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PROANCHOR ELITE HIGH STRENGTH ANCHORING EPOXY FOR CRACKED AND UNCRACKED CONCRETE

CSI Sections:

03 15 19—Cast-in Anchors
05 05 19—Post-Installed Concrete Anchors

1.0 RECOGNITION

The ProAnchor Elite High Strength Anchoring Epoxy recognized in this report has been evaluated for use to resist static, wind, and earthquake tension and shear loads. The structural performance properties of the ProAnchor Elite High Strength Anchoring Epoxy were evaluated for compliance with the following codes and standards:

- 2018, 2015, 2012, and 2009 International Building Code® (IBC)
- 2018, 2015, 2012, and 2009 International Residential Code® (IRC)
- ACI 318-14 and 318-11
- ACI 355.4-11
- ICC-ES AC308
- 2017 Florida Building Code, Building (FBC,-Building) – attached supplement
- 2017 Florida Building Code, Residential (FBC, Residential) – attached supplement
- 2020 City of Los Angeles Building Code (LABC) – attached supplement
- 2020 City of Los Angeles Residential Code (LARC) – attached supplement

2.0 LIMITATIONS

Use of the ProAnchor Elite High Strength Anchoring Epoxy recognized in this report is subject to the following limitations:

2.1 ProAnchor Elite High Strength Anchoring Epoxy shall be installed in accordance with the manufacturer's printed installation instructions (MPII) as shown in Figure 6 of this report.

2.2 Anchor elements shall be installed in cracked and uncracked normal-weight or lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

2.3 Values of f'_c used for calculation purposes shall not exceed 8,000 psi (55.1 MPa).

2.4 Anchor elements shall be installed in normal-weight or lightweight concrete as set forth in Figures 1 or 2 of this report in holes predrilled with either a rotary-hammer drilling method using carbide-tipped drill bits complying with the dimensional tolerances of ANSI B212.15-1994, or Milwaukee Tool vacuum drill bits, or diamond core drill bits.

2.5 ProAnchor Elite High Strength Anchoring Epoxy adhesive anchors are recognized to resist short-term and long-term loads, including wind and earthquake loads, subject to the conditions of this report.

2.6 Permitted installations considering anchor element type, hole drilling method, concrete condition, and installation environment are listed in Table 20 of this report.

2.7 In structures assigned to Seismic Design Category C, D, E, or F under the IBC or IRC, anchor strength shall be adjusted in accordance with Section 3.2.12 of this report.

2.8 ProAnchor Elite High Strength Anchoring Epoxy adhesive anchors are permitted to be installed in concrete that is cracked or may be expected to crack during the service life of the anchor, subject to the conditions of this report.

2.9 Anchors may be used to resist tension and shear forces in floor (downwardly inclined), wall (horizontally), or overhead (upwardly inclined) orientations only if installation is within the service temperature range shown in Tables 10, 11, 12, 15, 16, or 19 of this report.

2.10 Strength design values shall be established in accordance with Section 3.2 of this report. Loads applied to the anchors shall be adjusted in accordance with Section 1605.2 of the IBC for strength design.

2.11 Allowable design values shall be established in accordance with Section 3.3 of this report. Loads applied to the anchors shall be adjusted in accordance with Section 1605.3 of the IBC for allowable stress design.

2.12 Minimum anchor spacing and edge distance, critical edge distance, and minimum member thickness shall comply with the values described in this report.

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

2.14 Fire-resistive Construction: Anchors are not permitted to support fire-resistive construction. Where not otherwise prohibited in the applicable code, ProAnchor Elite High Strength Anchoring Epoxy adhesive anchors are permitted for installation in fire-resistive construction provided 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 nonstructural elements.

2.15 Since an evaluation 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.

2.16 Use of uncoated or zinc-plated carbon steel threaded rods or steel reinforcing bars is limited to dry, interior locations. Exterior anchor locations and water-saturated conditions require the use of hot-dipped galvanized carbon steel or stainless steel anchors, threaded rods, reinforcing bars, or threaded inserts. The coating weights for hot-dip galvanized steel shall be in accordance with ASTM A153 Class C or D.

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

2.18 Special inspection shall be provided in accordance with Section 3.5 of this report. Continuous special inspection for anchors installed in horizontally or upwardly inclined installations that are designed to resist sustained tension loads shall be provided in accordance with Section 3.5.2 of this report.

2.19 ProAnchor Elite High Strength Anchoring Epoxy Adhesive Anchor System may be used for floor (downwardly inclined), wall (horizontally inclined), and overhead (upwardly inclined) applications.

2.20 Anchors installed in a horizontally inclined or upwardly inclined orientation to resist sustained tension loads shall be performed by personnel certified by an applicable certification program in accordance with ACI 318-14 17.8.2.2 or 17.8.2.3 (ACI 318-11 D.9.2.2 or D.9.2.3).

2.21 ProAnchor Elite High Strength Anchoring Epoxy is manufactured and packaged into cartridges and bulk containers at approved locations.

2.22 Manufacture of POWER-Sert™ Internally Threaded and Bonded Inserts is beyond the scope of this report. Evidence of compliance with the specifications in Section 4.3.4.3, Table 3, and Table 16 of this report shall be submitted to the code official for approval.

3.0 PRODUCT USE

3.1 General: The ProAnchor Elite High Strength Anchoring Epoxy is used to resist static, wind, and earthquake (Seismic Design Categories A through F under the IBC) tension and shear loads in cracked and uncracked, normalweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa). Cracked concrete shall be assumed except for anchors located in a region of the concrete member where analysis indicates no cracking (uncracked) at service loads in accordance with ACI 318-14 17.4.2.6 and 17.5.2.7 (ACI 318-11 D.5.2.6 and D.6.2.7). The analysis for the determination of crack formation shall include the effects of restrained shrinkage, as applicable, in accordance with ACI 318-14 24.4.2 (ACI 318-11 7.12.1.2). Cracked concrete also shall be assumed for anchors in structures assigned to Seismic Design Category C, D, E, or F. The adhesive anchor system complies with Section 1901.3 of the 2018 and 2015 IBC; and is an alternative to anchors described in Sections 1908 and 1909 of the 2012 IBC and Sections 1911 and 1912 of the 2009 IBC. The anchoring system may also be used where an engineering design is submitted in accordance with Section R301.1.3 of the 2018, 2015, 2012, and 2009 IRC. Table 7 of this report references tables for any permitted combination of design strength, load direction, concrete condition, anchor type, and hole drilling method. Figures 1 and 2 of this report illustrate installed anchor element types and notations.

3.2 Strength Design and Installation

3.2.1 General: Strength design under the 2018 and 2015 IBC and Section R301.1.3 of the 2018 and 2015 IRC shall be in accordance with ACI 318-14 and Section 3.2.2 of this report. Strength design under the 2012 and 2009 IBC, as well as Section R301.1.3 of the 2012 and 2009 IRC, shall be in accordance with ACI 318-11 and Section 3.2.2 of this report. Allowable Stress Design shall be in accordance with Section 3.3 of this report.

3.2.2 Anchor design strengths, ϕN_n, and ϕV_n, shall be determined in accordance with Chapter 17 of ACI 318-14 or Appendix D of ACI 318-11 and this report. Design parameters are provided in Tables 8 through 18 of this report and are based on the 2018 or 2015 IBC unless noted otherwise in this report. Anchor designs shall satisfy the requirements of ACI 318-14 17.3.1.1, 17.3.1.2, and 17.3.1.3 (ACI 318-11 D.4.1.1, D.4.1.2, and D.4.1.3). Anchor group effects shall be considered in accordance with ACI 318-14 17.2.1.1 (ACI 318-11 D.3.1.1). Strength reduction factors, ϕ, as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3 or D.4.4) are given for each diameter in Tables 8 through 18 of this report. Strength reduction factors, ϕ, described in ACI 318-11 D.4.4, shall be used for load combinations calculated in accordance with Appendix C of ACI 318-11. This section provides amendments to ACI 318-14 and ACI 318-11 Appendix D as required for the strength design of adhesive anchors.

3.2.3 Static Steel Strength in Tension: Nominal steel strength of a single anchor in tension, N_{sa}, shall be calculated in accordance with ACI 318-14 17.4.1.2 (ACI 318-11 D.5.1.2), and the corresponding strength reduction factors, depending on whether the steel is considered brittle or ductile, in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3) are given in Tables 8, 13, and 16 of this report for computing design strengths of corresponding anchor steel elements.

3.2.4 Static Concrete Breakout Strength in Tension: Nominal concrete breakout strength of a single anchor or group of anchors in tension, N_{cb}, and N_{cbg}, shall be calculated in accordance with ACI 318-14 17.4.2 (ACI 318-11 D.5.2) with the following addition:

The basic concrete breakout strength of a single anchor in tension, N_b, shall be calculated in accordance with ACI 318-14 17.4.2.2 (ACI 318-11 D.5.2.2) where the values of h_{ef} comply with Tables 9, 14, and 17 of this report. The value of k_c to be used in ACI 318-14 Eq. (17.4.2.2a) or ACI 318-11 Eq. (D-6) shall be as follows:

$k_{c,cr}$ = 17 where analysis indicates cracking at service load levels in the vicinity of the anchor (cracked concrete).

$k_{c,uncr}$ = 24 where analysis indicates no cracking ($f_t < f_r$) at service load levels in the vicinity of the anchor (uncracked concrete).

To design for uncracked concrete, anchors shall be located in a region of the concrete member where analysis indicates no cracking at service load levels. The Anchor Categories and corresponding strength reduction factors, ϕ, are given for each anchor element type in Tables 9, 14, and 18 of this report for Condition B, as defined in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). For anchors in lightweight concrete, the modification factor λ_a shall be applied to ACI 318-14 Eq. (17.4.2.2a) (ACI 318-11 Eq. (D-6)) in accordance with ACI 318-14 17.2.6 (ACI 318-11 D.3.6). The value of f'_c shall be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318-14 17.2.7 (ACI 318-11 D.3.7).

3.2.5 Static Bond Strength in Tension: The nominal static bond strength of a single adhesive anchor, N_{ba}, or group of adhesive anchors in tension shall be calculated in accordance with ACI 318-14 17.4.5 (ACI 318-11 D.5.5). For anchors designed to resist sustained tension loads, bond strength shall be calculated in accordance with ACI 318-14 17.2.5 and 17.3.1.2 (ACI 318-11 D.3.5 and D.4.1.2). Embedment depths shall comply with ACI 318-14 17.3.2.3 (ACI 318-11 D.4.2.3) and Tables 10, 11, 12, 15, 16, or 19 of this report, depending on anchor type. Bond strength values are a function of concrete conditions (i.e., cracked or uncracked), hole drilling method (hammer drill, core drill, hollow vacuum drill), concrete temperature, installation conditions (i.e. dry, water-saturated, or water-filled), and special inspection level (i.e., continuous or periodic). To design for uncracked concrete, anchors shall be located in a region where analysis indicates no cracking at service load levels. Elevated concrete temperatures arise from a number of factors, including sun exposure, proximity to operating machinery, or containments of liquids or gases at elevated temperatures. Therefore, bond strengths, anchor categories, and strength reduction factors, ϕ, are listed in Tables 10, 11, 12, 15, 16, and 19 of this report for each anchor element type and diameter, permitted normal weight concrete condition, concrete temperature, installation condition, and special inspection level. Bond strength values given in these tables correspond to concrete compressive strength, f'_c = 2,500 psi (17.2 MPa). Bond strength values in uncracked concrete may be increased for higher concrete compressive strengths, and no increase is permitted in cracked concrete. Bond strength values shall be modified with the corresponding strength reduction and adjustment factors for cases wherein the holes are drilled in dry concrete, water-saturated concrete, or water-filled holes in concrete. For anchors in lightweight concrete, the modification factor λ_a shall be applied to ACI 318-14 Eq. (17.4.2.2a) (ACI 318-11 Eq. (D-6)) in accordance with ACI 318-14 17.2.6 (ACI 318-11 D.3.6).

3.2.5.1 Sustained Loads: In addition to requirements in Section 3.2.5 of this report for the design of a single anchor in tension to resist sustained loads, ACI 318-14 17.3.1.2 (ACI 318-11 D.4.1.2) shall apply.

3.2.6 Splitting Control: ACI 318-14 17.4.5.5 (ACI 318-11 D.5.5.5) shall be replaced as follows:

17.4.5.5 (D.5.5.5) – The modification factor for adhesive anchors designed for uncracked concrete in accordance with 17.4.5.2 (D.5.5.2) without supplementary reinforcement to control splitting, $\psi_{cp,Na}$, shall be calculated as:

If $c_{a,min} \geq c_{ac}$ then $\psi_{cp,Na} = 1.0$
(Eq.17.4.5.5.a for ACI 318-14) ((D-26) for ACI 318-11)

If $c_{a,min} < c_{ac}$ then $\psi_{cp,Na} = c_{a,min} / c_{ac}$
(Eq.17.4.5.5.b for ACI 318-14) ((D-27) for ACI 318-11)

where

c_{ac} *shall be determined in accordance with (Eq. 17.4.5.5.c for ACI 318-14) (D-27a for ACI 318-11)*

$c_{ac} = h_{ef} \times (\tau_{k,uncr}/1160)^{0.4} \times [3.1 - 0.7(h/h_{ef})]$ (inches)
(Eq. 17.4.5.5.c for ACI 318-14) (D-27a for ACI 318-11)

where

(h/h_{ef}) *need not be taken as larger than 2.4; and* $\tau_{k,uncr}$ = *characteristic bond strength stated in Tables 10, 11, 12, 15, and 18 of this Evaluation Report, whereby* $\tau_{k,uncr}$ *need not be taken as larger than:*

$\tau_{k,uncr} = (k_{uncr}\,(h_{ef} \times f'_c)^{0.5})/(\pi \times d_a)$

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

3.2.7 Static Steel Strength in Shear: The nominal steel strength of a single anchor in shear, V_{sa}, in accordance with ACI 318-14 17.5.1.2 (ACI 318-11 D.6.1.2), is given in Tables 8, 13, and 16 of this report. The strength reduction factor, ϕ, corresponding to the steel element selected and whether the steel is considered brittle or ductile, is also given in Tables 8, 13, and 16 of this report, for use with load combinations of ACI 318-14 5.3 as set forth in 17.3.3 (ACI 318-11 9.2 as set forth in D.4.3).

3.2.8 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}, shall be calculated in accordance with ACI 318-14 17.5.2 (ACI 318-11 D.6.2) with modifications as described in this section. The basic concrete breakout strength in shear, V_b, shall be calculated in accordance with ACI 318-14 17.5.2.2 (ACI 318-11 D.6.2.2) using the applicable values of h_{ef} and d_a as described in Tables 9, 14, and 18 of this report in lieu of l_e and d_a. In no case shall l_e exceed $8d_a$. The value of f'_c shall be limited to 8,000 psi (55 MPa), in accordance with ACI 318-14 17.2.7 (ACI 318-11 D.3.7). For anchors in lightweight concrete, the modification factor λ_a shall be applied to ACI 318-14 Eq. (17.4.2.2a) (ACI 318-11 Eq. (D-6)) in accordance with ACI 318-14 17.2.6 (ACI 318-11 D.3.6). Corresponding strength reduction factors, ϕ, are given in Tables 9, 14, and 18 of this report for Condition B, as defined in ACI 318-14 17.3.3 (ACI 318-11 D.4.3).

3.2.9 Static Concrete Pryout Strength in Shear: The nominal static pryout strength of a single anchor or group of anchors in shear, V_{cp}, or V_{cpg}, shall be calculated in accordance with ACI 318-14 17.5.3.1 (ACI 318-11 D.6.3.1).

3.2.10 Interaction of Tensile and Shear Forces: For loadings that include combined tension and shear, the design shall be performed in accordance with ACI 318-14 17.6 (ACI 318-11 D.7).

3.2.11 Minimum Member Thickness, Minimum Anchor Spacing, and Minimum Edge Distance: In lieu of using ACI 318-14 17.7.1 and 17.7.3 (ACI 318-11 D.8.1 and D.8.3), values of c_{min} and s_{min} provided in Tables 9, 14, or 17 of this report shall be used. In lieu of using ACI 318-14 17.7.5 (ACI 318-11 D.8.5), minimum member thickness, h_{min}, shall be in accordance with Tables 9, 14, or 18 of this report. In determining minimum edge distances, c_{min}, the following section shall be added to ACI 318 Chapter 17 (ACI 318 Appendix D):

For adhesive anchors that are either torqued or remain untorqued, the minimum edge distance and spacing shall be taken from Tables 9, 14, or 17 of this report.

3.2.12 Design Strength in Seismic Design Categories C, D, E, and F: In structures assigned to Seismic Design Category C, D, E, or F under the IBC or IRC, the design shall be performed according to ACI 318-14 17.2.3.1 as modified by Section 1905.1.8 of the 2018 and 2015 IBC (ACI 318-11 D.3.3 as modified by Section 3.2.12.1 of this report which replaces Section 1905.1.9 of the 2012 IBC). Nominal steel shear strength, V_{sa}, shall be adjusted be $\alpha_{V,seis}$ as given in Tables 8 and 13 of this report for the corresponding anchor steel. The nominal bond strength, $\tau_{k,cr}$, shall be adjusted by the seismic reduction factor, $\alpha_{N,seis}$, as given in Tables 10, 11, 12, 13, and 15 of this report for the corresponding anchor steel.

3.2.12.1 Section 1905.1.9 of the 2012 IBC shall be replaced with the following:

Modify ACI 318-11 Sections D.3.3.4.2, D.3.3.4.3 (d), and D.3.3.5.2 and replace with the following:

D.3.3.4.2 – Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 percent of the 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:

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_o. 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 $^5/_8$ inch (16 mm).

1.3. Anchor bolts are embedded into concrete a minimum of 7 inches (178 mm).

1.4. Anchor bolts are located a minimum of 1¾ 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 $^5/_8$ inch (16 mm).

2.2. Anchors are embedded into concrete a minimum of 7 inches (178 mm).

2.3. Anchors are located a minimum of 1¾ 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 non-bearing 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).

3.3 Allowable Stress Design (ASD)

3.3.1 General: For anchor designed using load combinations in accordance with IBC Section 1605.3, allowable loads shall be established using Eq. (3-3) or Eq. (3-4):

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \quad \text{Eq. (3-3)}$$

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

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 318-14 Chapter 17 or ACI 318-11 Appendix D and as amended in Section 3.3 of this report.

ϕV_n = lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318-14 Chapter 17 or ACI 318-11 Appendix D and as amended in Section 3.3 of this report.

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

3.3.2 Interaction of Tensile and Shear Forces: In lieu of ACI 318-14 17.6.1, 17.6.2, and 17.6.3 (ACI 318-11 D.7.1, D.7.2 and D.7.3), the interaction of tension and shear loads shall be calculated as follows:

17.6.1 (D.7.1): If $V_{applied} \leq 0.2\ V_{allowable,ASD}$, for the governing strength in shear, then the full allowable strength in tension, $T_{allowable,ASD}$, shall be permitted.

17.6.2 (D.7.2): If $T_{applied} \leq 0.2\ T_{allowable,ASD}$, for the governing strength in tension, then the full allowable strength in shear, $V_{allowable,ASD}$, shall be permitted.

17.6.3 (D.7.3): If $V_{applied} \leq 0.2\ V_{allowable,ASD}$, for the governing strength in shear and $T_{applied} \leq 0.2\ T_{allowable,ASD}$ for the governing strength in tension.

For all other cases: Eq. (3-5) applies Eq. (3-5)

$$\frac{T}{T_{allowable,ASD}} + \frac{V}{V_{allowable,ASD}} \leq 1.2$$

3.4 Installation: Installation shall be in accordance with the codes referenced in Section 1.0 of this report and the manufacturer's printed installation instructions (MPII) in Figure 7 of this report. Where conflicts occur, the more restrictive shall govern. Installation parameters are provided in Tables 1, 2, and 3 and Figures 1 and 2 of this report. Anchor locations shall comply with this report and the plans and specifications approved by the code official. The approved plans shall include the information specified in ACI 318-14 17.8.1, 17.8.2, and 17.8.2.1 (ACI 318-11 D.9.2 and D.9.2.1). Installation of the ProAnchor Elite High Strength Anchoring Epoxy shall conform to the MPII included in the packages, and as described in detail in Figure 6 of this report. Anchor elements described in Section 4.3.4 of this report; and mixing nozzles, brushes, dispensing tools, and piston plugs shown in Figures 4 and 5 and listed in Tables 1 through 6 of this report as supplied by the manufacturer, shall be used along with the anchoring adhesive system delivered either from cartridges or from bulk dispensing systems. Installation of anchor elements may be downwardly inclined (floor), horizontally inclined (walls), and upwardly inclined (ceilings).

Permitted installations considering anchor element type, hole drilling method, concrete condition, and installation environment are listed in Table 20 of this report.

3.5 Special Inspection

3.5.1 General: All adhesive anchor systems shall be installed with special inspection. Installations may be made under continuous special inspection or periodic special inspection in accordance with the requirements in Tables 10, 11, 12, 15, 16, and 19 of this report as determined by the registered design professional and approved by the code official. Continuous special inspection is required for all cases where adhesive anchors are installed in horizontally or upwardly inclined orientations that are designed to resist sustained tension loads in accordance with 2018 and 2015 IBC Table 1705.3 and ACI 318-14 17.8.2.4 and 26.13.3.2(c) (ACI 318-11 D.9.2.4).

Installations made under special inspection shall be performed in accordance with Sections 1705.1 and 1705.3 of the 2018, 2015, and 2012 IBC, Sections 1704.4 and 1704.15 of the 2009 IBC, with continuous and periodic special inspection as defined in IBC Sections 202 and 1702.1 and this report.

3.5.2 Continuous Special Inspection: Installations made under continuous special inspection with an onsite proof loading program shall be performed in accordance with 2018 and 2015 IBC Section 1705.1 and Table 1705.3, 2012 IBC Section 1705.1.1 and Table 1705.3, 2009 IBC Sections 1704.4 and 1704.15, ACI 318-14 17.8.2.4 and 26.13.3.2 (ACI 318-11 D.9.2.4), and this report. The special inspector shall be on the job site continuously during anchor installation to verify anchor element type, material, diameter, length, spacing, location, embedment and edge distances, adhesive system identification in accordance with Section 5.0 of this report, adhesive expiration date, concrete type, compressive strength and thickness; hole drilling method, dimensions and cleaning procedures, cleaning brush identification, cleaning air pressure, installation torque and adhesive installation in accordance with manufacturer's printed installation instructions (MPII). In addition, for where adhesive anchors are installed in horizontally or upwardly inclined orientations that are designed to resist sustained tension loads, the special inspector shall verify that the installation personnel are certified for such work in accordance with ACI 318-14 17.8.2.2 or 17.8.2.3 (ACI 318-11 D.9.2.2 or D.9.2.3). The special inspector shall observe all aspects of the anchor installation except holes shall be permitted to be drilled in the absence of the special inspector provided the special inspector examines the drill bits used for the drilling and verifies the hole sizes.

3.5.3 Periodic Special Inspection: Periodic special inspection shall be provided in accordance with 2018 and 2015 IBC Sections 1705.1 and 1705.3 and Table 1705.3, 2012 IBC Section 1705.1.1 and Table 1705.3, 2009 IBC Sections 1704.4 and 1704.15; ACI 318-14 26.13.3.3, and this report. The special inspector shall be on the job site initially during anchor installation to verify those items shown for continuous special inspection in Section 3.5.2 of this report. The special inspector shall verify the initial installations of each type and size of the adhesive anchor by construction personnel on-site. Subsequent installations of the same anchor type and size by the same construction personnel are permitted to be performed in the absence of the special inspector. Any change in the anchor being installed or with the personnel performing the installation shall require an initial inspection. For ongoing installations over an extended period of time, the special inspector shall make regular inspections to confirm the correct handling and installation of the product.

3.5.4 Proof Loading Program: An on-site proof loading program is required for all installations subject to continuous special inspection and those designated by the registered design professional or code official. Where required, a proof loading program shall be established by the registered design professional and approved by the code official. As a minimum, the following requirements shall be addressed: frequency of proof loading based on anchor type, diameter, and embedment; proof loads by anchor type, diameter, embedment, and location; acceptable displacement at proof load; and remedial action in the event of failure to achieve the prescribed proof load or excessive displacement.

Unless otherwise directed by the registered design professional and approved by the code official, proof loads shall be applied as confined tension tests. Proof load levels shall not exceed the lesser of 67 percent of the load corresponding to the nominal bond strength as calculated from the characteristic bond stress for uncracked concrete modified for edge effects and concrete properties or 80 percent of the minimum specified anchor element yield strength ($A_{se,N} \cdot f_{ya}$). Proof loads shall be maintained at the required load level for a minimum of 10 seconds.

4.0 PRODUCT DESCRIPTION

4.1 General: The ProAnchor Elite High Strength Anchoring Epoxy is inserted into a pre-drilled hole in hardened normal-weight or lightweight concrete and transfers loads to the concrete by the bond between the anchor and the adhesive, and bond between the adhesive and the concrete.

4.2 Product Information: The ProAnchor Elite High Strength Anchoring Epoxy is comprised of the following components:

- Epoxy resin and hardener packaged in cartridges and bulk
- Adhesive mixing and dispensing equipment
- Equipment for cleaning holes and injecting adhesive

Continuously threaded steel rods or deformed steel reinforcing bars shall be provided by the installer or a third party according to the standard specifications and are not proprietary. POWER-Sert™ internally threaded and bonded inserts are proprietary and evidence of conformance with the specifications shall be presented for approval.

Installation may occur into dry concrete, water-saturated concrete, or water-filled holes in concrete. The manufacturer's printed installation instructions (MPII) and parameters are included on each adhesive unit package and are detailed as shown in Figure 6 of this report.

4.3 Material Information

4.3.1 ProAnchor Elite High Strength Anchoring Epoxy: ProAnchor Elite is a two-component (resin and hardener) adhesive supplied in cartridges and in bulk, separating the chemical components, which are combined in a 1:1 ratio by volume when dispensed through the system-specific static mixing nozzle. ProAnchor Elite High Strength Anchoring Epoxy adhesive anchor system is available in the following packaging options:

Cartridges: 8.6 oz. (254 ml), 21.2 oz. (627 ml), 53 oz. (1.6 L)

Bulk: 10-gallon (38 L) Bulk Kit

The shelf life of the ProAnchor Elite High Strength Anchoring Epoxy is 24 months when stored in the manufacturer's unopened cartridges or containers at temperatures between 40 °F (4 °C) and 95 °F (35 °C). Gel (working) and full cure times based on product and base material temperatures are shown in Table 4 of this report. Minimum cartridge and container temperatures shown in Table 4 of this report shall be observed.

4.3.2 Dispensing Equipment

4.3.2.1 Cartridges: The ProAnchor Elite High Strength Anchoring Epoxy in cartridges shall be dispensed using pneumatic, battery, or manual actuated dispensing tools listed in Table 5 and shown in Figure 4 of this report as supplied by Dayton Superior or Unitex by Dayton Superior.

4.3.2.2 Bulk: The ProAnchor Elite High Strength Anchoring Epoxy in bulk shall be dispensed using two-component delivery systems whereby metering of individual components, and mixing of the two components, are automatically controlled during dispensing. The mixing nozzles to be used on the manifold of the bulk dispenser wand are listed in Table 5 and shown in Figure 5 of this report.

4.3.3 Hole Preparation Equipment

4.3.3.1 Hammer Drill: Holes formed with a hammer drill bit, complying with ANSI B212.15-1994 and of nominal diameters shown in Tables 1 and 2 of this report shall be cleaned with hole-cleaning brushes and air nozzles. Brushes shall be the appropriate size as shown in Tables 1, 2, and 3 of this report. Air nozzles shall be equipped with an extension capable of reaching the bottom of the drilled hole. Holes shall be prepared in accordance with the MPII shown in Figure 6 of this report.

4.3.3.2 Core Drill: Holes formed with a wet diamond core drill bit, of nominal diameters shown in Tables 1 and 2 of this report, shall first be flushed with clean water and then cleaned with hole-cleaning brushes and air nozzles. Brushes shall be the appropriate size as shown in Tables 1 and 2 of this report. Air nozzles shall be equipped with an extension capable of reaching the bottom of the drilled hole. Holes shall be prepared in accordance with the MPII shown in Figure 6 of this report.

4.3.3.3 Hollow Vacuum Drill: Holes formed with Milwaukee Tool's hollow vacuum drill bits, of nominal diameters shown in Tables 1 and 2 of this report, are automatically cleaned while drilling when used in conjunction with Dust Extractor vacuum with HEPA filter as specified by Milwaukee Tool. Once holes in dry or damp concrete are formed with the hollow vacuum drill system, no further hole cleaning steps are required when used with ProAnchor Elite. Milwaukee Tool vacuum drill components are listed in Table 6 of this report and drill bits shall comply with ANSI B212.15-1994. Holes shall be prepared in accordance with the MPII shown in Figure 6 of this report.

Hollow Vacuum Drill Hole Preparation

4.3.4 Anchor Elements

4.3.4.1 Threaded Rods: Steel threaded anchor rods shall be clean, continuously threaded rods (all-thread) in diameters and types (carbon and stainless steel) as described in Table 8 of this report. Carbon steel threaded rods may be furnished with a zinc electroplated coating, hot-dipped galvanized coating, or may be uncoated. Threaded steel rods shall be clean, straight, and free of mill scale, rust, mud, oil, and other coatings that may impair the bond with the adhesive. The tensile strength of the threaded anchor rods shall not exceed 145,000 psi (1,000 MPa).

4.3.4.2 Reinforcing Bars: Steel reinforcing bars are deformed bars. Table 13 of this report summarizes reinforcing bars (rebar) size ranges, specifications, and grades. Embedded portions of reinforcing bars shall be straight, and free of mill scale, rust, mud, oil, and other coatings or substances that may impair the bond with the adhesive. Reinforcing bars shall not be bent after installation except as set forth in ACI 318-14 26.6.3.1 (b) (ACI 318-11

7.3.2), with the additional condition that the bars shall be bent cold, and heating of reinforcing bars to facilitate field bending of bars is not permitted.

4.3.4.3 Internally Threaded and Bonded Inserts: Steel internally threaded and bonded inserts are to be POWER-Sert™ high-performance inserts bonded with ProAnchor Elite. Table 3 and Table 17 of this report summarize insert size ranges and material types. Carbon steel inserts shall comply with ASTM A29 Grade 1020, with a minimum tensile strength of 64,000 psi. Stainless steel inserts shall comply as ASTM F593 Type 316 CW1 with a minimum tensile strength of 100,000 psi for the ⅜, ½, and ⅝ inch internal diameters, or as ASTM F593 CW2 with a minimum tensile strength of 85,000 psi for the ¾ and 1-inch internal diameters. The inserts shall be clean, straight, and free of rust, mud, oil, and other coatings that may impair the bond with the adhesive.

4.3.5 Ductility: In accordance with ACI 318-14 2.3 (ACI 318-11 D.1), the steel element shall be considered ductile if the tested elongation is not less than 14 percent and the reduction of area is not less than 30 percent. Steel elements that do not satisfy either of these requirements shall be deemed brittle. Except as modified by ACI 318-14 17.2.3.4.2 (a) (vi) (ACI 318-11 D.3.3.4.3(a) 6) for earthquake effects, deformed reinforcing bars meeting the requirements of ASTM A615 or A706 shall be considered as ductile steel elements.

4.4 Concrete: Normal-weight and lightweight concrete shall comply with Sections 1901 and 1903 of the 2018, 2015, and 2012 IBC, or Sections 1903 and 1905 of the 2009 IBC, and have a minimum compressive strength at the time of anchor installation of 2,500 psi (17.2 MPa), but not less than that required by the applicable code, including IBC Section 1904 and ACI 318-14 19.3.2 (ACI 318-11 4.3), or the structural design, nor more than 8,500 psi (58.6 MPa).

5.0 IDENTIFICATION

5.1 The ProAnchor Elite High Strength Anchoring Epoxy is identified by permanent labels on the cartridge or bulk packaging, bearing the company name (Dayton Superior or Unitex by Dayton Superior), product name (ProAnchor Elite), lot number, expiration (use by) date, and this evaluation report number (ER-690).

Either of the following IAPMO UES Marks of Conformity may also occur on the label:

or

IAPMO UES ER-690

5.2 Threaded rods, nuts, washers, and deformed reinforcing bars are standard elements, and shall conform to applicable national or international specifications as shown in Tables 1 and 2 of this report where applicable.

5.3 Internally threaded and bonded inserts are identified as described in Tables 3 and 16 and as shown in Figure 2 of this report. They are marketed under the name POWER-Sert Adhesive Insert Anchors and are available in both carbon and stainless steel versions.

6.0 SUBSTANTIATING DATA

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements (AC308), Approved October 2017 (Editorially revised March 2018), 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 and cold temperatures, tests for resistance to alkalinity and sulfur exposure and tests for seismic tension and shear.

6.2 Data in accordance with ACI 318-14

6.3 Data in accordance with ACI 355.4-11

6.4 Test reports submitted are from laboratories in compliance with ISO/IEC 17025.

7.0 STATEMENT OF RECOGNITION

This evaluation report describes the results of research carried out by IAPMO Uniform Evaluation Service on Dayton Superior's and Unitex by Dayton Superior's ProAnchor Elite High Strength Anchoring Epoxy to assess conformance to the codes shown in Section 1.0 of this report and serves as documentation of the product certification. Products at locations noted in Section 2.21 of this report are manufactured under a quality control program with periodic inspection under the supervision of IAPMO UES.

For additional information about this evaluation report please visit www.uniform-es.org or email us at info@uniform-es.org

TABLE 1 – ProAnchor Elite INSTALLATION INFORMATION FOR THREADED RODS

Characteristic		Symbol	Units	Nominal Anchor Element Size						
Fractional Threaded Rod	Size	d_a	in.	3/8	1/2	5/8	3/4	7/8	1	1 1/4
	Drill Size	d_o	in.	7/16	9/16	3/4	7/8	1	1 1/8	1 3/8
Maximum Tightening Torque	A36/A307 Carbon Steel	T_{inst}	Ft-lb (N-m)	10 (14)	25 (34)	50 (68)	90 (122)	125 (170)	165 (224)	280 (381)
	A193-B7 Carbon Steel or F593 SS			16 (22)	30 (45)	60 (81)	105 (142)	125 (170)	165 (224)	280 (381)
Brush Part No.		-	-	100865	100867	100869	100871	100872	100873	100874
Brush Length		-	in.	6	6	6	6	9	9	9
Piston Plug Part No.		-	-	100895	100897	100899	100901	100902	100903	100904
Piston Plug Color		-	-	Black	Blue	Yellow	Green	Black	Orange	Brown

TABLE 2 – ProAnchor Elite INSTALLATION INFORMATION FOR REINFORCING BARS

Characteristic		Symbol	Units	Nominal Anchor Element Size							
US Reinforcing Bar	Size	d_a	in.	#3 (0.375)	#4 (0.50)	#5 (0.625)	#6 (0.75)	#7 (0.875)	#8 (1.00)	#9 (1.128)	#10 (1.27)
	Drill Size	d_o	in.	½	5/8	3/4	7/8	1	1 1/8	1 3/8	1 1/2
Brush Part No.		-	-	100865	100868	100869	100871	100872	100873	100874	100875
Brush Length		-	in.	6	6	6	6	9	9	9	9
Piston Plug Part No.		-	-	100895	100898	100899	100901	100902	100903	100904	100905
Piston Plug Color		-	-	Black	Red	Yellow	Green	Black	Orange	Brown	Gray

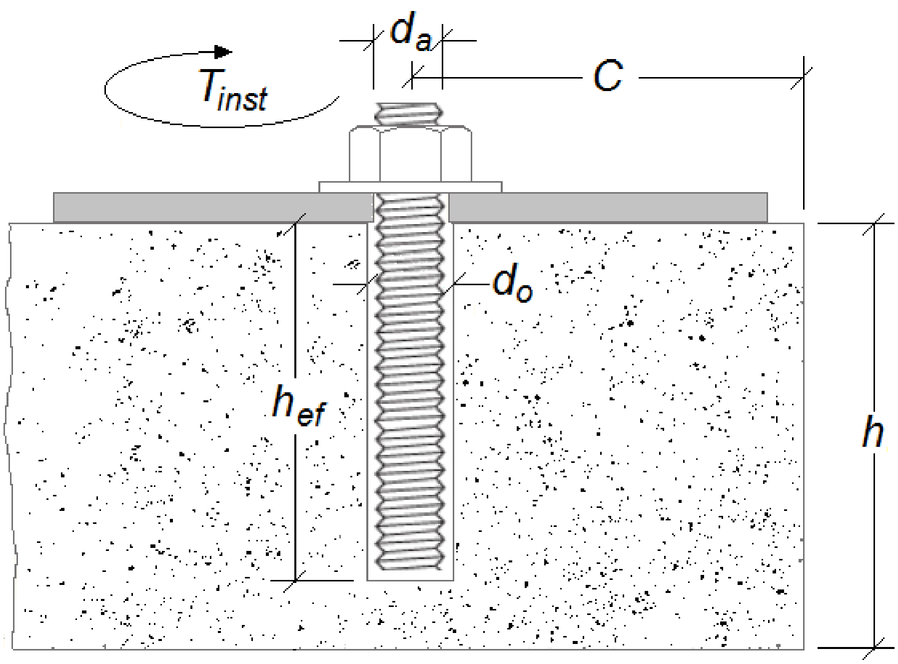


FIGURE 1 – ProAnchor Elite HIGH STRENGTH ADHESIVE ANCHOR WITH THREADED RODS

TABLE 3 – ProAnchor Elite INSTALLATION INFORMATION FOR INTERNALLY THREADED INSERT

Characteristic		Symbol	Units	Nominal Anchor Element Size				
Fractional Internally Threaded Insert	Insert Part #	----	----	PS2-38 or PS6-38	PS2-12 or PS6-12	PS2-58 or PS6-58	PS2-34 or PS6-34	PS2-1 or PS6-1
	Internal Thread Size	d_t	in.-TPI	3/8-16	1/2-13	5/8-11	3/4-10	1-8
	Drill Size	d_o	in.	1/2	5/8	7/8	1	1 1/2
	Thread Depth[1]	---	in.	1	1	1½	1½	2
Maximum Tightening Torque	A36/A307 Carbon Steel	T_{inst}	Ft-lb (N-m)	10 (14)	25 (34)	50 (68)	90 (122)	165 (224)
	A193 B7 Carbon Steel or F593 SS			16 (22)	30 (45)	60 (81)	105 (142)	165 (224)
Thread Depth[1]		h_t	in.	0.945	0.945	1.475	1.475	2.000
Brush Part No.		----	----	100866	100868	100871	100872	100875
Brush Length		----	in.	6	6	6	9	9
Piston Plug Part No.		----	----	100895	100898	100901	100902	100905
Piston Plug Color		----	----	Black	Red	Green	Black	Grey

For SI: 1 inch = 25.4 mm

[1] Minimum bolt length shall equal the sum of thread depth plus the thickness of attachments.

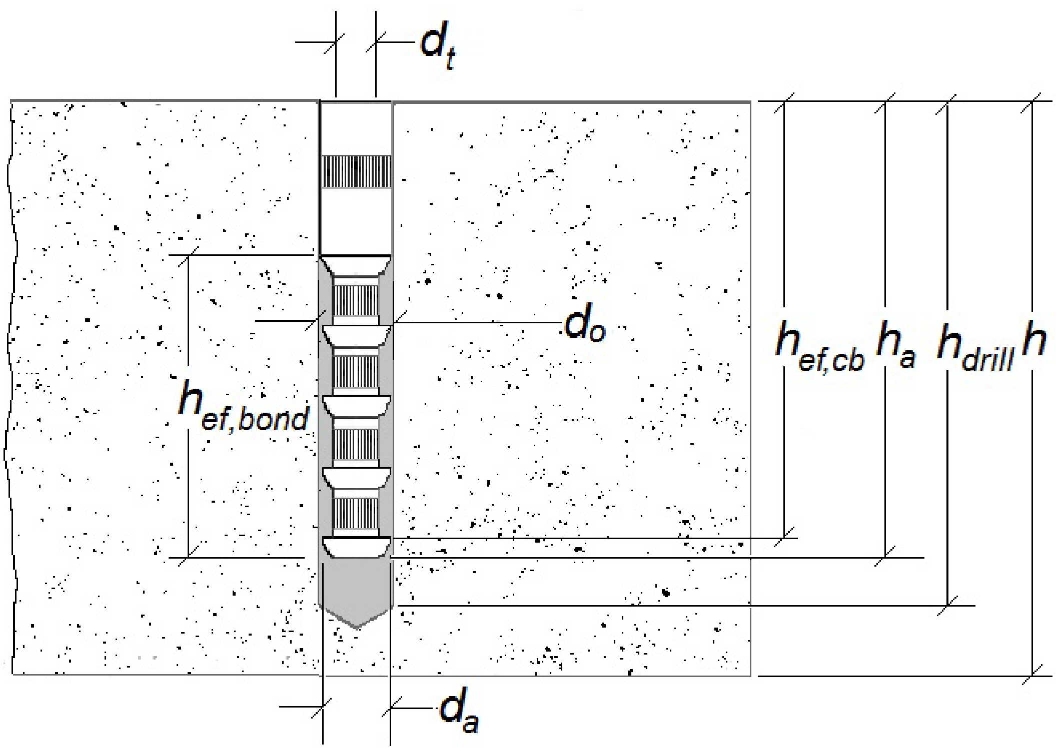


FIGURE 2 – ProAnchor Elite HIGH STRENGTH ADHESIVE ANCHOR WITH INTERNALLY THREADED INSERT

TABLE 4 – ProAnchor Elite WORKING TIME AND FULL CURE TIME SCHEDULE[1,2,3]

System	Concrete Temperature	Working Time[1]	Full Cure Time[2]
ProAnchor Elite	43 °F (6 °C)	45 minutes	144 hours
	50 °F (10 °C)	35 minutes	72 hours
	75 °F (24 °C)	16 minutes	7 hours
	90 °F (32 °C)	12 minutes	4 hours
	110 °F (43 °C)	3 minutes	2 hours

[1] Working and full cure times are approximate and may be linearly interpolated between listed temperatures and are based on cartridge/nozzle system performance.

[2] Base material and ambient air temperature shall be from 43 to 110 °F (6 to 43 °C) during installation.

[3] When ambient or base material temperature falls below 70 °F (21 °C), the adhesive shall be conditioned to 70 to 75 °F (21 to 24 °C) prior to use. A high-flow mixing nozzle (100879) may also be used to ease dispensing at colder temperatures or to increase the flow rate.

TABLE 5 – ProAnchor Elite ADHESIVE DISPENSING TOOLS AND MIXING NOZZLES

Package Size	8.6 oz. (254 ml) Cartridge	21.2 oz. (627 ml) Cartridge	53 oz. (1.6 L) Cartridge	10 Gallon (38 L) Kit	
				Resin	Hardener
Part #	100861	100862	100863	100864A	100864B
Manual Dispensing Tool	100884	100889	----		
Pneumatic Dispensing Tool	----	100891	100893	Pump	
Battery Tool		100892	----		
Recommended Mixing Nozzle	100878 or 100879			100879	
SDS Brush Adaptor	100876				
Brush Extension	100877				
Nozzle Extension Tubing	100882				
Retention Wedge	100883				

TABLE 6 – MILWAUKEE TOOL VACUUM DRILL COMPONENTS

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

TABLE 7 – ProAnchor Elite DESIGN STRENGTH TABLE INDEX

Design Strength		Drilling Method	Threaded Rod	Reinforcing Bar	Internally Threaded Insert
Steel Strength	N_{sa}, V_{sa}	----	8	13	17
Concrete Breakout	N_{cb}, V_{cb}, V_{cp}	----	9	14	18
Bond Strength Design (SD)	Cracked Concrete	Hammer Drill	10	15	----
	Uncracked Concrete		10	15	19
	Cracked Concrete	Vacuum Bit Drill	11	----	----
	Uncracked Concrete		11	----	----
	Uncracked Concrete	Core Drill	12	16	----

TABLE 8 – ProAnchor Elite STEEL DESIGN INFORMATION FOR THREADED ROD[1]

Design Information			Symbol	Units	Threaded Rod 3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Nominal Anchor Diameter			d_a	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.250 (31.8)
Threaded Rod Cross-Sectional Area[4]			A_{se}	in.^{2} (mm^2)	0.078 (50)	0.142 (92)	0.226 (146)	0.335 (216)	0.462 (298)	0.606 (391)	0.969 (625)
Carbon	ASTM A36 Grade 36 F1554 Grade 36	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	4,495 (20.0)	8,230 (36.6)	13,110 (58.3)	19,370 (86.2)	26,795 (119.2)	35,150 (156.4)	56,200 (250.0)
			V_{sa}	lb. (kN)	2,695 (12.0)	4,940 (22.0)	7,865 (35.0)	11,625 (51.7)	16,080 (71.5)	21,900 (97.4)	33,720 (150.0)
		Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.83	0.78	0.74	0.70	0.69	0.67	0.65
		Strength Reduction Factor for Tension[3]	ϕ	----	0.75						
		Strength Reduction actor for Shear[3]	ϕ	----	0.65						
	ASTM A193 B7 ASTM F1554 Grade 105	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	9,690 (43.1)	17,740 (78.9)	28,250 (125.7)	41,750 (185.7)	57,750 (256.9)	75,750 (337.0)	121,125 (538.8)
			V_{sa}	lb. (kN)	5,815 (25.9)	10,645 (47.4)	16,950 (75.4)	25,050 (111.4)	34,650 (154.1)	45,450 (202.2)	72,675 (323.3)
		Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.60	0.58	0.57	0.55	0.53	0.50	0.46
		Strength Reduction Factor for Tension[3]	ϕ	----	0.75						
		Strength Reduction Factor for Shear[3]	ϕ	----	0.65						
Stainless	ASTM F593 CW1&CW2 Type 304 & 316	Nominal Strength as Governed by Steel Strength	N_{sa}	Lb (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	28,390 (126.3)	39,270 (174.7)	51,510 (229.1)	82,365 (366.4)
			V_{sa}	Lb (kN)	4,650 (20.7)	8,515 (37.9)	13,560 (60.3)	17,035 (75.8)	23,560 (104.8)	30,905 (137.5)	49,420 (219.8)
		Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.65	0.62	0.60	0.58	0.57	0.55	0.53
		Strength Reduction Factor for Tension[2]	ϕ	----	0.65						
		Strength Reduction Factor for Shear[2]	ϕ	----	0.60						

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

[1] Values provided for common rod material types are based on specified strength and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable. Nuts and washers shall be appropriate for the rod strength and type.
[2] For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318-11 D4.4. Values correspond to a brittle steel element.
[3] For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318-11 D4.4. Values correspond to a ductile steel element.
[4] Cross-sectional area is the minimum stress area applicable for either tension or shear.

TABLE 9 –ProAnchor Elite CONCRETE BREAKOUT DESIGN INFORMATION FOR THREADED ROD

Design Information	Symbol	Units	Threaded Rod						
			3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Minimum Embedment Depth	$h_{ef,min}$	in. (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 3/4 (95)	4 (102)	5 (127)
Maximum Embedment Depth	$h_{ef,max}$	in. (mm)	7 1/2 (191)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	25 (635)
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	---- SI	17 (7.1)						
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	---- SI	24 (10)						
Minimum Spacing Distance	s_{min}	in. (mm)	$s_{min} = c_{min}$						
Minimum Edge Distance	c_{min}	in. (mm)	2 3/16 (56)	2 13/16 (71)	3 3/4 (95)	4 3/8 (111)	5 (127)	5 5/8 (143)	6 7/8 (175)
Minimum Concrete Thickness	h_{min}	in. (mm)	h_{ef} + 1.25, [≥ 3.937] (h_{ef} + 30, [≥ 100])	$h_{ef} + 2d_0$ where d_o is the hole diameter					
Critical Edge Distance (Uncracked Concrete Only)	c_{ac}	----	Section 3.2.6 of this report						
Strength Reduction Factor for Tension, Concrete Failure Mode, Condition B[1,2,3]	ϕ	----	0.65						
Strength Reduction Factor for Shear, Concrete Failure Mode, Condition B[1,2]	ϕ	----	0.70						

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

[1] Values provided for post-installed anchors with category as determined from ACI 355.4 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, while condition A requires supplemental reinforcement.
[2] Values are for use with the load combinations Section 1605.2 of the IBC, ACI 318-14 5.3, or ACI 318-11 Section 9.2, as applicable, as set forth in ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318-11 D.4.4.
[3] The anchor category, as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3), is Category 1.

TABLE 10 –ProAnchor Elite BOND STRENGTH DESIGN INFORMATION FOR THREADED ROD IN HAMMER DRILLED HOLES[1,2,3,4]

Design Information			Symbol	Units	Threaded Rod						
					3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Minimum Embedment Depth			$h_{ef,min}$	in. (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 3/4 (95)	4 (102)	5 (127)
Maximum Embedment Depth			$h_{ef,max}$	in. (mm)	7 1/2 (191)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	25 (635)
Maximum Short Term Temperature **150 °F** (66 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,cr}$	psi (MPa)	1,231 (8.5)	1,088 (7.5)	1,231 (8.5)	979 (6.7)	1,044 (7.2)	1,153 (7.9)	1,109 (7.6)
		No Sustained Load		psi (MPa)	1,414 (9.7)	1,248 (8.6)	1,414 (9.7)	1,127 (7.8)	1,201 (8.3)	1,327 (9.1)	1,275 (8.8)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	2,171 (15.0)	2,084 (14.4)	2,001 (13.8)	1,914 (13.2)	1,831 (12.6)	1,744 (12.0)	1,575 (10.9)
		No Sustained Load		psi (MPa)	2,497 (17.2)	2,397 (16.5)	2,301 (15.9)	2,201 (15.2)	2,105 (14.5)	2,005 (13.8)	1,810 (12.5)
Maximum Short Term Temperature **180 °F** (82 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,cr}$	psi (MPa)	1,083 (7.5)	957 (6.6)	1,083 (7.5)	861 (5.9)	918 (6.3)	1,018 (7.0)	974 (6.7)
		No Sustained Load		psi (MPa)	1,244 (8.6)	1,101 (7.6)	1,244 (8.6)	992 (6.8)	1,057 (7.3)	1,170 (8.1)	1,118 (7.7)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	1,910 (13.2)	1,836 (12.7)	1,762 (12.1)	1,683 (11.6)	1,610 (11.1)	1,536 (10.6)	1,388 (9.6)
		No Sustained Load		psi (MPa)	2,197 (15.1)	2,110 (14.5)	2,027 (14.0)	1,936 (13.3)	1,849 (12.7)	1,766 (12.2)	1,596 (11.0)
Maximum Short Term Temperature **205 °F** (96 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,cr}$	psi (MPa)	493 (3.4)	437 (3.0)	493 (3.4)	391 (2.7)	419 (2.9)	465 (3.2)	446 (3.1)
		No Sustained Load		psi (MPa)	567 (3.9)	502 (3.5)	567 (3.9)	451 (3.1)	479 (3.3)	535 (3.7)	512 (3.5)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	870 (6.0)	837 (5.8)	800 (5.5)	767 (5.3)	735 (5.1)	698 (4.8)	650 (4.5)
		No Sustained Load		psi (MPa)	1,000 (6.9)	963 (6.6)	921 (6.3)	884 (6.1)	846 (5.8)	800 (5.5)	725 (5.0)
Reduction Factor for Seismic Tension[5]			$\alpha_{N,seis}$	----	1.00			0.77	1.00	0.97	0.96
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions[6,7,8]	Dry Concrete	ϕ_d	----	0.65						
		Water Saturated Concrete	ϕ_{ws}	----	0.65		0.55				
		Water-Filled Holes in Concrete	ϕ_{wf}	----	0.55					0.45	
			K_{wf}	----	1.00					0.96	0.88
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions[6,7,8]	Dry Concrete	ϕ_d	----	0.65						
		Water Saturated Concrete	ϕ_{ws}	----	0.55		0.45				
		Water-Filled Holes in Concrete	ϕ_{wf}	----	0.45						
			K_{wf}	----	1.00					0.92	0.75

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

[1] Characteristic bond strength values correspond to concrete compressive strength f'_c =2,500 psi (17.2 MPa). For uncracked concrete compressive strength f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.1}$ (for SI: $(f'_c/17.2)^{0.1}$). For cracked concrete, no increase in bond strength is permitted.

[2] Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 D.3.6 as applicable.

[3] 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. The maximum long-term service temperature is 110 °F (43 °C).

[4] Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.

[5] For structures in regions assigned to Seismic Design Category C, D, E, or F, the bond strength values shall be multiplied by $\alpha_{n,seis}$.

[6] The tabulated value of ϕ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318 D.4.4.

[7] The values of ϕ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of ϕ shall be determined.

[8] The values of ϕ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The ϕ factor of 0.65 represents Category 1, 0.55 Category 2, and 0.45 Category 3.

TABLE 11 –ProAnchor Elite BOND STRENGTH DESIGN INFORMATION FOR THREADED ROD IN MILWAUKEE TOOL VACUUM BIT DRILLED HOLES[1,2,3,4]

Design Information			Symbol	Units	Threaded Rod 5/8"	3/4"	7/8"	1"	1 1/4"
Minimum Embedment Depth			$h_{ef,min}$	in. (mm)	3 1/8 (79)	3 1/2 (89)	3 3/4 (95)	4 (102)	5 (127)
Maximum Embedment Depth			$h_{ef,max}$	in. (mm)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	25 (635)
Maximum Short Term Temperature **150 °F** (66 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,cr}$	psi (MPa)	1,022 (7.0)	874 (6.0)	900 (6.2)	1,031 (7.1)	992 (6.8)
		No Sustained Load		psi (MPa)	1,175 (8.1)	1,005 (6.9)	1,031 (7.1)	1,183 (8.2)	1,140 (7.9)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	1,831 (12.6)	1,766 (12.2)	1,701 (11.7)	1,636 (11.3)	1,505 (10.4)
		No Sustained Load		psi (MPa)	2,101 (14.5)	2,027 (14.0)	1,953 (13.5)	1,879 (13.0)	1,727 (11.9)
Maximum Short Term Temperature **180 °F** (82 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,cr}$	psi (MPa)	900 (6.2)	770 (5.3)	792 (5.5)	909 (6.3)	874 (6.0)
		No Sustained Load		psi (MPa)	1,035 (7.1)	883 (6.1)	909 (6.3)	1,044 (7.2)	1,005 (6.9)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	1,610 (11.1)	1,553 (10.7)	1,496 (10.3)	1,440 (9.9)	1,327 (9.1)
		No Sustained Load		psi (MPa)	1,849 (12.7)	1,784 (12.3)	1,718 (11.8)	1,653 (11.4)	1,523 (10.5)
Maximum Short Term Temperature **205 °F** (96 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,cr}$	psi (MPa)	409 (2.8)	349 (2.4)	358 (2.5)	414 (2.9)	400 (2.8)
		No Sustained Load		psi (MPa)	470 (3.2)	405 (2.8)	414 (2.9)	474 (3.3)	456 (3.1)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	735 (5.1)	707 (4.9)	684 (4.7)	656 (4.5)	650 (4.5)
		No Sustained Load		psi (MPa)	842 (5.8)	814 (5.6)	781 (5.4)	753 (5.2)	693 (4.8)
Reduction Factor for Seismic Tension[5]			$\alpha_{N,seis}$	----	1.00	0.77	1.00	0.97	0.96
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions[6,7,8]	Dry Concrete	ϕ_d	----	0.65				
		Water Saturated Concrete	ϕ_{ws}	----	0.45		0.55		0.65
			K_{ws}	----	1.00				
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions[6,7,8]	Dry Concrete	ϕ_d	----	0.65				
		Water Saturated Concrete	ϕ_{ws}	----	0.45	0.45	0.45	0.45	0.55
			K_{ws}	----	0.89	0.96	1.00	1.00	1.00

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

[1] Characteristic bond strength values correspond to concrete compressive strength f'_c =2,500 psi (17.2 MPa). For uncracked concrete compressive strength f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.1}$ (for SI: $(f'_c/17.2)^{0.1}$). For cracked concrete, no increase in bond strength is permitted.
[2] Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 D.3.6 as applicable.
[3] 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. The maximum long-term service temperature is 110 °F (43 °C).
[4] Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.
[5] For structures in regions assigned to Seismic Design Category C, D, E, or F the bond strength values shall be multiplied by $\alpha_{n,seis}$.
[6] The tabulated value of ϕ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318 D.4.4.
[7] The values of ϕ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of ϕ shall be determined.
[8] The values of ϕ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The ϕ factor of 0.65 represents Category 1, 0.55 Category 2, and 0.45 Category 3.

TABLE 12 –ProAnchor Elite BOND STRENGTH DESIGN INFORMATION FOR THREADED ROD IN CORE DRILLED HOLES [1,2,3,4]

Design Information			Symbol	Units	Threaded Rod					
					1/2"	5/8"	3/4"	7/8"	1"	1 1/4"
Minimum Embedment Depth			$h_{ef,min}$	in. (mm)	2¾ (70)	3⅛ (79)	3½ (89)	3¾ (95)	4 (102)	5 (127)
Maximum Embedment Depth			$h_{ef,max}$	in. (mm)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	25 (635)
Maximum Short Term Temperature **150 °F** (66 °C)	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	866 (6.0)	866 (6.0)	866 (6.0)	866 (6.0)	866 (6.0)	866 (6.0)
		No Sustained Load		psi (MPa)	996 (6.9)	996 (6.9)	996 (6.9)	996 (6.9)	996 (6.9)	996 (6.9)
Maximum Short Term Temperature **180 °F** (82 °C)	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	766 (5.3)	766 (5.3)	766 (5.3)	766 (5.3)	766 (5.3)	766 (5.3)
		No Sustained Load		psi (MPa)	879 (6.1)	879 (6.1)	879 (6.1)	879 (6.1)	879 (6.1)	879 (6.1)
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions[5,6,7]	Dry Concrete	ϕ_d	----	0.65					
		Water Saturated Concrete	ϕ_{ws}	----	0.65					
			K_{ws}	----	1.00					
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions[5,6,7]	Dry Concrete	ϕ_d	----	0.65					
		Water Saturated Concrete	ϕ_{ws}	----	0.55					
			K_{ws}	----	1.00					

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

[1] Characteristic bond strength values correspond to concrete compressive strength f'_c =2,500 psi (17.2 MPa). For uncracked concrete compressive strength f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c /2,500)^{0.1}$ (for SI: $(f'_c /17.2)^{0.1}$).
[2] Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 D.3.6 as applicable.
[3] 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. The maximum long-term service temperature is 110 °F (43 °C).
[4] Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.
[5] The tabulated value of ϕ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318 D.4.4.
[6] The values of ϕ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of ϕ shall be determined.
[7] The values of ϕ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The ϕ factor of 0.65 represents Category 1 and 0.55 Category 2.

TABLE 13 –ProAnchor Elite STEEL DESIGN INFORMATION FOR REINFORCING BARS[1]

Design Information		Symbol	Units	Rebar Size							
				#3	#4	#5	#6	#7	#8	#9	#10
Nominal Anchor Diameter		d_a	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.127 (28.6)	1.270 (32.3)
Reinforcing Bar Cross-Sectional Area[4]		A_{se}	in.^{2} (mm^2)	0.110 (71)	0.200 (129)	0.310 (200)	0.440 (284)	0.600 (387)	0.790 (510)	1.000 (645)	1.270 (819)
ASTM A615 Grade 40	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	Grade 40 reinforcing bars are only available in sizes #3 through #6 per ASTM A615			
		V_{sa}	lb. (kN)	3,960 (17.6)	7,200 (32.0)	11,160 (49.6)	15,840 (70.5)				
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.70	0.74	0.78	0.82				
	Strength Reduction Factor for Tension[3]	ϕ	----	0.75							
	Strength Reduction Factor for Shear[3]	ϕ	----	0.65							
ASTM A706 Grade 60	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	8,800 (39.1)	16,000 (71.2)	24,800 (110.3)	35,200 (156.6)	48,000 (213.5)	63,200 (281.1)	80,000 (355.9)	101,600 (451.9)
		V_{sa}	lb. (kN)	5,280 (23.5)	9,600 (42.7)	14,880 (66.2)	21,120 (93.9)	28,800 (128.1)	37,920 (168.7)	48,000 (213.5)	60,960 (271.2)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.70	0.74	0.78	0.82	0.73	0.63	0.53	0.42
	Strength Reduction Factor for Tension[3]	ϕ	----	0.75							
	Strength Reduction Factor for Shear[3]	ϕ	----	0.65							
ASTM A615 Grade 60	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	9,900 (44.0)	18,000 (80.1)	27,900 (124.1)	39,600 (176.1)	54,000 (240.2)	71,100 (316.3)	90,000 (400.3)	114,300 (508.4)
		V_{sa}	lb. (kN)	5,940 (26.4)	10,800 (48.0)	16,740 (74.5)	23,760 (105.7)	32,400 (144.1)	42,660 (189.8)	54,000 (240.2)	68,580 (305.1)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.70	0.74	0.78	0.82	0.73	0.63	0.53	0.42
	Strength Reduction Factor for Tension[3]	ϕ	----	0.75							
	Strength Reduction Factor for Shear[3]	ϕ	----	0.65							
ASTM A615 Grade 75	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	11,000 (48.9)	20,000 (89.0)	31,000 (137.9)	44,000 (195.7)	60,000 (266.9)	79,000 (351.4)	100,000 (444.8)	127,000 (564.9)
		V_{sa}	lb. (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	36,000 (160.1)	47,400 (210.8)	60,000 (266.9)	76,200 (339.0)
	Reduction Factor for Seismic Shear	$\alpha_{V,seis}$	----	0.70	0.74	0.78	0.82	0.73	0.63	0.53	0.42
	Strength Reduction Factor for Tension[2]	ϕ	----	0.65							
	Strength Reduction Factor for Shear[2]	ϕ	----	0.60							

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

[1] Values provided for common rod material types are based on specified strength and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable. Nuts and washers shall be appropriate for the rod strength and type.
[2] For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318-11 D4.4. Values correspond to a brittle steel element.
[3] For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318-11 D4.4. Values correspond to a ductile steel element.
[4] Cross-sectional area is the minimum stress area applicable for either tension or shear.

TABLE 14 –ProAnchor Elite CONCRETE BREAKOUT DESIGN INFORMATION FOR REINFORCING BARS

Design Information	Symbol	Units	Reinforcing Bar Size							
			#3	#4	#5	#6	#7	#8	#9	#10
Minimum Embedment Depth	$h_{ef,min}$	in. (mm)	2⅜ (60)	2 ¾ (70)	3⅛ (79)	3½ (89)	3¾ (95)	4 (102)	4½ (114)	5 (127)
Maximum Embedment Depth	$h_{ef,max}$	in. (mm)	7 1/2 (191)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	22 1/2 (572)	25 (635)
Effectiveness Factor Cracked Concrete	$k_{c,cr}$	---- SI	17 (7.1)							
Effectiveness Factor Uncracked Concrete	$k_{c,uncr}$	---- SI	24 (10)							
Minimum Spacing Distance	s_{min}	in. (mm)	$S_{min} = C_{min}$							
Minimum Edge Distance	c_{min}	in. (mm)	2 3/16 (56)	2 13/16 (71)	3 3/4 (95)	4 3/8 (111)	5 (127)	5 5/8 (143)	6 1/4 (159)	6 7/8 (175)
Minimum Concrete Thickness	h_{min}	in. (mm)	(h_{ef} + 1.25, [≥ 3.937]) h_{ef} + 30, [≥ 100]		$h_{ef} + 2d_0$ where d_o is the hole diameter					
Critical Edge Distance (Uncracked Concrete Only)	c_{ac}	----	Section 3.2.6 of this report							
Strength Reduction Factor for Tension, Concrete Failure Mode, Condition B[1,2]	ϕ	----	0.65							
Strength Reduction Factor for Shear, Concrete Failure Mode, Condition B[1]	ϕ	----	0.70							

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

[1] Values provided for post-installed anchors with category as determined from ACI 355.4 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, while condition A requires supplemental reinforcement. Values are for use with the load combinations Section 1605.2 of the IBC, ACI 318-14 5.3, or ACI 318-11 Section 9.2, as applicable, as set forth in ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318-11 D.4.4.
[2] The anchor category, as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3), is Category 1.

TABLE 15 –ProAnchor Elite BOND STRENGTH DESIGN INFORMATION FOR REINFORCING BARS IN HAMMER DRILLED HOLES[1,2,3,4]

Design Information			Symbol	Units	Reinforcing Bar Size							
					#3	#4	#5	#6	#7	#8	#9	#10
Minimum Embedment Depth			$h_{ef,min}$	in. (mm)	2⅜ (60)	2¾ (70)	3⅛ (79)	3½ (89)	3¾ (95)	4 (102)	4 1/2 (114)	5 (127)
Maximum Embedment Depth			$h_{ef,max}$	in. (mm)	7 1/2 (191)	10 (254)	12 1/2 (318)	15 (381)	17 1/2 (445)	20 (508)	22 1/2 (572)	25 (635)
Maximum Short Term Temperature **150 °F** (66 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,cr}$	psi (MPa)	1,262 (8.7)	1,235 (8.5)	1,214 (8.4)	1,188 (8.2)	1,127 (7.8)	1,066 (7.3)	1,005 (6.9)	940 (6.5)
		No Sustained Load		psi (MPa)	1,449 (10.0)	1,422 (9.8)	1,396 (9.6)	1,366 (9.4)	1,296 (8.9)	1,227 (8.5)	1,157 (8.0)	1,079 (7.4)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	1,897 (13.1)	1,823 (12.6)	1,749 (12.1)	1,675 (11.5)	1,605 (11.1)	1,531 (10.6)	1,457 (10.0)	1,370 (9.4)
		No Sustained Load		psi (MPa)	2,179 (15.0)	2,097 (14.5)	2,010 (13.9)	1,927 (13.3)	1,844 (12.7)	1,762 (12.1)	1,675 (11.5)	1,575 (10.9)
Maximum Short Term Temperature **180 °F** (82 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,cr}$	psi (MPa)	1,109 (7.6)	1,088 (7.5)	1,070 (7.4)	1,044 (7.2)	992 (6.8)	940 (6.5)	887 (6.1)	827 (5.7)
		No Sustained Load		psi (MPa)	1,275 (8.8)	1,248 (8.6)	1,231 (8.5)	1,201 (8.3)	1,140 (7.9)	1,079 (7.4)	1,018 (7.0)	948 (6.5)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	1,666 (11.5)	1,601 (11.0)	1,540 (10.6)	1,475 (10.2)	1,409 (9.7)	1,344 (9.3)	1,279 (8.8)	1,209 (8.3)
		No Sustained Load		psi (MPa)	1,914 (13.2)	1,840 (12.7)	1,770 (12.2)	1,697 (11.7)	1,618 (11.2)	1,544 (10.6)	1,470 (10.1)	1,392 (9.6)
Maximum Short Term Temperature **205 °F** (96 °C)	Cracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,cr}$	psi (MPa)	507 (3.5)	498 (3.4)	488 (3.4)	474 (3.3)	451 (3.1)	428 (2.9)	405 (2.8)	377 (2.6)
		No Sustained Load		psi (MPa)	581 (4.0)	572 (3.9)	563 (3.9)	544 (3.8)	516 (3.6)	493 (3.4)	465 (3.2)	432 (3.0)
	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	758 (5.2)	730 (5.0)	702 (4.8)	670 (4.6)	650 (4.5)	650 (4.5)	Not Applicable	
		No Sustained Load		psi (MPa)	870 (6.0)	837 (5.8)	809 (5.6)	772 (5.3)	739 (5.1)	707 (4.9)	670 (4.6)	650 (4.5)
Reduction Factor for Seismic Tension[5]			$\alpha_{N,seis}$	----	1.00					0.97	0.97	0.96
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions[6,7,8]	Dry Concrete	ϕ_d	----	0.65							
		Water Saturated Concrete	ϕ_{ws}	----	0.65		0.55					
		Water-Filled Holes in Concrete	ϕ_{wf}	----	0.55					0.45		
			K_{wf}	----	1.00					0.96	0.92	0.88
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions[6,7,8]	Dry Concrete	ϕ_d	----	0.65							
		Water Saturated Concrete	ϕ_{ws}	----	0.55		0.45					
		Water-Filled Holes in Concrete	ϕ_{wf}	----	0.45							
			K_{wf}	----	1.00					0.92	0.83	0.75

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

[1] Characteristic bond strength values correspond to concrete compressive strength f'_c =2,500 psi (17.2 MPa). For uncracked concrete compressive strength f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.1}$ (for SI: $(f'_c/17.2)^{0.1}$). For cracked concrete, no increase in bond strength is permitted.
[2] Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 D.3.6 as applicable.
[3] 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. The maximum long-term service temperature is 110 °F (43 °C).
[4] Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.
[5] For structures in regions assigned to Seismic Design Category C, D, E, or F the bond strength values shall be multiplied by $\alpha_{n,seis}$.
[6] The tabulated value of ϕ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318 D.4.4.
[7] The values of ϕ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of ϕ shall be determined.
[8] The values of ϕ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The ϕ factor of 0.65 represents Category 1, 0.55 Category 2, and 0.45 Category 3.

TABLE 16 –ProAnchor Elite BOND STRENGTH DESIGN INFORMATION FOR REINFORCING BARS IN CORE DRILLED HOLES[1,2,3,4]

Design Information			Symbol	Units	Reinforcing Bar Size						
					#4	#5	#6	#7	#8	#9	#10
Minimum Embedment Depth			$h_{ef,min}$	in.	2 3/4	3 1/8	3 1/2	3 3/4	4	4 1/2	5
				(mm)	(70)	(79)	(89)	(95)	(102)	(114)	(127)
Maximum Embedment Depth			$h_{ef,max}$	in.	10	12 1/2	15	17 1/2	20	22 1/2	25
				(mm)	(254)	(318)	(381)	(445)	(508)	(572)	(635)
Maximum Short-Term Temperature **150 °F** (66 °C)	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi	1,335	1,300	1,200	1,105	1,010	910	800
				(MPa)	(9.2)	(8.9)	(8.3)	(7.6)	(7.0)	(6.3)	(5.5)
		No Sustained Load		psi	1,530	1,490	1,380	1,270	1,155	1,045	920
				(MPa)	(10.6)	(10.3)	(9.5)	(8.8)	(8.0)	(7.2)	(6.3)
Maximum Short-Term Temperature **180 °F** (82 °C)	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi	1,175	1,145	1,055	975	885	800	705
				(MPa)	(8.1)	(7.9)	(7.3)	(6.7)	(6.1)	(5.5)	(4.9)
		No Sustained Load		psi	1,350	1,315	1,215	1,120	1,020	920	810
				(MPa)	(9.3)	(9.1)	(8.4)	(7.7)	(7.0)	(6.3)	(5.6)
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions[5,6,7]	Dry Concrete	ϕ_d	----	0.65						
		Water Saturated Concrete	ϕ_{ws}	----	0.65						
			K_{ws}	----	1.00						
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions[5,6,7]	Dry Concrete	ϕ_d	----	0.65						
		Water Saturated Concrete	ϕ_{ws}	----	0.55						
			K_{ws}	----	1.00						

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

[1] Characteristic bond strength values correspond to concrete compressive strength f'_c =2,500 psi (17.2 MPa). For uncracked concrete compressive strength f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.1}$ (for SI: $(f'_c/17.2)^{0.1}$). For cracked concrete, no increase in bond strength is permitted.
[2] Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 D.3.6 as applicable.
[3] 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. The maximum long-term service temperature is 110 °F (43 °C).
[4] Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.
[5] The tabulated value of ϕ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318 D.4.4.
[6] The values of ϕ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of ϕ shall be determined.
[7] The values of ϕ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The ϕ factor of 0.65 represents Category 1 and 0.55 Category 2.

TABLE 17 –ProAnchor Elite STEEL DESIGN INFORMATION FOR INTERNALLY THREADED INSERT[1]

Design Information		Symbol	Units	PS2-38	PS2-12	PS2-58	PS2-34	PS2-1
Nominal Anchor Diameter		d_a	in. (mm)	0.484 (12.3)	0.591 (15.0)	0.819 (20.8)	0.898 (22.8)	1.450 (36.8)
Cross-Sectional Area[4]		A_{se}	in.^{2} (mm^2)	0.102 (66)	0.135 (87)	0.302 (195)	0.385 (248)	0.785 (506)
Specified Tensile Strength		F_{uta}	psi	64,000				
ASTM A29 Grade 1020 Carbon Steel	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	6,625 (29.5)	8,805 (39.2)	19,625 (87.3)	25,015 (111.3)	51,050 (227.1)
		V_{sa}	lb. (kN)	3,975 (17.7)	5,285 (23.5)	11,775 (52.4)	15,010 (66.8)	30,630 (136.2)
	Strength Reduction Factor for Tension[3]	ϕ	----	0.75				
	Strength Reduction Factor for Shear[3]	ϕ	----	0.65				
Design Information		**Symbol**	**Units**	**PS6-38**	**PS6-12**	**PS6-58**	**PS6-34**	**PS6-1**
Nominal Anchor Diameter		d_a	in. (mm)	0.484 (12.3)	0.591 (15.0)	0.819 (20.8)	0.898 (22.8)	1.450 (36.8)
Cross-Sectional Area		A_{se}	in.^{2} (mm^2)	0.102 (66)	0.135 (87)	0.302 (195)	0.385 (248)	0.785 (506)
Specified Tensile Strength		F_{uta}	psi	100,000		85,000		
Type 316 Stainless Steel	Nominal Strength as Governed by Steel Strength	N_{sa}	lb. (kN)	10,195 (45.3)	13,550 (60.3)	30,190 (134.3)	32,710 (145.5)	66,760 (297.0)
		V_{sa}	lb. (kN)	6,115 (27.2)	8,130 (36.2)	18,115 (80.6)	19,625 (87.3)	40,055 (178.2)
	Strength Reduction Factor for Tension[2]	ϕ	----	0.65				
	Strength Reduction Factor for Shear[2]	ϕ	----	0.60				

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

[1] Values provided for common rod material types are based on specified strength and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable. Nuts and washers shall be appropriate for the rod strength and type.
[2] For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318-11 D4.4. Values correspond to a brittle steel element.
[3] For use with load combinations of IBC Section 1605.2, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318-11 D4.4. Values correspond to a ductile steel element.
[4] Cross-sectional area is the minimum stress area applicable for either tension or shear.

TABLE 18 –ProAnchor Elite CONCRETE BREAKOUT DESIGN INFORMATION FOR INTERNALLY THREADED INSERT

Design Information	Symbol	Units	PS2-38 PS6-38	PS2-12 PS6-12	PS2-58 PS6-58	PS2-34 PS6-34	PS2-1 PS6-1
Minimum Embedment Depth	h_a	in. (mm)	2 3/4 (70)	3 11/16 (94)	5 3/4 (146)	6 1/2 (165)	8 1/2 (216)
Effective Embedment Depth for Concrete Breakout Design	$h_{ef,cb}$	in. (mm)	2½ (64)	3½ (89)	5½ (140)	6.2 (157)	8.2 (208)
Maximum Embedment Depth	$h_{ef,max}$	in. (mm)	Not Applicable				
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	---- SI	24 (10)				
Minimum Spacing Distance	s_{min}	in. (mm)	$S_{min} = C_{min}$				
Minimum Edge Distance	c_{min}	in. (mm)	2 1/2 (64)	3 1/8 (79)	4 3/8 (111)	5 (127)	7 1/2 (191)
Minimum Concrete Thickness	h_{min}	in. (mm)	4 1/2 (114)	5 3/8 (137)	8 (203)	9½ (241)	12 1/2 (318)
Critical Edge Distance (Uncracked Concrete Only)	c_{ac}	in.	Section 3.2.6 of this report				
Strength Reduction Factor for Tension, Concrete Failure Mode, Condition B[1,2]	ϕ	----	0.65				
Strength Reduction Factor for Shear, Concrete Failure Mode, Condition B[1]	ϕ	----	0.70				

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

[1] Values provided for post-installed anchors with category as determined from ACI 355.4 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, while condition A requires supplemental reinforcement. Values are for use with the load combinations Section 1605.2 of the IBC, ACI 318-14 5.3, or ACI 318-11 Section 9.2, as applicable, as set forth in ACI 318-11 D.4.3. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318-11 D.4.4.
[2] The anchor category, as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3), is Category 1.

TABLE 19 –ProAnchor Elite BOND STRENGTH DESIGN INFORMATION FOR INTERNALLY THREADED INSERT IN HAMMER DRILLED HOLES[1,2,3,4]

Design Information			Symbol	Units	PS2-38 PS6-38	PS2-12 PS6-12	PS2-58 PS6-58	PS2-34 PS6-34	PS2-1 PS6-1
Internal Thread Diameter			d_t	in.-TPI	3/8 - 16	1/2 - 13	5/8 - 11	3/4 - 10	1 - 8
Drill Bit Diameter			d_o	in.	1/2	5/8	7/8	1	1 1/2
Recommended Drill Depth			h_{drill}	in. (mm)	3 1/4 (83)	4 1/8 (105)	6 1/4 (159)	7 1/2 (191)	9 1/2 (241)
Overall Anchor Length			h_a	in. (mm)	2 3/4 (70)	3 11/16 (94)	5 3/4 (146)	6 1/2 (165)	8 1/2 (216)
Bond Effective Embedment Depth			$h_{ef,bond}$	in. (mm)	1.550 (39)	2.488 (63)	3.750 (95)	3.744 (95)	5.000 (127)
Maximum Short Term Temperature **150 °F** (66 °C)	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	1,905 (13.1)	1,814 (12.5)	1,627 (11.2)	1,562 (10.8)	1,096 (7.6)
		No Sustained Load		psi (MPa)	2,184 (15.1)	2,084 (14.4)	1,866 (12.9)	1,792 (12.4)	1,257 (8.7)
Maximum Short Term Temperature **180 °F** (82 °C)	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	1,675 (11.5)	1,596 (11.0)	1,431 (9.9)	1,375 (9.5)	966 (6.7)
		No Sustained Load		psi (MPa)	1,923 (13.3)	1,831 (12.6)	1,644 (11.3)	1,575 (10.9)	1,109 (7.6)
Maximum Short Term Temperature **205 °F** (96 °C)	Uncracked Concrete Characteristic Bond Strength	With Sustained Load	$\tau_{k,uncr}$	psi (MPa)	820 (5.7)	780 (5.4)	700 (4.8)	670 (4.6)	Not Applicable
		No Sustained Load		psi (MPa)	874 (6.0)	837 (5.8)	749 (5.2)	716 (4.9)	Not Applicable
Continuous Inspection	Strength Reduction Factors for Permissible Installation Conditions[5,6,7]	Dry Concrete	ϕ_d	----	0.65				
		Water Saturated Concrete	ϕ_{ws}	----	0.65	0.55			
Periodic Inspection	Strength Reduction Factors for Permissible Installation Conditions[5,6,7]	Dry Concrete	ϕ_d	----	0.65				
		Water Saturated Concrete	ϕ_{ws}	----	0.55	0.45			

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

[1] Characteristic bond strength values correspond to concrete compressive strength f'_c =2,500 psi (17.2 MPa). For uncracked concrete compressive strength f'_c between 2,500 psi (17.2 MPa) and 8,000 psi (55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c/2{,}500)^{0.1}$ (for SI: $(f'_c/17.2)^{0.1}$).
[2] Lightweight concrete may be used by applying a reduction factor as given in ACI 318-14 17.2.6 or ACI 318-11 D.3.6 as applicable.
[3] 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. The maximum long-term service temperature is 110 °F (43 °C).
[4] Characteristic bond strength values are for sustained loads (when noted), including dead and live loads.
[5] The tabulated value of ϕ applies when load combinations of Section 1605.2 of the IBC or ACI 318-14 5.3 (ACI 318-11 9.2), are used in accordance with ACI 318-14 17.3.3 (ACI 318-11 D.4.3). If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318 D.4.4.
[6] The values of ϕ correspond to Condition B as described in ACI 318-14 17.3.3 (ACI 318-11 D.4.3) for post-installed anchors designed using the load combinations of IBC Section 1605.2. If the load combinations in ACI 318-11 Appendix C are used, the corresponding value of ϕ shall be determined.
[7] The values of ϕ correspond to the anchor category as set forth in ACI 318-14 17.3.3 (ACI 318-11 D.4.3). The ϕ factor of 0.65 represents Category 1, 0.55 Category 2, and 0.45 Category 3.

TABLE 20 – ProAnchor Elite PERMITTED INSTALLATIONS

Anchor Type	Hole Drilling Method	Concrete Condition					
		Uncracked			Cracked		
		Installation Condition					
		Dry	Water Saturated Holes	Water-Filled Holes	Dry	Water Saturated Holes	Water-Filled Holes
Threaded Rod	Hammer Drill	✓	✓	✓	✓	✓	✓
	Vacuum Drill	✓	✓	-	✓	✓	-
	Core Drill	✓	✓	-	-	-	-
Reinforcing Bar	Hammer Drill	✓	✓	✓	✓	✓	✓
	Core Drill	✓	✓	-	-	-	-
Internally Threaded Insert	Hammer Drill	✓	✓	-	-	-	-

Threaded Rod | Reinforcing Bar (Rebar) | Internally Threaded Insert

FIGURE 3 – ProAnchor Elite HIGH STRENGTH ADHESIVE ANCHOR SYSTEM TYPICAL ANCHOR ELEMENTS

FIGURE 4 – ProAnchor Elite HIGH STRENGTH ADHESIVE ANCHOR SYSTEM DISPENSING EQUIPMENT

FIGURE 5 – ProAnchor Elite HIGH STRENGTH ADHESIVE ANCHOR SYSTEM BRUSHES, NOZZLES, EXTENSION TUBES, AND PISTON PLUGS

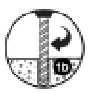
FIGURE 6 – MPII FOR ProAnchor Elite HIGH STRENGTH ANCHORING EPOXY

DRILLING AND CLEANING

Hammer Drilled Holes - Dry, Water Saturated (Damp) or Water-Filled (Wet) in Cracked and Uncracked Concrete

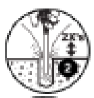
1a. Recommended Dust Extractor System for drilling into dry and damp uncracked concrete - Attach appropriate size drill bit to the Dust Extractor Vacuum System. The drill bit should conform to ANSI B212.15 and be the appropriate size for the anchor diameter to be installed. Drill hole to the specified embedment depth.

➔ GO TO STEP 6 FOR CARTRIDGE OR BULK SYSTEMS

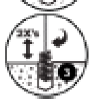


1b. Traditional Drilling Method for dry, damp and wet cracked and uncracked concrete: Using a rotary hammer drill, and while following the manufacturer's operations manual, select appropriate size drill bit in compliance with ANSI B212.15, drill hole into the base material to the specified embedment depth. **CAUTION:** Always wear appropriate personal protection equipment (PPE) for eyes, ears and skin. Avoid inhalation of dust during the drilling and cleaning process. Refer to the Safety Data Sheet (SDS) for details prior to proceeding.

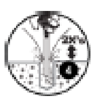
BLOW (2X) - BRUSH (2X) - BLOW (2X)



2. BLOW - NOTE: Remove any standing water from hole prior to beginning the cleaning process by using oil-free compressed air using a minimum pressure of 87 psi (6 bar). Insert the air wand to the bottom of the drilled hole and blow out the debris with an up/down motion for a minimum of 2 seconds/cycles (2X).



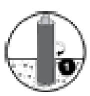
3. BRUSH - Select the correct wire brush size for the drilled hole diameter, making sure that the brush is long enough to reach the bottom of the drilled hole. Reaching the bottom of the hole (use brush extension if required), brush in an up/down and twisting motion for 2 cycles (2X). **CAUTION:** The brush should be clean and contact the walls of the hole. If it does not, the brush is either too worn or small and should be replaced with a new brush of the correct diameter.



4. BLOW - Blow the hole out once more to remove brush debris using oil free compressed air with a minimum pressure of 87 psi (6 bar). Insert the air wand to the bottom of the drilled hole and blow out the debris with an up/down motion for a minimum of 2 seconds/cycles (2X). Visually inspect the hole to confirm it is clean. **NOTE:** If installation will be delayed for any reason, cover cleaned holes to prevent contamination.

➔ GO TO STEP 6 FOR EITHER CARTRIDGE OR BULK SYSTEMS

Core Drilled Holes - Dry or Water Saturated (Damp) in Uncracked Concrete

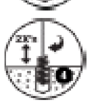


1. Using a core drill, and while following the manufacturer's operations manual, select appropriate size drill bit. Drill hole into the base material to the specified embedment depth. Remove center core and ensure that the specified embedment depth can be achieved. **CAUTION:** Always wear appropriate personal protection equipment (PPE) for eyes, ears and skin. Avoid inhalation of dust during the drilling and cleaning process. Refer to the Safety Data Sheet (SDS) for details prior to proceeding.

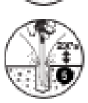
2. FLUSH - Using pressurized water, place the tip of the water nozzle at the bottom or back of the drilled hole. Rinse the drilled hole with pressurized water until the water flows clean and free of debris.

BLOW (2X) - BRUSH (2X) - BLOW (2X)

3. BLOW - NOTE: Remove any standing water from hole prior to beginning the cleaning process. Using oil-free compressed air with a minimum pressure of 87 psi (6 bar), insert the air wand to the bottom of the drilled hole and blow out the debris with an up/down motion for a minimum of 2 seconds/cycles (2X).



4. BRUSH - Select the correct wire brush size for the drilled hole diameter, making sure that the brush is long enough to reach the bottom of the drilled hole. Reaching the bottom of the hole (use brush extension if required), brush in an up/down and twisting motion for 2 cycles (2X). **CAUTION:** The brush should be clean and contact the walls of the hole. If it does not, the brush is either too worn or small and should be replaced with a new brush of the correct diameter.



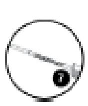
5. BLOW - Blow the hole out once more to remove brush debris using oil free compressed air with a minimum pressure of 87 psi (6 bar). Insert the air wand to the bottom of the drilled hole and blow out the debris with an up/down motion for a minimum of 2 seconds/cycles (2X). Visually inspect the hole to confirm it is clean. **NOTE:** If installation will be delayed for any reason, cover cleaned holes to prevent contamination.

➔ GO TO STEP 6 FOR CARTRIDGE OR BULK SYSTEMS

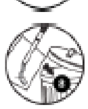
DISPENSING PREPARATION

Cartridge Systems

6. CAUTION: Check the expiration date on the cartridge to ensure it is not expired. **Do not use expired product!** Remove the protective cap from the cartridge and insert the cartridge into the recommended dispensing tool. Before attaching mixing nozzle, balance the cartridge by dispensing a small amount of material until both components are flowing evenly. For a cleaner environment, hand mix the two components and let cure prior to disposal in accordance with local regulations.



7. Only after the cartridge has been balanced, screw on the proper Dayton Superior Corporation mixing nozzle to the cartridge. Do not modify mixing nozzle and confirm that internal mixing element is in place prior to dispensing adhesive. Take note of the air and base material temperatures and review the working/full cure time chart prior to starting the injection process.



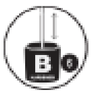
8. Dispense an initial amount of material from the mixing nozzle onto a disposable surface until the product is a uniform gray color with no streaks, as adhesive must be properly mixed in order to perform as published. Dispose of the initial amount of adhesive according to federal, state and local regulations prior to injection into the drill hole. **CAUTION:** When changing cartridges, never re-use nozzles. For a new cartridge (or if working time has been exceeded), ensure that cartridge opening is clean, install a new nozzle and repeat Steps 6 and 7 accordingly. Leave the mixing nozzle attached to the cartridge upon completion of work.

➔ GO TO STEP 11

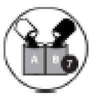
FIGURE 6 – MPII FOR ProAnchor Elite HIGH STRENGTH ANCHORING EPOXY (continued)

Bulk Systems

The bulk pump uses a two component delivery system whereby metering individual components and mixing of the two components are automatically controlled during dispensing through a metering manifold and disposable mixing nozzle. The bulk pump has a minimum input air pressure requirement of 80-90 psi @ 15 CFM, supplied through a regulator which reduces the pressure in order to control the rate of dispensing. The two individual adhesive components stay separate throughout the system, until they reach the specified disposable mixing nozzle via a manifold at the end of the bulk pump wand. Under normal operation, the bulk pump must be capable of dispensing the individual components at a 1:1 mix ratio by volume with a tolerance of ± 2%.



6. CAUTION: Check the expiration date on each product container to ensure it is not expired. **Do not use expired product!** Epoxy materials may separate. This is normal and can be expected when stored over a period of time. Part A Resin should not be remixed. Part B Hardener should be remixed with a clean 5 gallon paint stick in a "butter churning" motion to homogenize the product prior to pouring the hardener into the appropriate side of the bulk dispensing pump. **CAUTION:** Stir carefully to avoid whipping air into product.



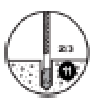
7. NOTE: Review Bulk Pump Operations Manual thoroughly before proceeding and follow all steps necessary for set- up and operation of the pump. Pour Resin into Side A pump reservoir. Close lid on Side A. Pour Hardener into Side B pump reservoir. Close lid on Side B. **NOTE:** Fill hoppers at least one-half full. Incoming air supply pressure should be maintained at approximately 100 psi (6.9 bar). Follow bulk pump instructions for filling the metering pump and outlet assembly, then bleed the air from the system and fill the hose and applicator.

8. Balance the bulk pump machine following instructions in the Bulk Pump Operations Manual. **NOTE:** Be sure to establish proper flow of both materials at the applicator tip prior to attaching mixing nozzle. A ratio check should always be performed before installation begins to ensure that equal volumes of Part A and Part B are being dispensed.

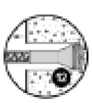
9. After the proper pump dispensing ratio has been verified, place the appropriate mixing nozzle onto the bulk pump wand. Do not modify mixing nozzle. Confirm that the internal mixing element is in place prior to dispensing adhesive. Never use without the mixing nozzle.

10. Dispense the initial amount of material from the mixing nozzle onto a disposable surface until the product Dispose of the initial amount of adhesive according to federal, state and local regulations prior to injection into the drill hole. Take note of the air and base material temperatures and review the working/full cure time chart prior to starting the injection process.

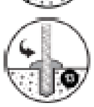
INSTALLATION AND CURING
Vertical Down, Horizontal and Overhead



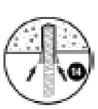
11. NOTE: The engineering drawings must be followed. For any applications not covered by this document, or for installation questions, please contact Dayton Superior Corporation. Insert the mixing nozzle, using an extension tube if necessary, to the bottom of the hole and fill from the bottom to the top approximately 2/3 full, being careful not to withdraw the nozzle too quickly as this may trap air in the adhesive. For internally threaded inserts only fill the hole to approximately half. **NOTE:** Building Code Requirements for Structural Concrete (ACI 318-11 / ACI 318-14) requires the Installer to be certified where adhesive anchors are to be installed in horizontal or overhead installations. If extension tubing is needed, it may be connected onto the outside of the tip of both the small mixing nozzle and the large mixing nozzle. **NOTE:** When using a pneumatic dispensing tool, ensure that pressure is set at 90 psi (6.2 bar) maximum.



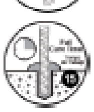
12. Piston plugs must be used for overhead installations and those between horizontal and overhead. Select the proper piston plug for the drill hole diameter. The piston plug fits directly onto the tip of both the small and large mixing nozzle. Extension tubing may also be used if needed in order to reach the bottom of the drill hole.



13. Prior to inserting the threaded rod or rebar into the hole, make sure it is straight, clean and free of oil and dirt and that the necessary embedment depth is marked on the anchor element. Insert the anchor element into the hole while turning 1-2 rotations prior to the anchor reaching the bottom of the hole. Excess adhesive should be visible on all sides of the fully installed anchor. For installing the internally threaded inserts, thread a bolt into the insert and press it into the hole with a slight twisting motion. To finish, drive the insert down with sharp blows to the head of the bolt with a hammer until it is flush with the surface of the concrete. **CAUTION:** Use extra care with deep embedment or high temperature installations to ensure that the working time has not elapsed prior to the anchor being fully installed.



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



15. Do not disturb, torque or apply any load to the installed anchor until the specified full cure time has passed. The amount of time needed to reach full cure is base material temperature dependent.

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PROANCHOR ELITE HIGH STRENGTH ANCHORING EPOXY FOR CRACKED AND UNCRACKED CONCRETE

CSI Sections:
03 15 19 Cast-in Anchors
05 05 19 Post-Installed Concrete Anchors

1.0 RECOGNITION

The ProAnchor Elite High Strength Anchoring Epoxy recognized in ER-690 has been evaluated for use to resist static, wind, and earthquake tension and shear loads. The structural performance properties of the ProAnchor Elite High Strength Anchoring Epoxy were evaluated for compliance with the following codes:

- 2017 Florida Building Code, Building (FBC, Building)
- 2017 Florida Building Code, Residential (FBC, Residential)

2.0 LIMITATIONS

The ProAnchor Elite High Strength Anchoring Epoxy described in IAPMO UES ER-690 complies with the 2017 FBC, Building, and the 2017 FBC, Residential, subject to the following limitations:

2.1. The design and installation of the ProAnchor Elite High Strength Anchoring Epoxy shall be in accordance with the 2015 International Building Code for the 2017 FBC-Building; or the 2015 International Residential Code for the 2017 FBC-Residential, as noted in ER-690.

2.2 Load combinations shall be in accordance with Sections 1605.2 or 1605.3 of the FBC, Building, as applicable.

2.3 Design wind loads shall be in accordance with Section 1609.5 of the FBC, Building, or Section R301.2.1.1 of the FBC, Residential, as applicable.

2.4 The ProAnchor Elite High Strength Anchoring Epoxy with stainless steel threaded rod and internally threaded insert materials complies with the High-Velocity Hurricane Zone provisions of the 2017 Florida Building Code, Building and the 2017 Florida Building Code, Residential, provided design wind loads are determined in accordance with Section 1620 of the FBC, Building.

2.5 Use of the ProAnchor Elite High Strength Anchoring Epoxy with carbon steel threaded rods, reinforcing bars, and internally threaded inserts in High-velocity Hurricane Zones set forth in the Florida Building Code, Building, and the Florida Building Code, Residential, is beyond the scope of the supplemental report.

2.6 For products falling under Section (5)(d) of Florida Rule 61G20-3.001, verification that the report holder's quality assurance program is audited by a quality assurance entity approved by the Florida Building Commission (or the building official when the report holder does not possess an approval by the Commission), to provide oversight and determine that the products are being manufactured as described in this evaluation report to establish continual product performance is required.

2.7 This supplement expires concurrently with ER-690.

For additional information about this evaluation report please visit www.uniform-es.org or email us at info@uniform-es.org

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PROANCHOR ELITE HIGH STRENGTH ANCHORING EPOXY FOR CRACKED AND UNCRACKED CONCRETE

CSI Sections:
03 15 19 Cast-in Concrete Anchors
05 05 19 Post-Installed Concrete Anchors

1.0 RECOGNITION

The ProAnchor Elite High Strength Anchoring Epoxy recognized in ER-690 have been evaluated for use to resist dead, live, wind, and seismic tension and shear loads. The structural performance properties of the ProAnchor Elite adhesive anchors were evaluated for compliance with the following codes:

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

2.0 LIMITATIONS

The ProAnchor Elite adhesive anchors described in IAPMO UES ER-690 comply with the 2017 LABC Chapter 19 and LARC subject to the following limitations:

2.1 The design, installation, conditions of use, and identification of the ProAnchor Elite adhesive anchors shall be in accordance with the 2018 International Building Code for the 2020 LABC; or the 2018 International Residential Code for the 2020 LARC, as noted in ER-690.

2.2 Prior to installation, calculations and details demonstrating compliance with this approval report and the Los Angeles Building Code or Los Angeles Residential Code shall be submitted to the structural plan check section for review and approval. The calculations and details shall be prepared by a registered engineer, licensed in the State of California.

2.3 The design and installation of the ProAnchor Elite adhesive anchors shall be in accordance with LABC Chapters 16 and 17 and Section 1901.3, as applicable.

2.4 The design information listed in the report and tables of ER-690 is valid for anchorage to concrete only. Connected members also shall be analyzed for structural capacities in accordance with the applicable requirements in the LABC or LARC.

2.5 Periodic special inspections shall be provided by the Registered Deputy Inspector in accordance with Section 1705 of the 2020 or 2017 LABC during installations of the ProAnchor Elite adhesive anchors.

2.6 Under the LARC, a design in accordance with Section R301.1.3 shall be submitted.

2.7 Minimum concrete cover requirements in Chapter 25 of the ACI 318-14 shall be observed where applicable.

2.8 This supplement expires concurrently with ER-690.