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FLO-ROK® FR5 MAX ADHESIVE ANCHOR SYSTEM

CSI Sections:

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

1.0 RECOGNITION

The FLO-ROK® FR5 MAX Adhesive Anchor System 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 FLO-ROK® FR5 MAX Adhesive Anchor System were evaluated for compliance with the following codes and standards:

- 2021, 2018, 2015, 2012, and 2009 International Building Code® (IBC)
- 2021, 2018, 2015, 2012, and 2009 International Residential Code® (IRC)
- ACI 318-19, ACI 318-14, ACI 318-11
- ACI 355.4-19, ACI 355.4-11
- ICC-ES AC308

2.0 LIMITATIONS

Use of the FLO-ROK® FR5 MAX Adhesive Anchor System recognized in this report is subject to the following limitations:

2.1 The FLO-ROK® FR5 MAX Adhesive Anchor System shall be installed in accordance with the manufacturer's printed installation instructions (MPII) as shown in Figures 7 through 9 of this report.

2.2 Anchor elements shall be installed in cracked and uncracked normalweight 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). Threaded steel rods (diameters M8 through M20 and ⅜ inch through ¾ inch) and steel reinforcing bars (Ø 10 through Ø 16 and diameters No. 3 through No. 6) may be used in uncracked concrete. Threaded steel rods (diameters M8 through M30 and ⅜ inch through 1¼ inch) may be used in cracked concrete.

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 normalweight or lightweight concrete as set forth in Figures 7 through 9 of this report in holes predrilled with a rotary-hammer drilling method using carbide-tipped drill bits complying with the dimensional tolerances of ANSI B212.15-1994 or ISO 5468 for metric sizes.

2.5 The FLO-ROK® FR5 MAX Adhesive Anchor System is recognized to resist short-term and long-term loads, including wind and earthquake loads, subject to the limitations of this report.

2.6 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.

2.7 The FLO-ROK® FR5 MAX Adhesive Anchor System is 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 limitations of this report.

2.8 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 concrete temperature range shown in Table 2 of this report.

2.9 Strength design values shall be established in accordance with Section 3.1 of this report. Loads applied to the anchors shall be adjusted in accordance with Section 1605.2 of the IBC for strength design.

2.10 Allowable 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 1605.1 of the 2021 IBC, or Section 1605.3 of the 2018, 2015, 2012, and 2009 IBC for allowable stress design.

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

2.12 Prior to installation, calculations, and details demonstrating compliance with this report shall be submitted to the building 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.

2.13 Fire-resistive construction: Anchors are not permitted to support fire-resistive construction. Where not otherwise prohibited in the applicable code, FLO-ROK® FR5 MAX Adhesive Anchor System is 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.

2.14 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 are beyond the scope of this report.

2.15 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 or threaded rods. The coating weights for hot-dip galvanized steel shall be in accordance with ASTM A153 Class C or D.

2.16 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.

2.17 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.

2.18 The FLO-ROK® FR5 MAX Adhesive Anchor System may be used for floor (downwardly inclined), wall (horizontally inclined), and overhead (upwardly inclined) applications.

2.19 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 318-19 26.7.2(e), ACI 318-14 17.8.2.2 or 17.8.2.3; or ACI 318-11 D.9.2.2 or D.9.2.3.

2.20 The FLO-ROK® FR5 MAX Adhesive Anchor System is manufactured and packaged into cartridges under a quality program with inspections by IAPMO UES.

3.0 PRODUCT USE

3.1 General: The FLO-ROK® FR5 MAX Adhesive Anchor System 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 318-19 17.6.2.5 and 17.7.2.5, ACI 318-14 17.4.2.6 and 17.5.2.7, or 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 318-19 and ACI 318-14 24.4.2 and 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 is an alternative to anchors described in Section 1901.3 of the 2021, 2018, and 2015 IBC, 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 IRC.

3.2 Design and Installation

3.2.1 General: Strength design under the 2021 IBC and Section R301.1.3 of the 2021 IRC shall be in accordance with ACI 318-19 and this report. 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 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 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 ACI 318-19 and ACI 318-14 Chapter 17 or ACI 318-11 Appendix D and this report. Design parameters are provided in Tables 5 through 12 of this report. Anchor designs shall satisfy the requirements of ACI 318-19 17.5.1.2; ACI 318-14 17.3.1.1, 17.3.1.2, and 17.3.1.3; or 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 318-19 17.5.1.3.1, ACI 318-14 17.2.1.1, or ACI 318-11 D.3.1.1. Strength reduction factors, ϕ, as described in ACI 318-19 17.5.3, ACI 318-14 17.3.3, or ACI 318-11 D.4.3 or D.4.4 are given for each diameter in Tables 9, 10, 11, and 12 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 318-19, 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: The nominal steel strength of a single anchor in tension, N_{sa}, shall be calculated in accordance with ACI 318-19 17.6.1.2, ACI 318-14 17.4.1.2, or ACI 318-11 D.5.1.2, and the corresponding strength reduction factors, depending on whether the steel is considered brittle or ductile, in accordance with ACI 318-19 17.5.3, ACI 318-14 17.3.3, or ACI 318-11 D.4.3 are given in Tables 5 and 6 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 318-19 17.6.2, ACI 318-14 17.4.2, or 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 318-19 17.6.2, ACI 318-14 17.4.2.2, or ACI 318-11 D.5.2.2 where the values of h_{ef} comply with Tables 7 and 8 of this report. The values of $k_{c,cr}$ and $k_{c,uncr}$ are given in Tables 7 and 8 of this report.

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. Corresponding strength reduction factors, ϕ, are given in Tables 7 and 8 of this report for Condition B, as defined in ACI 318-19 17.5.3, ACI 318-14 17.3.3, or ACI 318-11 D.4.3. For anchors in lightweight concrete, the modification factor λ_a shall be applied to the breakout strengths in accordance with ACI 318-19 17.2.4, ACI 318-14 Eq. 17.2.6; or ACI 318-11 Eq. D.3.6. The value of f'_c shall be limited to a maximum of 8,000 psi (55 MPa).

3.2.5 Static Bond Strength in Tension: The nominal static bond strength of a single adhesive anchor or group of adhesive anchors in tension, N_a or N_{ag}, shall be calculated in accordance with ACI 318-19 17.6.5, ACI 318-14 17.4.5, or ACI 318-11 D.5.5. For anchors designed to resist sustained tension loads, bond strength shall be calculated in accordance with ACI 318-19 17.5.2.2, ACI 318-14 17.2.5 and 17.3.1.2, or ACI 318-11 D.3.5 and D.4.1.2. Embedment depths shall comply with Tables 9 through 12 of this report. Bond strength values are a function of concrete conditions (i.e., cracked or uncracked), concrete temperature, installation conditions (i.e. dry, water-saturated, or water-filled), and special inspection level (i.e. continuous or periodic). The FLO-ROK® FR5 MAX Adhesive Anchor System has been tested at elevated temperatures in cracked and uncracked concrete using a hammer drill in dry, water-saturated, and water-filled concrete holes. 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 several 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, for each anchor diameter for installation in normalweight concrete are listed in Tables 9 through 12 of this report for each permitted 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 shall not be increased for concrete compressive strength. Bond strength values shall be modified with the factor ϕ_{ws} for cases wherein the holes are drilled in water-saturated concrete or ϕ_{wf} for cases where anchors are installed in water-filled holes in concrete as shown in Figure 1 of this report. Characteristic bond strength, τ_k, shown in Figure 1 of this report, refers to $\tau_{k,cr}$ or $\tau_{k,uncr}$, and where applicable, the modified bond strengths shall be used in lieu of $\tau_{k,cr}$ or $\tau_{k,uncr}$. For anchors in lightweight concrete, the modification factor λ_a shall be applied to the breakout strengths in accordance with ACI 318-19 17.2.4, ACI 318-14 Eq. 17.2.6, or ACI 318-11 Eq. 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 318-19 17.5.2.2, ACI 318-14 17.3.1.2, or ACI 318-11 D.4.1.2 shall apply.

3.2.6 Splitting Control: Replace ACI 318-14 17.4.5.5 (ACI 318-11 D.5.5.5) 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 7 through 14 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 static steel strength of a single anchor in shear, V_{sa}, in accordance with ACI 318-19 17.7.1.2, ACI 318-14 17.5.1.2, or ACI 318-11 D.6.1.2, is given in Tables 5 and 6 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 5 and 6 of this report, for use with load combinations of ACI 318-19 17.5.3, ACI 318-14 5.3 as set forth in 17.3.3, or ACI 318-11 9.2 as set forth in D.4.3.

3.2.8 Static Concrete Breakout Strength in Shear: The nominal static concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg}, shall be calculated in accordance with ACI 318-19 17.7.2, ACI 318-14 17.5.2, or 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 318-19 17.7.2.2, ACI 318-14 17.5.2.2, or ACI 318-11 D.6.2.2 using the applicable values of h_{ef} and d_a as described in Tables 7 and 8 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). For anchors in lightweight concrete, the modification factor λ_a shall be applied to the breakout strengths in accordance with ACI 318-19 17.2.4, ACI 318-14 Eq. 17.2.6, or ACI 318-11 Eq. D.3.6. Corresponding strength reduction factors, ϕ, are given in Tables 7 and 8 of this report for Condition B, as defined in ACI 318-19 17.5.3, ACI 318-14 17.3.3, or 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 318-19 17.7.3, ACI 318-14 17.5.3.1, or 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 318-19 17.5.2.3, ACI 318-14 17.6, or ACI 318-11 D.7.

3.2.11 Minimum Member Thickness, Minimum Anchor Spacing, and Minimum Edge Distance: In lieu of using ACI 318-19 17.9.2, ACI 318-14 17.7.1 and 17.7.3, or ACI 318-11 D.8.1 and D.8.3, values of c_{min} and s_{min} provided in Table 1a and 1b of this report shall be used. In lieu of using ACI 318-19 17.9.4, ACI 318-14 17.7.5, or ACI 318-11 D.8.5, minimum member thickness, h_{min}, shall be in accordance with Tables 1a and 1b of this report. In determining minimum edge distances, c_{min}, the following section shall be added to ACI 318-19 and ACI 318-14 Chapter 17 or ACI 318-11 Appendix D:

For adhesive anchors that will remain untorqued, the minimum edge distance shall be based on requirements for reinforcement in ACI 318-19 17.9.3, ACI 318-14 20.6.1 and 17.7.4, or ACI 318-11 7.7 and D.8.4. For adhesive anchors that will be torqued, the minimum edge distance and spacing shall be taken from Table 1 a and b 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 318-19 17.10, ACI 318-14 17.2.3.1 as modified by Section 1905.1.8 of the 2021, 2018, and 2015 IBC, and 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 5 and 6 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 5 and 6 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 ANSI/AWC 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 S100-16 or AISI S100-16 (2020) w/S2-20 Section J3.3.1, or AISI S100-12 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 Section 1605.1 of the 2021 IBC, or Section 1605.3 of the 2018, 2015, 2012, and 2009 IBC 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 318-19, 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 318-19, 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 318-19 17.8.2 and 17.8.3; ACI 318-14 17.6.1, 17.6.2, and 17.6.3; or ACI 318-11 D.7.1, D.7.2, and D.7.3, 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

$$\frac{T}{T_{allowable,ASD}} + \frac{V}{V_{allowable,ASD}} \leq 1.2 \qquad \text{Eq. (3-5)}$$

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). Where conflicts occur, the more restrictive shall govern. Installation parameters are provided in Tables 1a and 1b and Figures 7, 8, and 9 of this report. Anchor locations shall comply with this report and the plans and specifications approved by the building official. Installation of the FLO-ROK® FR5 MAX Adhesive Anchor System shall conform to the MPII included in each package unit and as described in Figures 7, 8, and 9 of this report. Nozzles, brushes, dispensing tools, and adhesive resin stoppers shown in Figures 2 through 6 and listed in Tables 13 and 14 of this report as supplied by the manufacturer, shall be used along with the adhesive compound cartridges. Installation of anchor elements may be downwardly inclined (floor), horizontally inclined (walls), and upwardly inclined (ceilings).

Installation may occur into dry concrete, water-saturated concrete, or flooded holes in normalweight or lightweight concrete. The use of anchors in submerged concrete is beyond the scope 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 9 through 12 of this report as determined by the registered design professional and approved by the building 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 ACI 318-19 26.13.3.2 (e), ACI 318-14 17.8.2.4 and 26.13.3.2(c), or 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 2021, 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 Section 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 2021, 2018, 2015, and 2012 IBC Sections 1705.1.1 and Table 1705.3, 2009 IBC Sections 1704.4 and 1704.15. 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). 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 2021, 2018, 2015, and 2012 IBC Sections 1705.1 and 1705.3; 2009 IBC Sections 1704.4 and 1704.15; 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 building official. Where required, a proof loading program shall be established by the registered design professional and approved by the building 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 building 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: FLO-ROK® FR5 MAX Adhesive and anchor are inserted into a pre-drilled hole in hardened normalweight 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 FLO-ROK® FR5 MAX Adhesive Anchor System is comprised of the following components:

- FR5 MAX Adhesive compound packaged in cartridges.
- Adhesive mixing and dispensing equipment.
- Equipment for cleaning holes and injecting the 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.

Installation may occur into dry concrete, water-saturated concrete, or flooded holes in concrete. The manufacturer's printed installation instructions (MPII) and parameters are included with each adhesive unit package as shown in Figures 7, 8, and 9 of this report.

4.3 Material Information

4.3.1 The FLO-ROK® FR5 MAX Adhesive Anchor Compound: The FLO-ROK® FR5 MAX Adhesive Anchor compound is a two-component (resin and hardener) adhesive supplied in dual, side-by-side cartridges or capsule-in-cartridge (CIC) system, separating the chemical components, which are combined in a 10:1 ratio by volume when dispensed through the system static mixing nozzle. FLO-ROK® FR5 MAX Adhesive Anchor System is available in the following packaging options:

Side-by-Side Cartridge:
825 ml (29.04 fl.oz.)

CIC:
150ml (5.28 fl. oz.), 300 ml (10.55 fl.oz.)

The shelf life of the FLO-ROK® FR5 MAX Adhesive Anchor System is 18 months when stored in the manufacturer's unopened cartridges at temperatures between 41°F (+5°C) and 77°F (25°C). Gel and cure times based on product and material temperatures are shown in Table 2 of this report. Minimum cartridge temperatures shown in Table 2 of this report shall be observed.

4.3.2 Dispensing Equipment: The FLO-ROK® FR5 MAX Adhesive Anchor System shall be dispensed using pneumatic, battery, or manual actuated dispensing tools listed in Figure 6 of this report.

4.3.3 Hole Preparation Equipment: Holes shall be cleaned with hole-cleaning brushes and air nozzles. Brushes shall be the appropriate size brush from the list shown in Tables 13 and 14 of this report. Air nozzles shall be equipped with an extension capable of reaching the bottom of the drilled hole and having an inside bore diameter of not less than ¼ inch (6.4 mm). Holes shall be prepared in accordance with the MPII shown in Figures 7, 8, and 9 of this report.

4.3.4 Anchor Elements

4.3.4.1 Threaded Steel Rod: Threaded anchor rods shall be clean, continuously threaded rods (all-thread) in diameters and types as described in Tables 5 and 6 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 Steel Reinforcing Bars: Steel reinforcing bars are deformed bars (rebar). Tables 5 and 6 of this report summarize reinforcing bar size ranges, specifications, and grades. Embedded portions of reinforcing bars shall be straight, and free of mill scale, rust, 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 318-19 26.6.3.2 (b), ACI 318-14 26.6.3.1 (b), or 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.

4.3.5 Ductility: In accordance with ACI 318-19, ACI 318-14 2.3, or ACI 318-11 Appendix 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 both of these requirements shall be deemed brittle. Except as modified by ACI 318-19 17.10.5.3 (a) (vi), ACI 318-14 17.2.3.4.2 (a) (vi), and 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: Normalweight and lightweight concrete shall comply with Sections 1901 and 1903 of the 2021, 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 318-19, ACI 318-14 19.3.2 or ACI 318-11 4.3, or the structural design, nor more than 8,500 psi (58.6 MPa).

5.0 IDENTIFICATION

5.1 The FLO-ROK® FR5 MAX Adhesive Anchor System is identified by permanent labels on the cartridge or packaging, bearing the company name (UCAN Fastening Products), product name (FLO-ROK® FR5 MAX), batch number, manufacturing date, expiration date, and this evaluation report number (ER-0490).

Either IAPMO UES Mark of Conformity may also be used as shown below:

IAPMO ES or UES

IAPMO UES ER-490

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 5 and 6 of this report where applicable.

6.0 SUBSTANTIATING DATA

6.1 Data in accordance with ACI 318-19, ACI 318-14, ACI 318-11, ACI 355.4, and the ICC-ES Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements (AC308), Approved February 2022.

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

7.0 STATEMENT OF RECOGNITION

This evaluation report describes the results of research completed by IAPMO Uniform Evaluation Service on the FLO-ROK® FR5 MAX Adhesive Anchor System to assess conformance to the codes shown in Section 1.0 of this report, and serves as documentation of the product certification. Products are manufactured as noted in Section 2.20 of this report under a quality control program with periodic inspections 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 1a – INSTALLATION INFORMATION - US THREADED ROD AND REBAR

Characteristic		Symbol	Units	Nominal Anchor Element Size					
Fractional Threaded Rods	Size	d_a	inch	3/8	½	5/8	3/4	1	1-1/4
	Drill Size	d_o	inch	1/2	9/16	11/16	13/16	1-1/16	1-3/8
Embedment Depth Range for US Threaded Rod		$h_{ef,min}$	inch	2-3/8	2-3/4	3-1/8	3-1/2	4	5
		$h_{ef,max}$	inch	7-1/2	10	12-1/2	15	20	25
US Reinforcing Bars	Size	d_a	inch	#3	#4	#5	#6	#8	#10
	Drill Size	d_o	inch	9/16	5/8	3/4	1	1-1/4	1-5/8
Embedment Depth Range for US Rebar	Size	$h_{ef,min}$	inch	2-3/8	3	3 3/4	4 ½	6	7 ½
	Drill Size	$h_{ef,max}$	inch	7 ½	10	12 ½	15	20	25
Maximum Tightening Torque		T_{inst}	ft.lb (Nm)	15 (20)	30 (40)	60 (80)	110 (150)	145 (200)	200 (275)
Minimum Concrete Thickness		h_{min}	-	2.0 h_{ef}					
Critical Edge Distance		c_{ac}	-	Section 3.1.11 of this report					
Minimum Edge Distance		c_{min}	-	0.5 h_{ef}					
Minimum Anchor Spacing		s_{min}	-	0.5 h_{ef}					

TABLE 1b – INSTALLATION INFORMATION – METRIC THREADED ROD AND REBAR

Characteristic		Symbol	Units	Nominal Anchor Element Size							
Metric Threaded Rods	Size	d_a	mm	M8	M10	M12	M16	M20	M24	M27	M30
	Drill Size	d_o	mm	10	12	14	18	22	26	30	35
Embedment Depth Range for Metric Threaded Rods		$h_{ef,min}$	mm	60	70	80	90	90	102	108	128
		$h_{ef,max}$	mm	160	200	240	320	400	480	540	600
Metric Reinforcing Bars	Size	d_a	mm	Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	-	Ø32
	Drill Size	d_o	mm	12	14	16	20	25	32	-	40
Embedment Depth Range for Metric Reinforcing Bars		$h_{ef,min}$	mm	60	70	80	96	120	150	-	192
		$h_{ef,max}$	mm	160	200	240	320	400	500	-	640
Maximum Tightening Torque		T_{inst}	ft.lb (Nm)	7 (10)	15 (20)	30 (40)	60 (80)	110 (150)	145 (200)	160 (216)	200 (275)
Minimum Concrete Thickness		h_{min}	-	2.0 h_{ef}							
Critical Edge Distance		c_{ac}	-	Section 3.1.11 of this report							
Minimum Edge Distance		c_{min}	-	0.5 h_{ef}							
Minimum Anchor Spacing		s_{min}	-	0.5 h_{ef}							

TABLE 2 – GEL AND CURE TIME SCHEDULE

System	Concrete Temperature		Gel Time[1]	Cure Time[2]
FR5 MAX	-10°C to +5°C	14°F to 41°F	15 minutes	12 hours
	+5°C to +10°C	41°F to 50°F	10 minutes	145 minutes
	+10°C to +15°C	50°F to 59°F	8 minutes	85 minutes
	+15°C to +20°C	59°F to 68°F	6 minutes	75 minutes
	+20°C to +25°C	68°F to 77°F	5 minutes	50 minutes
	+25°C to +30°C	77°F to 86°F	4 minutes	40 minutes
	+30°C to +35°C	86°F to 95°F	2 minutes	30 minutes
	Cartridge shall be conditioned to a minimum 41°F (+5°C) prior to use			

[1] Gel time refers to the highest temperature in the range
[2] Cure time refers to the lowest temperature in the range

TABLE 3 – SPECIFICATIONS AND PHYSICAL PROPERTIES OF COMMON THREADED CARBON AND STAINLESS STEEL ROD MATERIALS

Threaded Rod Specification		Units	Minimum Specified Ultimate Strength	Minimum Specified Yield Strength	f_{uta} / f_{ya}	Minimum Percent Elongation	Minimum Percent Reduction of Area	Specification for Nuts
Carbon Steel	ASTM F1554 Grade 36 (A 307 Gr.C)[1]	psi (MPa)	58,000 (400)	36,000 (250)	1.61	23	40	ASTM A194 Grade A
	ASTM A193 Grade B7[1]	psi (MPa)	125,000 (860)	105,000 (725)	1.19	16	50	ASTM A194
	ISO 898-1 Class 5.8[1]	psi (MPa)	72,500 (500)	58,000 (400)	1.25	22	35	DIN 934 (Grade 6)
	ISO 898-1 Class 8.8[2]	psi (MPa)	116,000 (800)	92,800 (640)	1.25	12	52	DIN 934 (Grade 8)
Stainless Steel	ASTM F593 CW1 (1/4 – 5/8)[2]	psi (MPa)	100,000 (690)	65,000 (450)	1.54	20	-	F594
	ASTM F593 CW2 (3/4 – 1 1/4)[2]	psi (MPa)	85,000 (585)	45,000 (310)	1.89	25	-	F594
	ASTM F593 SH1[2]	psi (MPa)	115,000 (800)	90,000 (620)	1.28	12	-	-
	ASTM F593 SH2[2]	psi (MPa)	105,000 (725)	70,000 (480)	1.50	15	-	-
	ASTM F593 SH3[2]	psi (MPa)	95,000 (655)	55,000 (380)	1.73	20	-	-
	ISO 3506-1 A4-70[2]	psi (MPa)	101,500 (700)	65,250 (450)	1.56	40	-	ISO 4032
	ISO 3506-1 A4-80[2]	psi (MPa)	116,000 (800)	87,000 (600)	1.33	30	-	-

[1] Rods are considered ductile steel elements in accordance with Sections 4.3.4.1, 4.3.4.2, and 4.3.5 of this report.
[2] Rods are considered brittle steel elements in accordance with Sections 4.3.4.1, 4.3.4.2, and 4.3.5 of this report.

TABLE 4 – SPECIFICATIONS AND PHYSICAL PROPERTIES OF COMMON STEEL DEFORMED REINFORCING BARS

Reinforcing Bar Specification	Units	Minimum Specified Ultimate Strength, f_{uta}	Minimum Specified Yield Strength, f_{ya}
ASTM A615 Grade 40	Psi (MPa)	60,000 (415)	40,000 (275)
ASTM A615 Grade 60	Psi (MPa)	90,000 (620)	60,000 (415)
DIN 488 BSt 500	Psi (MPa)	79,750 (550)	72,500 (500)

FIGURE 1 – FLOW CHART FOR THE ESTABLISHMENT OF DESIGN BOND STRENGTH

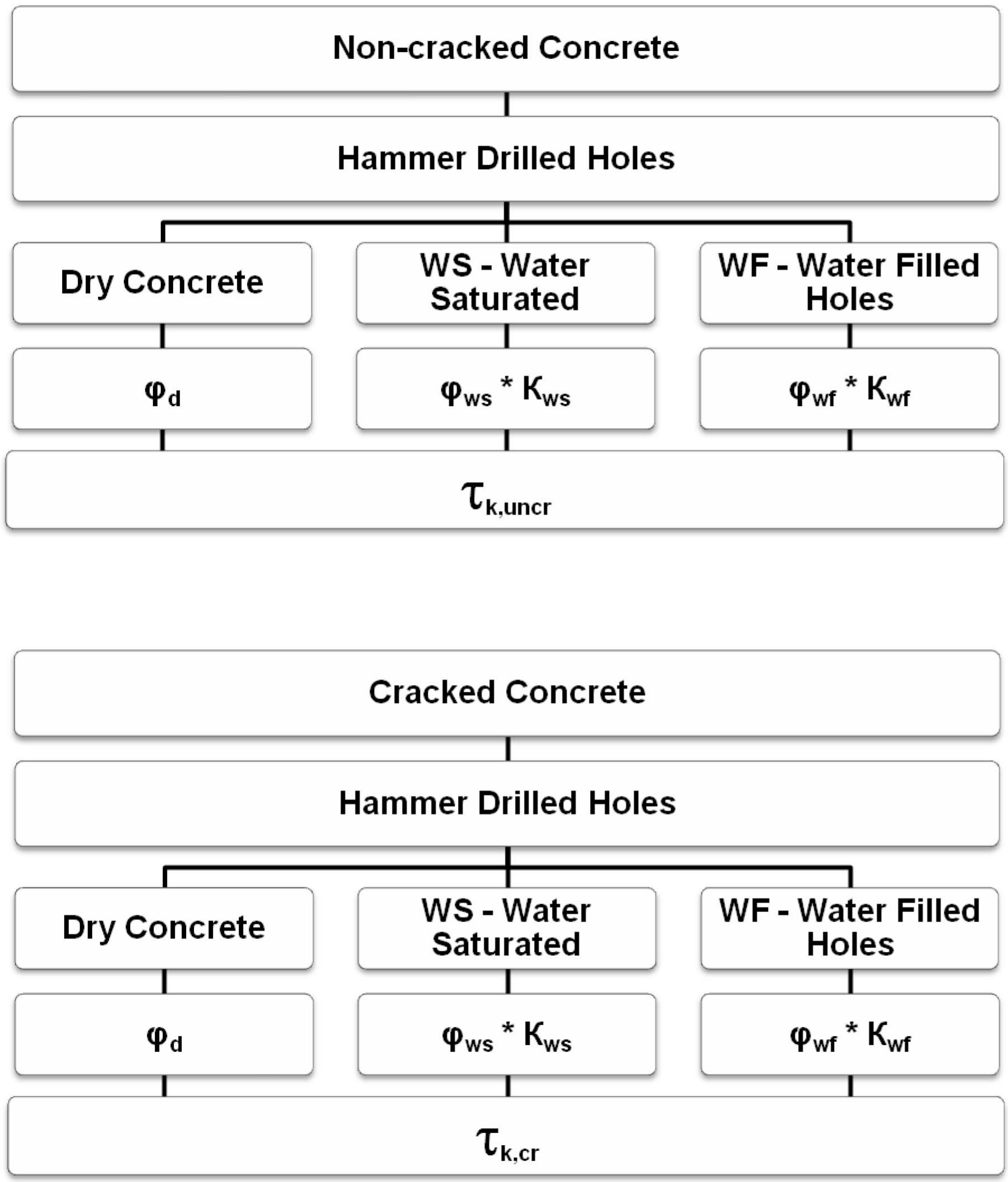

TABLE 5 – STEEL DESIGN INFORMATION FOR US CUSTOMARY STEEL THREADED RODS AND REINFORCING BAR STEEL GRADES[1]

Characteristic		Symbol	Units	Nominal Anchor Element Diameter					
Fractional Threaded Rods	Nominal Anchor Diameter	d_a	inch	3/8	1/2	5/8	3/4	1	1-1/4
	Stress Area[2]	A_{se}	in.[2]	0.078	0.142	0.226	0.334	0.606	0.969
	Tension Resistance of Carbon Steel ASTM F 1554 Grade 36 (A 307 Gr. C)	N_{sa}	lb (kN)	4495 (20.0)	8230 (36.6)	13110 (58.3)	19370 (86.2)	35150 (156.4)	56200 (250.0)
	Tension Resistance of Carbon Steel ASTM A 193 B7	N_{sa}	lb (kN)	9690 (43.1)	17740 (78.9)	28250 (125.7)	41750 (185.7)	75750 (337.0)	121125 (538.8)
	Tension Resistance of Stainless Steel ASTM F 593 CW1	N_{sa}	lb (kN)	7750 (34.5)	14190 (63.1)	22600 (100.5)	-	-	-
	Tension Resistance of Stainless Steel ASTM F 593 CW2	N_{sa}	lb (kN)	-	-	-	28390 (126.3)	51510 (229.1)	82365 (366.4)
	Tension Resistance of Stainless Steel ASTM F 593 SH1	N_{sa}	lb (kN)	8915 (39.7)	16320 (72.6)	25990 (115.6)	-	-	-
	Tension Resistance of Stainless Steel ASTM F 593 SH2	N_{sa}	lb (kN)	-	-	-	35070 (156.0)	63630 (283.0)	-
	Tension Resistance of Stainless Steel ASTM F 593 SH3	N_{sa}	lb (kN)	-	-	-	-	-	92055 (409.5)
	Shear Resistance of Carbon Steel ASTM F 1554 Grade 36 (A 307 Gr. C)	V_{sa}	lb (kN)	2250 (10.0)	4940 (22.0)	7865 (35.0)	11625 (51.7)	21090 (93.8)	33720 (150.0)
	Shear Resistance of Carbon Steel ASTM A 193 B7	V_{sa}	lb (kN)	4845 (21.6)	10645 (47.4)	16950 (75.4)	25050 (111.4)	45450 (202.2)	72675 (323.3)
	Shear Resistance of Stainless Steel ASTM F 593 CW1	V_{sa}	lb (kN)	3875 (17.2)	7095 (31.6)	11300 (50.3)	-	-	-
	Shear Resistance of Stainless Steel ASTM F 593 CW2	V_{sa}	lb (kN)	-	-	-	14195 (63.1)	25755 (114.6)	41185 (183.2)
	Shear Resistance of Stainless Steel ASTM F 593 SH1	V_{sa}	lb (kN)	4455 (19.8)	9790 (43.5)	15595 (69.4)	-	-	-
	Shear Resistance of Stainless Steel ASTM F 593 SH2	V_{sa}	lb (kN)	-	-	-	17535 (78.0)	31815 (141.5)	-
	Shear Resistance of Stainless Steel ASTM F 593 SH3	V_{sa}	lb (kN)	-	-	-	-	-	46030 (204.8)
	Strength Reduction Factor for Tension Steel Failure[3]	ϕ	-	0.75					
	Strength Reduction Factor for Shear Steel Failure[3]	ϕ	-	0.65					
	Reduction for Seismic Shear	$\alpha_{V,seis}$	-	0.80	0.80	0.79	0.79	0.75	0.75
US Reinforcing Bar	Nominal Anchor Diameter	d_a	inch	#3	#4	#5	#6	#8	#10
	Stress Area[2]	A_{se}	in.[2]	0.11	0.20	0.31	0.44	0.79	1.27
	Tension Resistance of Reinforcing Bars ASTM A 615 Grade 40	N_{sa}	lb (kN)	6600 (29.4)	12000 (53.4)	18600 (82.7)	26400 (117.4)	47400 (210.8)	76200 (339)
	Tension Resistance of Reinforcing Bars ASTM A 615 Grade 60	N_{sa}	lb (kN)	9900 (44.0)	18000 (80.1)	27900 (124.1)	39600 (176.1)	71100 (316.3)	114300 (509.4)
	Shear Resistance of Reinforcing Bars ASTM A 615 Grade 40	V_{sa}	lb (kN)	3960 (17.6)	7200 (32.0)	11160 (49.6)	15840 (70.5)	28440 (126.5)	45720 (203.4)
	Shear Resistance of Reinforcing Bars ASTM A 615 Grade 60	V_{sa}	lb (kN)	5940 (26.4)	10800 (48.0)	16740 (74.5)	23760 (105.7)	42660 (189.8)	68580 (305.1)
	Strength Reduction Factor for Tension Steel Failure[3]	ϕ	-	0.75					
	Strength Reduction Factor for Shear Steel Failure[3]	ϕ	-	0.65					
	Reduction for Seismic Shear	$\alpha_{V,seis}$	-	0.78	0.78	0.9	0.9	0.8	0.8

Notes for Table 5 continued on the next page -

[1] Values provided for common rod material types are based on specified strength and calculated in accordance with ACI 318-19 Eq. (17.6.1.2), 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). Nuts and washers shall be appropriate for the rod as set forth in Table 3 of this report.
[2] Stress area is the minimum stress area applicable for either tension or shear.

[3] Tabulated value of ϕ complies with ACI 318-19 17.5.3, ACI 318-14 17.3.3, or ACI 318-11 D.4.3 and applies when the load combinations of 1605.1 of the IBC or ACI 318-19, ACI 318-14 5.3 or ACI 318-11 9.2 are used. When the load combinations in ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318-11 D.4.4.

TABLE 6 – STEEL DESIGN INFORMATION FOR METRIC THREADED ROD AND REINFORCING BAR STEEL GRADES[1] (continued on next page)

Characteristic		Symbol	Units	Nominal Anchor Element Diameter							
Metric Threaded Rods	Nominal Anchor Diameter	d_a	mm	M8	M10	M12	M16	M20	M24	M27	M30
	Stress Area[2]	A_{se}	mm²	36.6	58.0	84.3	157.0	245.0	353.0	459.0	561.0
	Tension Resistance of Carbon Steel ISO 898 Class 5.8	N_{sa}	kN (lb)	18.3 (4414)	29.0 (6519)	42.0 (9476)	78.5 (17647)	122.5 (27539)	176.5 (39679)	229.5 (51594)	280.5 (63059)
	Tension Resistance of Carbon Steel ISO 898 Class 8.8	N_{sa}	kN (lb)	29.3 (6582)	46.5 (10431)	67.5 (15161)	125.5 (28236)	196.0 (44063)	282.5 (63486)	367.0 (82550)	449.0 (100894)
	Tension Resistance of Stainless Steel ISO 3506-1 A4-70	N_{sa}	kN (lb)	26.0 (5845)	40.6 (9127)	59.0 (13266)	109.9 (24707)	171.5 (38555)	247.1 (55550)	321.0 (72163)	392.7 (88282)
	Tension Resistance of Stainless Steel ISO 3506-1 A4-80	N_{sa}	kN (lb)	29.0 (6519)	46.6 (10431)	67.4 (15161)	125.6 (28236)	196.0 (44063)	282.4 (63486)	367.0 (82504)	448.8 (100894)
	Shear Resistance of Carbon Steel ISO 898 Class 5.8	V_{sa}	kN (lb)	11.0 (2648)	14.5 (3260)	25.5 (5685)	47.0 (10588)	73.5 (16523)	106.0 (23807)	137.5 (30956)	168.5 (37835)
	Shear Resistance of Carbon Steel ISO 898 Class 8.8	V_{sa}	kN (lb)	17.6 (3949)	23.0 (5216)	40.5 (9097)	75.5 (16942)	117.5 (26438)	169.5 (38.092)	220.5 (49530)	269.5 (60537)
	Shear Resistance of Stainless Steel ISO 3506-1 A4-70	V_{sa}	kN (lb)	13.0 (2922)	24.4 (5476)	35.4 (7960)	65.9 (14824)	102.9 (32133)	148.3 (33330)	161.0 (36194)	235.6 (52969)
	Shear Resistance of Stainless Steel ISO 3506-1 A4-80	V_{sa}	kN (lb)	15.0 (3372)	27.8 (6259)	40.5 (9097)	75.4 (16942)	117.6 (26438)	169.4 (38092)	184.0 (41364)	269.3 (60537)
	Strength Reduction Factor for Tension Steel Failure[3]	Φ	-	0.65							
	Strength Reduction Factor for Shear Steel Failure[3]	Φ	-	0.60							
	Reduction for Seismic Shear	$\alpha_{V,seis}$	-	0.80	0.80	0.80	0.79	0.79	0.75	0.75	0.75

Metric Rebar	Nominal Anchor Diameter	d_a	mm	8	10	12	16	20	25	-	32
	Stress Area[2]	A_{se}	mm^2	50.8	78.5	113.0	201.0	314	419	-	804
	Tension Resistance of Reinforcing Bars DIN 488 B St 500	N_{sa}	kN (lb)	27.5 (6215)	43.2 (9706)	62.2 (13972)	110.6 (24853)	172.7 (38825)	270.1 (60710)	-	442.2 (99.411)
	Shear Resistance of Reinforcing Bars DIN 488 B St 500	V_{sa}	kN (lb)	16.5 (3729)	25.9 5824)	37.3 (8383)	66.3 (14912)	103.6 (23295)	162 (36.426)	-	265.3 (59.646)
	Strength Reduction Factor for Tension Steel Failure[3]	Φ	-	0.65							
	Strength Reduction Factor for Shear Steel Failure[3]	Φ	-	0.60							
	Reduction for Seismic Shear	$\alpha_{V,seis}$	-	0.80	0.80	0.79	0.79	0.75	0.75	-	0.75

[1] Values provided for common rod material types are based on specified strength and calculated in accordance with ACI 318-19 Eq. (17.6.1.2), 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). Nuts and washers shall be appropriate for the rod as set forth in Table 3 of this report.
[2] Stress area is the minimum stress area applicable for either tension or shear.
[3] Tabulated value of ϕ complies with ACI 318-19 17.5.3, ACI 318-14 17.3.3, or ACI 318-11 D.4.3 and applies when the load combinations of 1605.1 of the IBC or ACI 318-19, ACI 318-14 5.3 or ACI 318-11 9.2 are used. When the load combinations in ACI 318-11 Appendix C are used, the appropriate value of ϕ shall be determined in accordance with ACI 318-11 D.4.4.

TABLE 7 – CONCRETE BREAKOUT DESIGN INFORMATION FOR FRACTIONALLY-SIZED THREADED RODS AND US REINFORCING BARS

Design Information	Symbol	Units	Nominal Anchor Element Diameter – Threaded Rod (Rebar)					
			3/8”	1/2"	5/8”	3/4"	1”	1-1/4”
			#3	#4	#5	#6	#8	#10
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	in-lb (SI)	17 (7.1)					
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	in-lb (SI)	24 (10)					
Minimum Embedment Depth (Threaded Rod)	$h_{ef,min}$	in.	2-3/8	2-3/4	3-1/8	3-1/2	4	5
Maximum Embedment Depth (Threaded Rod)	$h_{ef,max}$	in.	7-1/2	10	12-1/2	15	20	25
Minimum Embedment Depth (Rebar)	$h_{ef,min}$	in.	2-3/8	3	3-3/4	4-1/2	6	7-1/2
Maximum Embedment Depth (Rebar)	$h_{ef,max}$	in.	7-1/2	10	12-1/2	15	20	25
Minimum Edge Distance	c_{min}	in.	0.5 h_{ef}					
Minimum Anchor Spacing	s_{min}	in.	0.5 h_{ef}					
Critical Edge Distance	c_{ac}	in.	See Section 3.1.10 of this report					
Minimum Concrete Thickness	h_{min}	in.	2.0 h_{ef}					
Strength Reduction Factor for Tension, Concrete Failure Modes, Condition B	ϕ	-	0.65					
Strength Reduction Factor for Shear, Concrete Failure Modes, Condition B	ϕ	-	0.70					

TABLE 8 – CONCRETE BREAKOUT DESIGN INFORMATION FOR METRIC-SIZED THREADED RODS AND METRIC-SIZED REINFORCING BARS

Design Information	Symbol	Units	Nominal Anchor Element Diameter							
			M8	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
			8mm	**10mm**	**12mm**	**16mm**	**20mm**	**25mm**	**27mm**	**32mm**
Effectiveness Factor for Cracked Concrete	$k_{c,cr}$	in-lb (SI)	17 (7.1)							
Effectiveness Factor for Uncracked Concrete	$k_{c,uncr}$	in-lb (SI)	24 (10)							
Minimum Embedment Depth for Threaded Rods	$h_{ef,min}$	Mm	60	70	80	90	90	102	108	128
Maximum Embedment Depth for Threaded Rods	$h_{ef,max}$	Mm	160	200	240	320	400	480	540	600
Minimum Embedment Depth for Rebars	$h_{ef,min}$	Mm	60	70	80	96	120	150	-	192
Maximum Embedment Depth for Rebars	$h_{ef,max}$	Mm	160	200	240	320	400	500	-	640
Minimum Edge Distance	c_{min}	in.	0.5 h_{ef}							
Minimum Anchor Spacing	s_{min}	in.	0.5 h_{ef}							
Critical Edge Distance	c_{ac}	in.	See Section 3.1.10 of this report							
Minimum Concrete Thickness	h_{min}	in.	2.0 h_{ef}							
Strength Reduction Factor for Tension, Concrete Failure Modes, Condition B	Φ	-	0.65							
Strength Reduction Factor for Shear, Concrete Failure Modes, Condition B	Φ	-	0.70							

TABLE 9 – BOND STRENGTH DESIGN INFORMATION FOR FRACTIONAL STEEL THREADED RODS IN HAMMER-DRILLED HOLES

Design Information		Symbol	Units	Nominal Anchor Element Diameter					
				3/8”	1/2"	5/8”	3/4"	1”	1-1/4”
Minimum Embedment Depth		$h_{ef,min}$	Inch	2-3/8	2-3/4	3-1/8	3-1/2	4	5
Maximum Embedment Depth		$h_{ef,max}$	Inch	7-1/2	10	12-1/2	15	20	25
Characteristic Bond Strength in Uncracked Concrete for Sustained Tension Loading[2, 3, 6]		$\tau_{k,sust,uncr}$	Psi (N/mm^2)	1320 (9.1)	1237 (8.5)	1154 (7.9)	1070 (7.3)	890 (6.1)	735 (5.0)
Characteristic Bond Strength in Cracked Concrete for Sustained Tension Loading[2, 3, 6]		$\tau_{k,sust,cr}$	Psi (N/mm^2)	1000 (6.9)	1000 (6.9)	1000 (6.9)	1000 (6.9)	700 (4.8)	620 (4.2)
Permissible Installation Conditions, Periodic Special Inspection	Dry Concrete	Anchor Category		1	1	2	2	2	3
		ϕ_d	-	0.65	0.65	0.55	0.55	0.55	0.45
	Water-saturated Concrete	Anchor Category	-	1	2	2	2	2	2
		ϕ_{ws}	-	0.65	0.55	0.55	0.55	0.55	0.55
	Water-filled Holes	Anchor Category	-	3	3	3	3	3	3
		ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45
Permissible Installation Conditions, Continuous Special Inspection	Dry Concrete	Anchor Category	-	1	1	1	1	1	1
		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65
	Water-saturated Concrete	Anchor Category	-	1	1	1	1	1	1
		ϕ_{ws}	-	0.65	0.65	0.65	0.65	0.65	0.65
	Water-filled Holes	Anchor Category	-	1	1	1	1	1	1
		ϕ_{wf}	-	0.65	0.65	0.65	0.65	0.65	0.65
Reduction for Seismic Tension		$\alpha_{N,seis}$	-	1.00	1.00	1.00	1.00	1.00	1.00

[1] Bond strength values correspond to concrete compressive strength, f'_c = 2,500 psi (17.2 MPa). Bond strength values shall not be increased for concrete compressive strength.
[2] Maximum long term temperature: 122°F (+50°C); maximum short-term temperature: 176°F (+80°C).
[3] Short-term elevated concrete temperatures are those that occur over brief intervals, e.g. transient or part of a regular cycle of heating and cooling, such as day-night temperature rise and fall. Long-term elevated concrete temperatures are roughly constant over significant periods of time.
[4] The tabulated value of ϕ applies when load combinations of Section 1605.2 of the IBC or ACI 318-19, ACI 318-14 5.3, or ACI 318-11 9.2, are used in accordance with ACI 318-19 17.5.3, 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 D.4.4.
[5] The values of ϕ correspond to Condition B as described in ACI 318-19 17.5.3, ACI 318-14 17.3.3, or 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.
[6] For load combinations consisting of short-term loads only such as wind, the bond strength values remain the same.

TABLE 10 – BOND STRENGTH DESIGN INFORMATION FOR METRIC STEEL THREADED RODS IN HAMMER-DRILLED HOLES

Design Information		Symbol	Units	Nominal Anchor Element Diameter							
				M8	M10	M12	M16	M20	M24	M27	M30
Minimum Embedment Depth		$h_{ef,min}$	Mm	60	70	80	90	90	102	108	128
Maximum Embedment Depth[6]		$h_{ef,max}$	Mm	160	200	240	320	400	480	540	600
Characteristic Bond Strength in Uncracked Concrete for Sustained Tension Loading[2,3]		$\tau_{k,sust,uncr}$	N/mm² (psi)	9.4 (1,360)	9.0 (1,305)	8.7 (1,255)	7.9 (1,150)	7.2 (1,045)	5.8 (845)	5.5 (800)	4.8 (700)
Characteristic Bond Strength in Cracked Concrete for Sustained Tension Loading[2,3]		$\tau_{k,sust,cr}$	N/mm² (psi)	6.4 (930)	6.2 (900)	5.7 (830)	5.6 (825)	5.1 (750)	4.6 (675)	4.1 (600)	3.8 (550)
Permissible Installation Conditions, Periodic Special Inspection	Dry Concrete	*Anchor Category*	-	1	1	1	2	2	2	3	3
		ϕ_d	-	0.65	0.65	0.65	0.55	0.55	0.55	0.45	0.45
	Water-saturated Concrete	*Anchor Category*	-	1	1	2	2	2	2	2	2
		ϕ_{ws}	-	0.65	0.65	0.55	0.55	0.55	0.55	0.55	0.55
	Water-filled Holes	*Anchor Category*	-	3	3	3	3	3	3	3	3
		ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Permissible Installation Conditions, Continuous Special Inspection	Dry Concrete	*Anchor Category*	-	1	1	1	1	1	1	1	1
		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	Water-saturated Concrete	*Anchor Category*	-	1	1	1	1	1	1	1	1
		ϕ_{ws}	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	Water-filled Holes	*Anchor Category*	-	1	1	1	1	1	1	1	1
		ϕ_{wf}	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Reduction for Seismic Tension		$\alpha_{N,seis}$	-	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90

[1] Bond strength values correspond to concrete compressive strength, f'_c = 2,500 psi (17.2 MPa). Bond strength values shall not be increased for concrete compressive strength.

[2] Maximum long term temperature: 122°F (+50°C); maximum short-term temperature: 176°F (+80°C).

[3] Short-term elevated concrete temperatures are those that occur over brief intervals, e.g. transient or part of a regular cycle of heating and cooling, such as day-night temperature rise and fall. Long-term elevated concrete temperatures are roughly constant over significant periods of time.

[4] The tabulated value of ϕ applies when load combinations of Section 1605.2 of the IBC or ACI 318-19, ACI 318-14 5.3, or ACI 318-11 9.2, are used in accordance with ACI 318-19 17.5.3, 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 D.4.4.

[5] The values of ϕ correspond to Condition B as described in ACI 318-19 17.5.3, ACI 318-14 17.3.3, or 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.

TABLE 11 – BOND STRENGTH DESIGN INFORMATION FOR US REINFORCING BARS IN HAMMER-DRILLED HOLES USED AS ANCHOR ELEMENTS

Design Information		Symbol	Units	Nominal Anchor Element Diameter					
				#3	#4	#5	#6	#8	#10
Minimum Embedment Depth		$h_{ef,min}$	inch	2-3/8	3	3-1/4	4-1/2	6	7 ½
Maximum Embedment Depth		$h_{ef,max}$	inch	7-1/2	10	12-1/2	15	20	25
Characteristic Bond Strength in Uncracked Concrete for Sustained Tension Loading[2, 3, 6]		$\tau_{k,sust,uncr}$	psi (N/mm^2)	1262 (8.7)	1174 (8.1)	1087 (7.5)	1,000 (6.9)	700 (4.8)	575 (3.9)
Characteristic Bond Strength in Cracked Concrete for Sustained Tension Loading[2, 3, 6]		$\tau_{k,sust,cr}$	psi (N/mm^2)	800 (5.5)	800 (5.5)	800 (5.5)	800 (5.5)	600 (4.1)	500 (3.4)
Permissible Installation Conditions, Periodic Special Inspection	Dry Concrete	*Anchor Category*	-	1	1	2	2	3	3
		ϕ_d	-	0.65	0.65	0.55	0.55	0.45	0.45
	Water-saturated Concrete	*Anchor Category*	-	1	2	2	2	2	2
		ϕ_{ws}	-	0.65	0.55	0.55	0.55	0.55	0.55
	Water-filled Holes	*Anchor Category*	-	3	3	3	3	3	3
		ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45
Permissible Installation Conditions, Continuous Special Inspection	Dry Concrete	*Anchor Category*	-	1	1	1	1	1	1
		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65
	Water-saturated Concrete	*Anchor Category*	-	1	1	1	1	1	1
		ϕ_{ws}	-	0.65	0.65	0.65	0.65	0.65	0.65
	Water-filled Holes	*Anchor Category*	-	1	1	1	1	1	1
		ϕ_{wf}	-	0.65	0.65	0.65	0.65	0.65	0.65
Reduction for Seismic Tension		$\alpha_{N,seis}$	-	0.90	0.90	0.90	0.90	0.90	0.90

[1] Bond strength values correspond to concrete compressive strengths, f'_c = 2,500 psi (17.2 MPa). Bond strength values shall not be increased for concrete compressive strength.

[2] Maximum long term temperature: 122°F (+50°C); maximum short-term temperature: 176°F (+80°C).

[3] Short-term elevated concrete temperatures are those that occur over brief intervals, e.g. transient or part of a regular cycle of heating and cooling, such as day-night temperature rise and fall. Long-term elevated concrete temperatures are roughly constant over significant periods of time.

[4] The tabulated value of ϕ applies when load combinations of Section 1605.2 of the IBC or ACI 318-19, ACI 318-14 5.3, or ACI 318-11 9.2, are used in accordance with ACI 318-19 17.5.3, 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 D.4.4.

[5] The values of ϕ correspond to Condition B as described in ACI 318-19 17.5.3, ACI 318-14 17.3.3, or 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.

[6] For load combinations consisting of short-term loads only such as wind, the bond strength values remain the same.

TABLE 12 – BOND STRENGTH DESIGN INFORMATION FOR METRIC REINFORCING BARS IN HAMMER-DRILLED HOLES USED AS ANCHOR ELEMENTS

Design Information		Symbol	Units	Nominal Anchor Element Diameter						
				Ø8mm	Ø10mm	Ø12mm	Ø16mm	Ø20mm	Ø25mm	Ø32mm
Minimum Embedment Depth		$h_{ef,min}$	mm	60	70	80	96	120	150	192
Maximum Embedment Depth[6]		$h_{ef,max}$	mm	160	200	240	320	400	500	640
Characteristic Bond Strength in Uncracked Concrete for Sustained Tension Loading[2,3]		$\tau_{k,sust,uncr}$	N/mm² (psi)	9.0 (1300)	8.6 (1250)	8.2 (1190)	7.4 (1080)	5.4 (790)	5.1 (740)	4.1 (600)
Characteristic Bond Strength in Cracked Concrete for Sustained Tension Loading[2,3]		$\tau_{k,sust,Cr}$	N/mm² (psi)	4.5 (660)	4.4 (650)	4.00 (580)	3.7 (550)	3.4 (500)	2.9 (425)	2.2 (325)
Permissible Installation Conditions, Periodic Special Inspection	Dry Concrete	Anchor Category	-	1	1	1	1	1	2	3
		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.55	0.45
	Water-saturated Concrete	Anchor Category	-	1	1	2	2	2	2	2
		ϕ_{ws}	-	0.65	0.65	0.55	0.55	0.55	0.55	0.55
	Water-filled Holes	Anchor Category	-	3	3	3	3	3	3	3
		ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Permissible Installation Conditions, Continuous Special Inspection	Dry Concrete	Anchor Category	-	1	1	1	1	1	1	1
		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	Water-saturated Concrete	Anchor Category	-	1	1	1	1	1	1	1
		ϕ_{ws}	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	Water-filled Holes	Anchor Category	-	1	1	1	1	1	1	1
		ϕ_{wf}	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Reduction for Seismic Tension		$\alpha_{N,seis}$	-	0.90	0.90	0.90	0.90	0.90	0.90	0.90

[1] Bond strength values correspond to concrete compressive strength, f'_c = 2,500 psi (17.2 MPa). Bond strength values shall not be increased for concrete compressive strength.

[2] Maximum long term temperature: 122°F (+50°C); maximum short-term temperature: 176°F (+80°C).

[3] Short-term elevated concrete temperatures are those that occur over brief intervals, e.g. transient or part of a regular cycle of heating and cooling, such as day-night temperature rise and fall. Long-term elevated concrete temperatures are roughly constant over significant periods of time.

[4] The tabulated value of ϕ applies when load combinations of Section 1605.2 of the IBC or ACI 318-19, ACI 318-14 5.3, or ACI 318-11 9.2, are used in accordance with ACI 318-19 17.5.3, 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 D.4.4.

[5] The values of ϕ correspond to Condition B as described in ACI 318-19 17.5.3, ACI 318-14 17.3.3, or 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.

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FIGURE 2 – FLO-ROK® FR5 MAX Adhesive PACKAGING CONFIGURATIONS

Side-by-Side Cartridge

FLO-ROK® FR5-28 MAX	825 ml (29.04 fl.oz.)

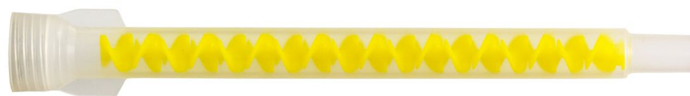
Capsule-in-Cartridge (CIC)

FLO-ROK® FR5-10 MAX EASY	300 ml (10.55 fl.oz.)

FIGURE 3 – MIXER NOZZLES

PAM 38

PAM 5812X



PAM EXT

FIGURE 4 – HOLE CLEANING BRUSHES

Hole cleaning brush

Hole cleaning brush extension piece

Hole cleaning brush extension handle

Hole Cleaning Brush	SBR 12	SBR 916	SBR 34	SBR 78	SBR 1	SBR 118	SBR 114	SBR 138	SBR 112	SBR 134
Brush Diameter, d_h	1/2	9/16	34	7/8	1	1-1/8	1-1/4	1-3/8	1-1/2	1-3/4

FIGURE 5 – EXTENSION TUBES AND RESIN STOPPERS

PAM 6EXT (9mm x 10m Extension Tube)

PAM 6EXTW (14mm x10 Extension Tube)

Resin Stoppers

FIGURE 6 – DISPENSING TOOLS

A – PA 5000 Heavy Duty Cordless Dispensing Tool

B – PA 3600 Manual Side-by-Side Dispensing Tool

C – PA 100 Manual 10 oz Dispensing Tool

Cartridge	Dispensing Tool		
	A	B	C
FLO-ROK® FR5-28 MAX, 825 ml (29.92 fl.oz)	✓	✓	
FLO-ROK® FR5-10 MAX, 300ml (10.55 fl.oz)			✓

TABLE 13 – INSTALLATION TOOLS FOR FRACTIONAL AND US CUSTOMARY-SIZED ANCHORS

Anchor Size		$h_{ef,min}$ (inch)	$h_{ef,max}$ (inch)	d_o (inch)	Cleaning Brush d_b	Extension Tube and Resin Stopper Combinations		
						PAM 38	PAM 5812X	
Threaded Rods	3/8"	2-3/8	7-1/2	1/2	SBR 12	✓	×	PAM 6EXT when h_{ef} > 4-1/2"
	1/2"	2-3/4	10	9/16	SBR 34	✓	×	PAM 6EXT when h_{ef} > 5"
	5/8"	3-1/8	12-1/2	11/16	SBR 34	✓	✓	PAM 6EXT when h_{ef} > 6-1/2" PAM 6EXTW when h_{ef} > 8"
	3/4"	3-1/2	15	13/16	SBR 118	✓	✓	PAM 6EXTW with FR6 P18 when h_{ef} > 8"
	1"	4	20	1-1/16	SBR 118	✓	✓	PAM 6EXTW with FR6 P22
	1-1/4"	5	25	1-3/8	SBR 112	✓	✓	PAM 6EXTW with FR6 P30
Rebar	#3	2-3/8	7-1/2	9/16	SBR 34	✓	×	PAM 6EXT when h_{ef} > 5"
	#4	3	10	5/8	SBR 34	✓	×	PAM 6EXT when h_{ef} > 5"
	#5	3 3/4	12-1/2	3/4	SBR 118	✓	✓	PAM 6EXTW with FR6 P18 when h_{ef} > 8"
	#6	4-1/2	15	1	SBR 118	✓	✓	PAM 6EXTW with FR6 P22 when h_{ef} > 8"
	#8	6	20	1 ¼	SBR 112	✓	✓	PAM 6EXTW with FR6 P30 when h_{ef} > 8"
	#10	7 ½	25	1 5/8	SBR 112	✓	✓	PAM 6EXTW with FR6 P36 when h_{ef} > 8"

6EXT = 11 mm diameter extension tube (cut to suit anchor embedment) attached to mixer nozzle, not compatible with PAM 5812X mixer nozzle
6EXTW = 14 mm diameter extension tube (cut to suit anchor embedment) attached to PAM 5812X mixer nozzle
P18 = Resin stopper, 18 mm outside diameter
P22 = Resin stopper, 22 mm outside diameter
P30 = Resin stopper, 30 mm outside diameter
P36 = Resin stopper, 36 mm outside diameter

TABLE 14 – INSTALLATION TOOLS FOR METRIC-SIZED ANCHORS

Anchor Size		$h_{ef,min}$ (mm)	$h_{ef,max}$ (mm)	d_o (mm)	Cleaning Brush d_b (mm)	Extension Tube and Resin Stopper Combinations		
						PAM 38	PAM 5812X	
Threaded Rods	M8	60	160	10	SBR 12	✓	×	N/A
	M10	70	200	12	SBR 12	✓	×	PAM 6EXT when $h_{ef} > 115$ mm
	M12	80	240	16	SBR 34	✓	×	PAM 6EXT when $h_{ef} > 125$ mm
	M16	90	320	18	SBR 34	✓	✓	PAM 6EXT when $h_{ef} > 160$ mm PAM 6EXTW when $h_{ef} > 200$mm
	M20	90	400	22	SBR 118	✓	✓	PAM 6EXTW with P18 when $h_{ef} > 200$ mm
	M24	102	480	26	SBR 118	✓	✓	PAM 6EXTW with P22
	M27	108	540	30	SBR 112	✓	✓	PAM 6EXTW with P22
	M30	128	600	35	SBR 112	✓	✓	PAM 6EXTW with P30
Rebar	Ø8	60	160	12	H14	✓	×	N/A
	Ø10	70	200	14	H20	✓	×	PAM 6EXT when $h_{ef} > 125$ mm
	Ø12	80	240	16	H20	✓	×	PAM 6EXT when $h_{ef} > 150$ mm
	Ø16	96	320	20	H24	✓	✓	PAM 6EXTW with P18 when $h_{ef} > 180$ mm
	Ø20	120	400	24	H29	✓	✓	PAM 6EXTW with P22
	Ø25	150	500	32	H40	✓	✓	PAM 6EXTW with P30
	Ø32	192	640	40	H40	✓	✓	PAM 6EXTW with P36

6EXT = 11 mm diameter extension tube (cut to suit anchor embedment) attached to mixer nozzle, not compatible with PAM 5812X mixer nozzle
6EXTW = 14 mm diameter extension tube (cut to suit anchor embedment) attached to PAM 5812X mixer nozzle
P18 = Resin stopper, 18 mm outside diameter
P22 = Resin stopper, 22 mm outside diameter
P30 = Resin stopper, 30 mm outside diameter
P36 = Resin stopper, 36 mm outside diameter

FIGURE 7 – MANUFACTURER'S PRINTED INSTALLATION INSTRUCTIONS (MPII)

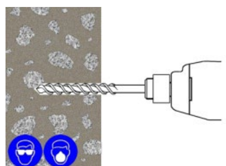
The FLO-ROK® FR5 MAX Adhesive Anchor System : Installation Instructions
Installation for Anchors between Horizontal and Downward Orientations

Before commencing installation ensure the operative is equipped with appropriate personal protection equipment, SDS hammer drill, air lance, hole cleaning brush, good quality dispensing tool (either manual or power operated), chemical cartridge with mixing nozzle and extension tube, if needed.

Important: check the expiration date on the cartridge **(do not use expired material)** and that the cartridge has been stored in its original packaging, the correct way up, in cool conditions (41°F to 77°F / 5°C to 25°C) out of direct sunlight.

Installation of the FLO-ROK® FR5 MAX Adhesive Anchor System is limited to the following temperature ranges:
FLO-ROK® FR5 MAX : minimum installation temperature: 14°F (-10°C); maximum installation temperature: 95°F (+35°C)

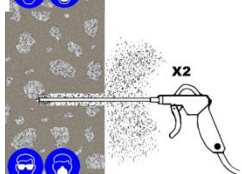
1 Using the SDS Hammer Drill in rotary hammer mode for drilling, with a carbide tipped drill bit (ANSI B212.15-1994) of the appropriate size, drill the hole to the specified hole diameter and depth.



2 Insert the air lance to the bottom of the hole and blow out the hole by depressing the trigger for approximately 2 seconds.

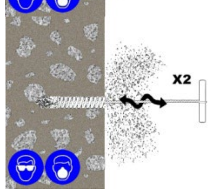
Compressed air shall be clean and dry with a minimum pressure of 90 psi (6 bar).

Perform the blowing operation twice.



3 Select the correct size Hole Cleaning Brush. Ensure that the brush is in good condition and the correct diameter. Insert the brush to the bottom of the hole, using a brush extension if needed to reach the bottom of the hole and withdraw with a twisting motion. *There should be positive interaction between the bristles of the brush and the sides of the drilled hole.*

Perform the brushing operation twice.

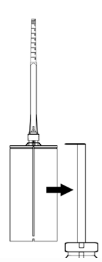


4 Repeat 2

5 Repeat 3

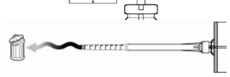
6 Repeat 2

7 Select the appropriate static mixer nozzle, checking that the mixing elements are present and correct **(do not modify the mixer)**. Attach mixer nozzle to the cartridge. Check the Dispensing Tool is in good working order. Place the cartridge into the dispensing tool.



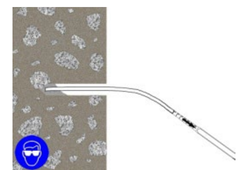
8 Extrude some resin to waste until an even colored mixture is achieved.

The cartridge is now ready to use.

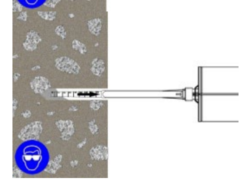


9 If required, attach an extension tube with resin stopper to the end of the mixing nozzle with a push fit.

(The extension tubes may be pushed into the resin stoppers and are held in place with a coarse internal thread).



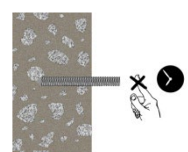
10 Insert the mixing nozzle to the bottom of the hole. Extrude the resin and slowly withdraw the nozzle from the hole. **Ensure no air voids are created** as the nozzle is withdrawn. Inject resin until the hole is approximately ¾ full and remove the nozzle from the hole.



11 Select the steel anchor element ensuring it is free from oil or other contaminants, and mark with the required embedment depth. Insert the steel element into the hole using a back and forth twisting motion to ensure complete cover, until it reaches the bottom of the hole. Excess resin will be expelled from the hole evenly around the steel element and there shall be no gaps between the anchor element and the wall of the drilled hole.

12 Clean any excess resin from around the mouth of the hole.

13 Do not disturb the anchor until at least the minimum cure time has elapsed. Refer to the Working and Load Timetable to determine the appropriate cure time.



14 Position the fixture and tighten the anchor to the appropriate installation torque.

Do not over-torque the anchor as this could adversely affect its performance.

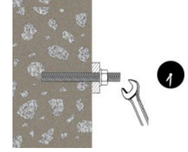


FIGURE 9 – MANUFACTURER'S PRINTED INSTALLATION INSTRUCTIONS (MPII) – CONTINUED

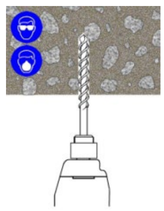
The FLO-ROK® FR5 MAX Adhesive Anchor System : Installation Instructions
Installation for Anchors Overhead and Upwardly Inclined Orientations

Before commencing installation ensure the operative is equipped with appropriate personal protection equipment, SDS hammer drill, air lance, hole cleaning brush, good quality dispensing tool (either manual or power operated), chemical cartridge with mixing nozzle and extension tube, if needed.

Important: check the expiration date on the cartridge **(do not use expired material)** and that the cartridge has been stored in its original packaging, the correct way up, in cool conditions (41°F to 77°F / 5°C to 25°C) out of direct sunlight.

Installation of the FLO-ROK® FR5 MAX Adhesive Anchor System is limited to the following temperature ranges:
FLO-ROK® FR5 MAX : minimum installation temperature: 14°F (-10°C); maximum installation temperature: 95°F (+35°C)

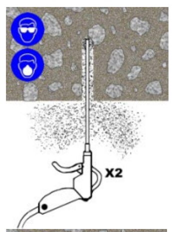
1 Using the SDS Hammer Drill in rotary hammer mode for drilling, with a carbide tipped drill bit (ANSI B212.15-1994) of the appropriate size, drill the hole to the specified hole diameter and depth.



2 Insert the air lance to the bottom of the hole and blow out the hole by depressing the trigger for approximately 2 seconds.

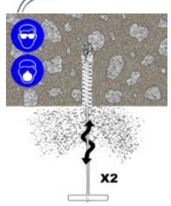
Compressed air shall be clean and dry with a minimum pressure of 90 psi (6 bar).

Perform the blowing operation twice.



3 Select the correct size Hole Cleaning Brush. Ensure that the brush is in good condition and the correct diameter. Insert the brush to the bottom of the hole, using a brush extension if needed to reach the bottom of the hole and withdraw with a twisting motion. *There should be positive interaction between the bristles of the brush and the sides of the drilled hole.*

Perform the brushing operation twice.

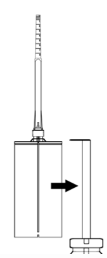


4 Repeat 2

5 Repeat 3

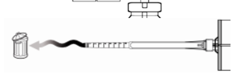
6 Repeat 2

7 Select the appropriate static mixer nozzle, checking that the mixing elements are present and correct **(do not modify the mixer)**. Attach mixer nozzle to the cartridge. Check the Dispensing Tool is in good working order. Place the cartridge into the dispensing tool.



8 Extrude some resin to waste until an even colored mixture is achieved.

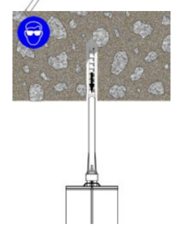
The cartridge is now ready to use.



9 If required, attach an extension tube with resin stopper to the end of the mixing nozzle with a push fit.

(The extension tubes may be pushed into the resin stoppers and are held in place with a coarse internal thread).

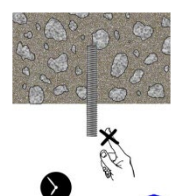
10 Insert the mixing nozzle to the bottom of the hole. Extrude the resin and slowly withdraw the nozzle from the hole. **Ensure no air voids are created** as the nozzle is withdrawn. Inject resin until the hole is approximately ¾ full and remove the nozzle from the hole.



11 Select the steel anchor element ensuring it is free from oil or other contaminants, and mark with the required embedment depth. Insert the steel element into the hole using a back and forth twisting motion to ensure complete cover, until it reaches the bottom of the hole. Excess resin will be expelled from the hole evenly around the steel element and there shall be no gaps between the anchor element and the wall of the drilled hole.

12 Clean any excess resin from around the mouth of the hole.

13 Do not disturb the anchor until at least the minimum cure time has elapsed. Refer to the Working and Load Timetable to determine the appropriate cure time.



14 Position the fixture and tighten the anchor to the appropriate installation torque.

Do not over-torque the anchor as this could adversely affect its performance.