions provided in Figure 3 of this report.

5.4 Loads applied to the anchors 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.

5.5 Powers Pure110+ epoxy adhesive anchors are recognized for use to resist short and long-term loads, including wind and earthquake, subject to the conditions of this report.

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

5.7 Powers Pure110+ epoxy adhesive anchors are permitted to be installed in concrete that is cracked or that may be expected to crack during the service life of the anchor, subject to the conditions of this report.

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

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

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

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

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

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

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

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

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

5.16 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.

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

5.18 Installation of anchors in horizontal or upwardly inclined orientations to resist sustained tension loads must be performed by personnel certified by an applicable certification program in accordance with ACI 318 D.9.2.2 or D.9.2.3.

5.19 Powers 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 September 2014, which incorporates requirements in 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 and tests for seismic tension and shear.

7.0 IDENTIFICATION

Powers Pure110+ epoxy adhesive is identified by packaging labeled with the lot number, expiration date, company name and corresponding product name as set forth in Table A of this report, 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.

TABLE A—PRODUCT NAMES BY COMPANY

COMPANY NAME	PRODUCT NAME
Powers Fasteners	Pure110+
DEWALT (Stanley Black & Decker)	Pure110-PRO

TABLE 1—DESIGN USE AND REPORT TABLE INDEX

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	MINIMUM EMBEDMENT	MAXIMUM EMBEDMENT	SEISMIC DESIGN CATEGORIES[3]
Normal-weight and lightweight	Cracked	$^3/_8$, $^1/_2$, $^5/_8$, $^3/_4$, $^7/_8$, 1 and $1^1/_4$	3, 4, 5, 6, 7, 8, 9, 10	Hammer-drill	See Table 7	See Table 7	A through F
	Uncracked	$^3/_8$, $^1/_2$, $^5/_8$, $^3/_4$, $^7/_8$, 1 and $1^1/_4$	3, 4, 5, 6, 7, 8, 9, 10	Hammer-drill	See Table 7	See Table 7	A through F
CONCRETE TYPE	**CONCRETE STATE**	**THREADED ROD DIAMETER (mm)**	**REINFORCING BAR SIZE (Ø)**	**DRILLING METHOD**	**MINIMUM EMBEDMENT**	**MAXIMUM EMBEDMENT**	**SEISMIC DESIGN CATEGORIES[3]**
Normal-weight and lightweight	Cracked	10, 12, 16, 20, 24, 27 and 30	10, 12, 14, 16, 20, 25, 28, 32	Hammer-drill	See Table 11	See Table 11	A through F
	Uncracked	10, 12, 16, 20, 24, 27 and 30	10, 12, 14, 16, 20, 25, 28, 32	Hammer-drill	See Table 11	See Table 11	A through F

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

[1]Reference ACI 318-11 D.4.1.1. 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.

[3]See Section 4.1.11 for requirements for seismic design, where applicable.

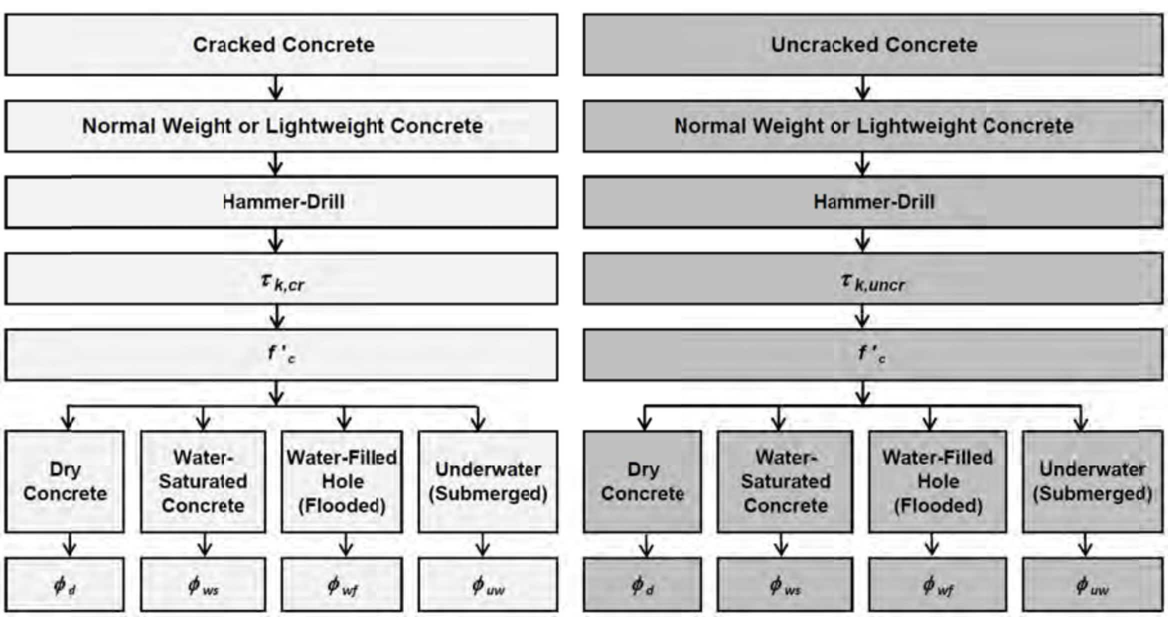


FIGURE 1—FLOWCHART FOR THE ESTABLISHMENT OF DESIGN BOND STRENGTH

TABLE 2—SPECIFICATIONS AND PHYSICAL 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.

[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 4d and ISO 898, which is based on 5d.
[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 PHYSICAL 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)

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 318-11 D.3.3.4.3(a)6, deformed reinforcing bars meeting this specification used as ductile steel elements to resist earthquake effects shall be limited to reinforcing bars bars satisfying the requirements of 21.1.5.2(a) and (b). 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.

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	0.80	0.80	0.80	0.80	0.80	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	0.80	0.80	0.80	0.80	0.80	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	0.80	0.80	0.80	0.80	0.80	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	0.80	0.80	0.80	0.80	0.80	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	0.80	0.80	0.80	0.80	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	0.70	0.80	0.80	0.80	0.80	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	0.70	0.80	0.80	0.80	0.80	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	0.70	0.80	0.80	0.80	0.80	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 318-11 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 or ACI 318 Section 9.2 are used in accordance with ACI 318-11 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4. Values correspond to ductile steel elements.

[3]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used in accordance with ACI 318-11 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4. Values correspond to brittle steel elements.

[4]In accordance with 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 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]							
				No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 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	0.70	0.80	0.80	0.80	0.80	0.80	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	0.70	0.80	0.80	0.80	0.80	0.80	0.80
	Strength reduction factor for tension[2]	ϕ	-	0.75							
	Strength reduction factor for shear[2]	ϕ	-	0.65							
ASTM A706 Grade 60	Nominal strength as governed by steel strength (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	0.70	0.80	0.80	0.80	0.80	0.80	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	0.70	0.80	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 reinforcing bar material types based on minimum specified strengths and calculated in accordance with ACI 318-11 Eq. (D-2) and Eq. (D-29).

[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4. Values correspond to ductile steel elements. In accordance with ACI 318-11 D.3.3.4.3(a)6, deformed reinforcing bars meeting this specification used as ductile steel elements to resist earthquake effects shall be limited to reinforcing bars bars satisfying the requirements of 21.1.5.2(a) and (b).

[3]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4. 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)	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:							
			$1^3/_4$ (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)
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}	inch (mm)	See Section 4.1.10 of this report							
Strength reduction factor for tension, concrete failure modes, Condition B[2]	ϕ	-	0.65							
Strength reduction factor for shear, concrete failure modes, Condition B[2]	ϕ	-	0.70							

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

[1]Additional setting information is described in the installation instructions, Figure 3 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 D.4.3. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4.

TABLE 7—BOND STRENGTH DESIGN INFORMATION FOR FRACTIONAL THREADED RODS 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
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]	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	psi (N/mm²)	990 (6.8)	990 (6.8)	959 (6.6)	959 (6.6)	959 (6.6)	918 (6.3)	846 (5.8)	846 (5.8)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		psi (N/mm²)	990 (6.8)	990 (6.8)	959 (6.6)	959 (6.6)	959 (6.6)	918 (6.3)	846 (5.8)	846 (5.8)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	psi (N/mm²)	1,756 (12.1)	1,668 (11.5)	1,604 (11.1)	1,553 (10.7)	1,512 (10.4)	1,477 (10.2)	1,446 (10.0)	1,420 (9.8)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		psi (N/mm²)	1,756 (12.1)	1,668 (11.5)	1,604 (11.1)	1,553 (10.7)	1,512 (10.4)	1,477 (10.2)	1,446 (10.0)	1,420 (9.8)
110°F (43°C) Maximum long-term service temperature; 176°F (80°C) maximum short-term service temperature[4,5]	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	psi (N/mm²)	725 (5.0)	725 (5.0)	696 (4.8)	696 (4.8)	696 (4.8)	667 (4.6)	624 (4.3)	624 (4.3)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		psi (N/mm²)	725 (5.0)	725 (5.0)	696 (4.8)	696 (4.8)	696 (4.8)	667 (4.6)	624 (4.3)	624 (4.3)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	psi (N/mm²)	1,276 (8.8)	1,218 (8.4)	1,175 (8.1)	1,131 (7.6)	1,102 (7.6)	1,073 (7.4)	1,059 (7.3)	1,030 (7.1)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		psi (N/mm²)	1,276 (8.8)	1,218 (8.4)	1,175 (8.1)	1,131 (7.6)	1,102 (7.6)	1,073 (7.4)	1,059 (7.3)	1,030 (7.1)
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 D.3.6, 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 at the time of anchor installation. For installation instructions see Figure 3 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	0.80	0.80	0.80	0.80	0.80	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	0.80	0.80	0.80	0.80	0.80	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	0.80	0.80	0.80	0.80	0.80	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	0.80	0.80	0.80	0.80	0.80	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	0.80	0.80	0.80	0.80	0.80	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 318-11 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 or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4. Values correspond to ductile steel elements.

[3]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4. Values correspond to brittle steel elements.

[4]In accordance with 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)							
				10	12	14	16	20	25	28	32
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	0.70	0.80	0.80	0.80	0.80	0.80	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 318-11 Eq. (D-2) and Eq. (D-29).
[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.4. 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:											
			45 (1.75)	45 (1.75)	45 (1.75)	45 (1.75)	45 (1.75)	45 (1.75)	45 (1.75)	45 (1.75)	70 (2.75)	70 (2.75)	70 (2.75)	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[2]	ϕ	-	0.65											
Strength reduction factor for shear, concrete failure modes, Condition B[2]	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 the installation instructions, Figure 3 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 D.4.3. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.5.

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

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL ROD DIAMETER / REINFORCING BAR SIZE										
				M10 or Ø10	**M12 or Ø12**	**Ø14**	**M16 or Ø16**	**M20 or Ø20**	**M24**	**Ø25**	**M27**	**Ø28**	**M30**	**Ø32**
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)
110°F (43°C) Maximum long-term service temperature; 140°F (60°C) maximum short-term service temperature[3,5]	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	N/mm² (psi)	6.8 (990)	6.8 (990)	6.6 (959)	6.6 (959)	6.6 (959)	6.3 (918)	6.3 (918)	5.8 (846)	5.8 (846)	5.8 (846)	5.8 (846)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		N/mm² (psi)	6.8 (990)	6.8 (990)	6.6 (959)	6.6 (959)	6.6 (959)	6.3 (918)	6.3 (918)	5.8 (846)	5.8 (846)	5.8 (846)	5.8 (846)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	N/mm² (psi)	12.0 (1740)	11.6 (1685)	11.3 (1640)	11.0 (1602)	10.6 (1540)	10.3 (1492)	10.2 (1481)	10.1 (1461)	10.0 (1452)	9.9 (1434)	9.8 (1418)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		N/mm² (psi)	12.0 (1740)	11.6 (1685)	11.3 (1640)	11.0 (1602)	10.6 (1540)	10.3 (1492)	10.2 (1481)	10.1 (1461)	10.0 (1452)	9.9 (1434)	9.8 (1418)
110°F (43°C) Maximum long-term service temperature; 176°F (80°C) maximum short-term service temperature[4,5]	Characteristic bond strength in cracked concrete[6,9]	$\tau_{k,cr}$	N/mm² (psi)	5.0 (725)	5.0 (725)	4.8 (696)	4.8 (696)	4.8 (696)	4.6 (667)	4.6 (667)	4.3 (624)	4.3 (624)	4.3 (624)	4.3 (624)
	Characteristic bond strength in cracked concrete, short-term loading only[9]		N/mm² (psi)	5.0 (725)	5.0 (725)	4.8 (696)	4.8 (696)	4.8 (696)	4.6 (667)	4.6 (667)	4.3 (624)	4.3 (624)	4.3 (624)	4.3 (624)
	Characteristic bond strength in uncracked concrete[6,8]	$\tau_{k,uncr}$	N/mm² (psi)	8.8 (1276)	8.5 (1233)	8.3 (1204)	8.1 (1175)	7.8 (1131)	7.5 (1088)	7.5 (1088)	7.4 (1073)	7.3 (1059)	7.2 (1044)	7.1 (1030)
	Characteristic bond strength in uncracked concrete, short-term loading only[8]		N/mm² (psi)	8.8 (1276)	8.5 (1233)	8.3 (1204)	8.1 (1175)	7.8 (1131)	7.5 (1088)	7.5 (1088)	7.4 (1073)	7.3 (1059)	7.2 (1044)	7.1 (1030)
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 D.3.6, 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 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.

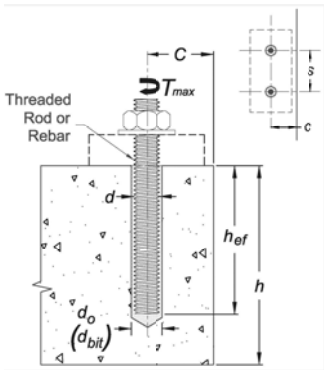
[6]Characteristic bond strengths are for sustained loads including dead and live loads.

[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 at the time of anchor installation. For installation instructions see Figure 3 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 ROD AND REINFORCING BARS



PARAMETER	SYMBOL	UNITS	FRACTIONAL 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	$1^1/_4$	#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	d_o (d_{bit})	inch	$^7/_{16}$	$^9/_{16}$	$^{11}/_{16}$ 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	d_o (d_{bit})	mm	12	14	14	16	18	18	20	24	24	28	32	32	35	35	37
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 is acceptable for this threaded rod diameter and rebar size.

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

TABLE 13—EXAMPLE OF PURE110+ EPOXY ADHESIVE ANCHOR ALLOWABLE STRESS DESIGN (ASD) VALUES FOR ILLUSTRATIVE PURPOSES (FRACTIONAL)[1,2,3,4,6,9,10,13,14,16]

NOMINAL ANCHOR ROD DIAMETER OR REBAR SIZE, *d* (inch) / (No.)	EFFECTIVE EMBED.[5] h_{ef} (inches)	CONCRETE STRENGTH[12] f'_c (psi)	EFFECTIVE-NESS FACTOR FOR UNCRACKED CONCRETE k_{uncr}	CHARACTERISTIC BOND STRENGTH $\tau_{k,uncr}$ (psi)		NOMINAL STRENGTH IN TENSION N_n (pounds)		STRENGTH REDUCTON FACTOR ϕ[15]		ALLOWABLE TENSION LOAD[11] $\phi N_n / \alpha$ (pounds)	
				110°F LT, 140°F ST[7]	110°F LT, 176°F ST[8]	110°F LT, 140°F ST[7]	110°F LT, 176°F ST[8]	110°F LT, 140°F ST[7]	110°F LT, 176°F ST[8]	110°F LT, 140°F ST[7]	110°F LT, 176°F ST[8]
ASTM A193 Grade B7 Threaded Rod											
3/8	2 3/8	2,500	24	1,756	1,276	4,392	3,570	0.65 (conc)	0.65 (bond)	1,930	1,570
	7 1/2	2,500	24	1,756	1,276	9,685	9,685	0.75 (steel)	0.75 (steel)	4,910	4,910
1/2	2 3/4	2,500	24	1,668	1,218	5,472	5,261	0.65 (conc)	0.65 (bond)	2,400	2,310
	10	2,500	24	1,668	1,218	17,735	17,735	0.75 (steel)	0.65 (bond)	8,990	8,400
5/8	3 1/8	2,500	24	1,604	1,175	6,629	6,629	0.65 (conc)	0.65 (conc)	2,910	2,910
	12 1/2	2,500	24	1,604	1,175	28,250	28,839	0.75 (steel)	0.65 (bond)	14,320	12,665
3/4	3 1/2	2,500	24	1553	1,131	7,857	7,857	0.65 (conc)	0.65 (conc)	3,450	3,450
	15	2,500	24	1553	1,131	41,810	39,973	0.75 (steel)	0.65 (bond)	21,190	17,555
7/8	3 1/2	2,500	24	1,512	1,102	7,857	7,857	0.65 (conc)	0.65 (conc)	3,450	3,450
	17 1/2	2,500	24	1,512	1,102	57,710	53,012	0.75 (steel)	0.65 (bond)	29,245	23,285
1	4	2,500	24	1,477	1,073	9,600	9,600	0.65 (conc)	0.65 (conc)	4,215	4,215
	20	2,500	24	1,477	1,073	75,710	67,419	0.75 (steel)	0.65 (bond)	38,370	29,610
1 1/4	5	2,500	24	1,420	1,030	13,416	13,416	0.65 (conc)	0.65 (conc)	5,890	5,890
	25	2,500	24	1,420	1,030	121,135	101,120	0.65 (bond)	0.65 (bond)	61,225	44,410
ASTM A706 Grade 60 Reinforcing Bar											
3	2 3/8	2,500	24	1,756	1,276	4,392	3,570	0.65 (conc)	0.65 (bond)	1,930	1,570
	7 1/2	2,500	24	1,756	1,276	8,800	8,800	0.75 (steel)	0.75 (steel)	4,460	4,460
4	2 3/4	2,500	24	1,668	1,218	5,472	5,261	0.65 (conc)	0.65 (bond)	2,400	2,310
	10	2,500	24	1,668	1,218	17,710	17710	0.75 (steel)	0.75 (steel)	8,110	8,110
5	3 1/8	2,500	24	1,604	1,175	6,629	6,629	0.65 (conc)	0.65 (conc)	2,910	2,910
	12 1/2	2,500	24	1,604	1,175	24,800	24,800	0.75 (steel)	0.75 (steel)	12,570	12,570
6	3 1/2	2,500	24	1553	1,131	7,857	7,857	0.65 (conc)	0.65 (conc)	3,450	3,450
	15	2,500	24	1553	1,131	35,200	35,200	0.75 (steel)	0.65 (bond)	17,840	17,555
7	3 1/2	2,500	24	1,512	1,102	7,857	7,857	0.65 (conc)	0.65 (conc)	3,450	3,450
	17 1/2	2,500	24	1,512	1,102	48,000	48,000	0.75 (steel)	0.65 (bond)	24,325	23,285
8	4	2,500	24	1,477	1,073	9,600	9,600	0.65 (conc)	0.65 (conc)	4,215	4,215
	20	2,500	24	1,477	1,073	63,200	63,200	0.75 (steel)	0.65 (bond)	32,025	29,610
9	4 1/2	2,500	24	1,446	1,059	11,455	11,455	0.65 (conc)	0.65 (conc)	5,030	5,890
	22 1/2	2,500	24	1,446	1,059	80,000	80,000	0.75 (steel)	0.65 (bond)	40,540	36,985
10	5	2,500	24	1,420	1,030	13,416	13,416	0.65 (conc)	0.65 (conc)	5,890	5,890
	25	2,500	24	1,420	1,030	101,600	101,120	0.75 (steel)	0.65 (bond)	51,485	44,410

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.448 N, 1 psi = 0.006894 MPa. For **pound-inch** units: 1 mm = 0.03937 inch, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

[1]Single anchor with static tension load only; ASTM A193 Grade B7 threaded rod and ASTM A706 Grade 60 reinforcing bar.
[2]Vertical downward installation direction.
[3]Special inspection interval = Periodic.
[4]Installation temperature = 50°F (10°C) to 104°F (40°C) for base material; 50°F (10°C) to 104°F (40°C) for cartridge adhesive.
[5]Embedment = $h_{ef,min}$ and $h_{ef,max}$ for each diameter.
[6]Concrete determined to remain uncracked for the life of the anchorage.
[7]Long-term service temperature = 110°F (43°C), short-term service temperature = 140°F (60°C).
[8]Long-term service temperature = 110°F (43°C), short-term service temperature = 176°F (80°C).
[9]Load combinations are based on ACI 318 Section 9.2 with no seismic loading considered.
[10]Thirty percent (30%) dead load and seventy percent (70%) live load; controlling load combination 1.2*D* + 1.6*L*.
[11]Calculation of weighted average for the conversion factor, α = 1.2(0.3) + 1.6(0.7) = 1.48.
[12]f'_c = 2,500 psi compressive strength (normal-weight concrete).
[13]$c_{a1} = c_{a2} > c_{ac}$.
[14]$h \geq h_{min}$.
[15]Strength reduction factor from controlling nominal strength in tension [i.e. steel, concrete (conc), bond] decisive from design assumptions.
[16]Hammer-drilled holes in dry concrete.

POWERS Pure110+ Instruction Card

DESCRIPTION:
Pure110+ is a high strength, 100% solids epoxy anchoring adhesive which is formulated for use in anchoring applications by trained professionals. Please refer to Powers Fasteners installation instructions and MSDS 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 Material Safety Data Sheet (MSDS).
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 95°F (35°C). Keep away from excessive heat and flame. Keep partially used containers closed when not in use. Protect from damage. Store away from heat and light.

Note expiration date on product label before use. Do not use expired product. Cartridge temperature must be between 50°F - 104°F (10°C - 40°C) when in use. 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 the initial quantity of the anchor adhesive as described in the installation instructions.

Powers Fasteners, Inc. www.powers.com
2 Powers Lane P: +1 (914) 235-6300
Brewster, NY, 10509 U.S.A. or (800) 524-3244 [D]

[I.] Pure110+ epoxy adhesive anchor system selection table

Injection tool	Plastic cartridge system	Extra mixing nozzle
10 fl. oz. caulking gun Cat. #08437	9 fl. oz. Quik-Shot w/ nozzle and extension tube Cat. #08310SD	Mixing nozzle w/ extension tube Cat. #08294
21 fl. oz. manual tool Cat. #08409	21 fl. oz. dual cartridge w/nozzle and extension tube Cat. #08321SD	Mixing nozzle w/ extension tube Cat. #08609
21 fl. oz. pneumatic tool Cat. #8459		
21 fl. oz. battery tool Cat. #08442		

A plastic extension tube (Cat# 08281) or equivalent approved by Powers must be used for embedment depths greater than 8 inches.
Contact Powers for information regarding the 51 fl. oz. size cartridge system.

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

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

Linear interpolation for intermediate base material temperatures is possible.

[III.] Hole Cleaning Tools and Accessories[2,3,4]

Fractional anchor sizes

Rod dia. (inch)	Rebar size (No.)	Drill bit size[1] (inch)	Brush size (inch)	Brush length (inches)	Wire brush (Cat. #)	Plug size (inch)	Piston plug (Cat. #)
3/8	3	7/16	1/2	6 3/4	08284	-	-
1/2	4	9/16	5/8	6 3/4	08285	9/16	08302
5/8	5	11/16	3/4	7 7/8	08286	11/16	08258
		3/4	13/16	7 7/8	08278	3/4	08259
3/4	6	7/8	15/16	7 7/8	08287	7/8	08300
7/8	7	1	1-1/16	11 7/8	08288	1	08301
1	8	1 1/8	1-3/16	11 7/8	08289	1 1/8	08303
1 1/4	9	1 3/8	1-7/16	11 7/8	08290	1 3/8	08305
-	10	1 1/2	1-9/16	11 7/8	08291	1 1/2	08309

Note: a 5/8-inch-diameter piston plug is also available with Cat# 08304


Wire brush and brush extension


Compressed air nozzle, Cat #8292, (min. 90 psi)


Piston plug

Metric anchor sizes

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. #)
10	-	12	14	170	23325	-	-
12	10	14	16	200	23327	14	23377
-	12	16	18	200	23330	16	23378
16	14	18	20	200	23335	18	23379
-	16	20	22	200	23340	20	23380
20	20	24	26	300	23355	24 (22)	23381
24	-	28	30	300	23360	28 (27)	23385
27	25	32	34	300	23365	32 (30)	23386
30	28	35	37	300	23370	35 (34)	23387
-	32	38	40	300	23375	35 (36)	23387

[1] For installations with 5/8-inch threaded rod and #5 rebar size, the preferred ANSI drill bit diameter is 3/4-inch. If an 11/16-inch ANSI drill bit is used the user must check before injecting the adhesive to verify that the steel anchor element can be inserted into the cleaned borehole without resistance.
[2] A brush extension (Cat. #08282) must be used with a steel wire brush for holes drilled deeper than the listed brush length.
[3] A flexible plastic extension tube (Cat# 08297) or equivalent approved by Powers must be used with piston plugs.
[4] All overhead installations require the use of piston plugs where one is tabulated together with the anchor size.
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.
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

Anchor property / Setting information	Threaded rod / reinforcing bar size (rebar)								
	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"	#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_o (d_{bit}) = Nominal ANSI drill bit size (in.)	7/16	9/16	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} + $2d_o$						
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[1]	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	Threaded rod / reinforcing bar size (rebar)														
	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_o (d_{bit}) = Nominal ANSI drill bit size (mm)	12	14	14	16	18	18	20	24	24	28	32	32	35	35	37
$h_{ef,min}$ = 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} + $2d_o$												
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 (Class 1) stainless rod[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.
[3] These torque values apply to ASTM A 193 Grade B8/B8M (Class 1) stainless steel threaded rod only.

FIGURE 3—MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII)

Installation instructions for solid base material – For any application not covered by this document please contact Powers Fasteners (www.powers.com)

SELECT HAMMER DRILLING METHOD AS SUITABLE FOR APPLICATION

HAMMER DRILLING

1. Drill a hole into the base material with rotary hammer drill (i.e. percussion drill) to the size and embedment required by the selected steel hardware element (see Table III). Tolerances of carbide drill bits must meet ANSI Standard B212.15. Precaution: Wear suitable eye and skin protection. Avoid inhalation of dusts during drilling and/or removal.

Notes: *In case of standing water in the drilled bore hole (flooded hole condition), all the water has to be removed from the hole (e.g. vacuum, compressed air, etc.) prior to cleaning.*
For underwater (submerged) installations please see separate specific instructions below.

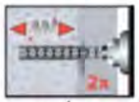
→ *Next go to Step 2a-i; or 2b-i for underwater (submerged) installations.*

HOLE CLEANING DRY OR WET HOLES

Blow 2x

2a-i. Starting from the bottom or back of the drilled anchor hole, blow the hole clean (free of noticeable dust) a minimum of *two* times (**2x**).

Use a compressed air nozzle (min. 90 psi) for all sizes of anchor rod and reinforcing bar (rebar).



Brush 2x

2a-ii. Determine brush diameter (see Table III) for the drilled hole and attach the brush with adaptor to a rotary drill tool or battery screw gun. Brush the hole with the selected wire brush a minimum of *two* times (**2x**).

A brush extension (supplied by Powers Fasteners) must be used for holes drilled deeper than the listed brush length. The wire brush diameter must be checked periodically during use; The brush should resist insertion into the drilled hole, if not the brush is too small and must be replaced with the proper brush diameter (e.g. new brush).

Repeat Blowing 2x

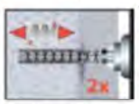
2a-iii. **Repeat Step 2a-i** again by blowing the hole clean a minimum of *two* times (**2x**).

When finished the hole should be clean and free of dust, debris, ice, grease, oil or other foreign material. → **→ Next go to Step 3.**

HOLE CLEANING UNDERWATER INSTALLATION

Rinse

2a-i. Starting from the bottom or back of the drilled anchor hole, rinse/flush the hole clean with air/water (air/water line pressure) until clear water comes out.



Brush 2x

2a-ii. Determine brush diameter (see Table III) for the drilled hole and attach the brush with adaptor to a rotary drill tool. Brush the hole with the selected wire brush a minimum of *two* times (**2x**).

A brush extension (supplied by Powers Fasteners) must be used for holes drilled deeper than the listed brush length. The wire brush diameter must be checked periodically during use; The brush should resist insertion into the drilled hole, if not the brush is too small and must be replaced with the proper brush diameter (e.g. new brush).

Repeat Rinsing

2a-iii. Repeat Step 2a-i again by rinse/flushing the hole clean with air/water.

When finished the hole should be clean and free of dust, debris, or other foreign material.

→ Next go to Step 3.

This section is intentionally left blank.

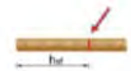
FOLLOW STEPS #1 THROUGH #10 FOR RECOMMENDED INSTALLATION

PREPARING

3. Check adhesive expiration date on cartridge label. Do not use expired product. Review Material Safety Data Sheet (MSDS) before use. Cartridge temperature must be between 50°F - 104°F (10°C - 40°C) when in use; for overhead applications cartridge temperature must be between 50°F - 90°F (10°C - 30°C). Review published working and cure times. Consideration should be given to the reduced gel (working) time of the adhesive in warm temperatures. For the permitted range of the base material temperature see Table II.

Attach a supplied mixing nozzle to the cartridge. Do not modify the mixer in any way and make sure the mixing element is inside the nozzle. Load the cartridge into the correct dispensing tool.

Note: *Always use a new mixing nozzle with new cartridges of adhesive and also for all work interruptions exceeding the published gel (working) time of the adhesive.*



4. Prior to inserting the anchor rod or rebar into the filled bore hole, the position of the embedment depth has to be marked on the anchor. Verify anchor element is straight and free of surface damage.

5. Adhesive must be properly mixed to achieve published properties. Prior to dispensing adhesive into the drilled hole, separately dispense at least three full strokes of adhesive through the mixing nozzle until the adhesive is a consistent *red* color.

Review and note the published working and cure times (see Table II) prior to injection of the mixed adhesive into the cleaned anchor hole.

INSTALLATION

6. Fill the cleaned hole approximately two-thirds full with mixed adhesive starting from the bottom or back of the anchor hole. Slowly withdraw the mixing nozzle as the hole fills to avoid creating air pockets or voids. For embedment depths greater than 8" a plastic extension tube must be used with the mixing nozzle (see Table I).

with piston plug:

Note: Piston plugs must be used with and attached to mixing nozzle and extension tube for overhead and horizontal installations with anchor rod sizes as indicated in Table III. Insert piston plug to the back of the drilled hole and inject as described in the method above. During installation the piston plug will be naturally extruded from the drilled hole by the adhesive pressure.

Attention! *Do not install anchors overhead without proper training, and installation hardware provided by Powers Fasteners. Contact Powers for details prior to use.*

7. The anchor should be free of dirt, grease, oil or other foreign material. Push clean threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. Observe the gel (working) time.

8. Ensure that the anchor element is installed to the specified embedment depth. Adhesive must completely fill the annular gap at the concrete surface. Following installation of the anchor element, remove excess adhesive. Protect the anchor element threads from fouling with adhesive. For all installations the anchor element must be fully restrained from movement throughout the specified curing period, where necessary through the use of temporary wedges, external supports, or other methods. Minor adjustments to the position of the anchor element may be performed during the gel time only.

CURING AND FIXTURE

9. Allow the adhesive anchor to cure to the specified full curing time prior to applying any load (see Table IV).

Do not disturb, torque or load the anchor until it is fully cured.

10. After full curing of the adhesive anchor, a fixture can be installed to the anchor and tightened up to the maximum torque (shown in Table III) by using a calibrated torque wrench.

Note: *Take care not to exceed the maximum torque for the selected anchor.*

FIGURE 3—MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII) (Continued)

ICC-ES Evaluation Report

ESR-3298 FBC Supplement

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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:

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EVALUATION SUBJECT:

POWERS PURE110+ EPOXY ADHESIVE ANCHOR SYSTEM IN CRACKED AND UNCRACKED CONCRETE

1.0 REPORT PURPOSE AND SCOPE

Purpose:

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

Applicable code editions:

- 2010 *Florida Building Code—Building*
- 2010 *Florida Building Code—Residential*

2.0 CONCLUSIONS

The Powers Pure110+ Epoxy Adhesive Anchor System in Cracked and Uncracked Concrete**,** described in Sections 2.0 through 7.0 of the master evaluation report ESR-3298, complies with the 2010 *Florida Building Code—Building* and the 2010 *Florida Building Code—Residential*, provided the design and installation are in accordance with the *International Building Code®* provisions noted in the master report, and under the following conditions:

- Design wind loads must be based on Section 1609 of the 2010 *Florida Building Code—Building* or Section 301.2.1.1 of the 2010 *Florida Building Code—Residential*, as applicable.
- Load combinations must be in accordance with Section 1605.2 or Section 1605.3 of the 2010 *Florida Building Code—Building*, as applicable.
- The modifications to ACI 318 as shown in 2009 IBC Sections 1908.1.9 and 1908.1.10, as noted in 2009 IBC Section 1912.1, do not apply to the 2010 *Florida Building Code*.

Use of the Powers Pure110+ epoxy adhesive anchors with stainless steel threaded rod materials and reinforcing bars has also been found to be in compliance with the High-Velocity Hurricane Zone provisions of the 2010 *Florida Building Code—Building* and the 2010 *Florida Building Code—Residential*, when the following conditions are met:

- Design wind loads for use of the anchors in a High-Velocity Hurricane Zone must be based on Section 1620 of the *Florida Building Code—Building*.
- Reinforcing bars must be in accordance with Section 1922.4 of the *Florida Building Code—Building*.

Use of the Powers Pure110+ epoxy adhesive anchors with carbon steel threaded rod materials for compliance with the High-Velocity Hurricane Zone provisions of the 2010 *Florida Building Code—Building* and the 2010 *Florida Building Code—Residential* has not been evaluated, and is outside the scope of this supplemental report.

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

This supplement expires concurrently with the master report, reissued July 2015.