ICC EVALUATION SERVICE

ICC-ES Evaluation Report

ESR-3410

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

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

REPORT HOLDER:

MUNGO BEFESTIGUNGSTECHNIK AG

EVALUATION SUBJECT:

MUNGO MIT-SE PLUS

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2015, 2012, 2009 and 2006 *International Building Code*® (IBC)
- 2015, 2012, 2009 and 2006 *International Residential Code*® (IRC)
- 2013 *Abu Dhabi International Building Code* (ADIBC)†

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

Property evaluated:

Structural

2.0 USES

Mungo MIT-SE Plus adhesive anchors are used to resist static, wind or earthquake (IBC Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normal-weight concrete with $^1/_2$-, $^5/_8$-, $^3/_4$-, $^7/_8$-, 1-, and $1^1/_4$-inch-diameter (12.7, 15.9, 19.1, 22.2, 25.4 and 31.8 mm) threaded steel rods and No. 4 through No. 10 steel reinforcing bars in hammer-drilled holes. The anchors are used to resist static, wind or earthquake (IBC Seismic Design Categories A and B only) tension and shear loads in uncracked normal-weight concrete only with $^3/_8$-inch-diameter (9.5 mm) threaded steel rods and No. 3 steel reinforcing bars in hammer-drilled holes. Use is limited to normal-weight concrete with a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

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

3.0 DESCRIPTION

3.1 General:

The Mungo MIT-SE Plus Adhesive Anchor System is comprised of Mungo MIT-SE Plus two-component adhesive filled in cartridges, static mixing nozzles and manual or powered dispensing tools, hole cleaning equipment and adhesive injection accessories.

Mungo MIT-SE Plus adhesive may be used with continuously threaded steel rods or deformed steel reinforcing bars. The primary components of the Mungo MIT-SE Plus Adhesive Anchor System, including the Mungo MIT-SE Plus adhesive cartridge, static mixing nozzle, the nozzle extension tube and steel anchor elements, are shown in Figures 1 and 2 of this report. The manufacturer's printed installation instructions (MPII), included with each adhesive unit package, are shown in Figure 3 of this report.

3.2 Materials:

3.2.1 Mungo MIT-SE Plus Adhesive: Mungo MIT-SE Plus adhesive is an injectable two-component vinylester adhesive. The two components are kept separate by means of a labeled dual-cylinder cartridge. The two components combine and react when dispensed through a static mixing nozzle, supplied by Mungo, which is attached to the cartridge. Mungo MIT-SE Plus is available in 5-ounce (150 mL), 8-ounce (235 mL), 10-ounce (280 mL), 12-ounce (345 mL), 13-ounce (380 mL), and 28-ounce (825 mL) cartridges. Each cartridge label is marked with the adhesive expiration date. The shelf life, as indicated by the expiration date, applies to an unopened cartridge stored in a dry, dark, and cool environment, in accordance with the MPII, as illustrated in Figure 3 of this report.

3.2.2 Hole Cleaning Equipment: Hole cleaning equipment is comprised of steel wire brushes supplied by Mungo and air blowers which are shown in Figure 3 of this report.

3.2.3 Dispensers: Mungo MIT-SE Plus adhesive must be dispensed with manual dispensers, pneumatic dispensers, or electric powered dispensers supplied by Mungo.

3.2.4 Steel Anchor Elements:

3.2.4.1 Threaded Steel Rods: Threaded steel rods must be clean and continuously threaded (all-thread) in diameters described in Table 4 and Figure 3. Specifications for grades of threaded rod, including the mechanical properties, and corresponding nuts and

washers, are included in Table 2 of this report. Carbon steel threaded rods must be furnished with a minimum 0.0002-inch-thick (0.005 mm) zinc electroplated coating complying with ASTM B633 SC 1 or a minimum 0.0021-inch-thick (0.053 mm) mechanically deposited zinc coating complying with ASTM B695, Class 55. The stainless steel threaded rods must comply with ASTM F593. Steel grades and types of material (carbon, stainless) for the washers and nuts must match the threaded rods. Threaded steel rods must be clean, straight and free of indentations or other defects along their length. The embedded end may be flat cut or cut on the bias to a chisel point.

3.2.4.2 Steel Reinforcing Bars: Steel reinforcing bars are deformed reinforcing bars as described in Table 3 of this report. Table 7 and Figure 3 summarize reinforcing bar size ranges. The embedded portions of reinforcing bars must be clean, straight, and free of mill scale, rust, mud, oil and other coatings (other than zinc) that may impair the bond with the adhesive. Reinforcing bars must not be bent after installation except as set forth in ACI 318-14 Section 26.6.3.1 (b) or ACI 318-11 Section 7.3.2 , as applicable, with the additional condition that the bars must be bent cold, and heating of reinforcing bars to facilitate field bending is not permitted.

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

3.3 Concrete:

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

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

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

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

Design parameters are provided in Tables 4 through Table 9. Strength reduction factors, ϕ, as given in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, must be used for load combinations calculated in accordance with Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable. Strength reduction factors, ϕ, as given in ACI 318-11 D.4.4 must be used for load combinations calculated in accordance with ACI 318-11 Appendix C.

4.1.2 Static Steel Strength in Tension: The nominal static steel strength of a single anchor in tension, N_{sa}, in accordance with ACI 318-14 17.4.1.2 or ACI 318-11 D.5.1.2, as applicable, and the associated strength reduction factors, ϕ, in accordance with ACI 318-11 D.4.3, as applicable, are provided in Table 4 and Table 7 of this report for the corresponding anchor steel.

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

The basic concrete breakout strength of a single anchor in tension, N_b, must be calculated in accordance with ACI 318-17.4.2.2 or ACI 318-11 D.5.2.2, as applicable, using the values of $k_{c,cr}$ and $k_{c,uncr}$ as provided in Table 5 and Table 8 of this report. Where analysis indicates no cracking in accordance with ACI 318-14 17.4.2.6 or ACI 318-11 D.5.2.6, as applicable, N_b must be calculated using $k_{c,uncr}$ and $\Psi_{c,N}$ = 1.0. The value of f'_c used for calculation must be limited to 8,000 psi (55 MPa) in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable. Additional information for the determination of nominal bond strength in tension is given in Section 4.1.4 of this report.

4.1.4 Static Bond Strength in Tension: The nominal static bond strength of a single adhesive anchor or group of adhesive anchors in tension, N_a or N_{ag}, must be calculated in accordance with ACI 318-14 17.4.5 or ACI 318-11 D.5.5. Bond strength values ($\tau_{k,cr}$, $\tau_{k,uncr}$) are a function of concrete compressive strength, concrete state (cracked, uncracked), and installation conditions (dry concrete, water-saturated concrete, water-filled holes). The following table summarizes the requirements:

CONCRETE STATE	BOND STRENGTH	CONCRETE COMPRESSIVE STRENGTH	PERMISSIBLE INSTALLATION CONDITIONS	ASSOCIATED STRENGTH REDUCTION FACTOR
Cracked	$\tau_{k,cr}$	f'_c	Dry concrete	ϕ_d
			Water-saturated concrete	ϕ_{ws}
			Water-filled hole (flooded)	ϕ_{wf}
Uncracked	$\tau_{k,uncr}$	f'_c	Dry concrete	ϕ_d
			Water-saturated concrete	ϕ_{ws}
			Water-filled hole (flooded)	ϕ_{wf}

Strength reduction factors for determination of the bond strength are given in Tables 6 and 9 of this report. Adjustments to the bond strength may also be made for increased concrete compressive strength as noted in the footnotes to the corresponding tables and this section.

The bond strength values in Table 6 and Table 9 of this report correspond to concrete compressive strength f'_c equal to 2,500 psi (17.2 MPa). For concrete compressive strength, f'_c between 2,500 psi and 8,000 psi (17.2 MPa and 55 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1], the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.13}$ [For **SI**: $(f'_c / 17.2)^{0.13}$]. Where applicable, the modified bond strength values must be used in lieu of $\tau_{k,cr}$ and $\tau_{k,uncr}$ in ACI 318-14 Equations (17.4.5.1d) and (17.4.5.2) or ACI 318-11 Equations (D-21) and (D-22), as appplicable.

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

4.1.5 Static Steel Strength in Shear: The nominal static steel strength of a single anchor in shear as governed by the steel, V_{sa}, in accordance with ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable, and strength reduction factor, ϕ, in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are given in Table 4 and Table 7 of this report for the corresponding anchor steel.

4.1.6 Static Concrete Breakout Strength in Shear: The nominal static concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg}, must be calculated in accordance with ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, based on information given in Table 5 and Table 8 in this report.

The basic concrete breakout strength of a single anchor in shear, V_b, must be calculated in accordance with ACI 318-14 17.5.2.2 or ACI 318-11 D.6.2.2, as applicable, using the values of d given in Tables 4, 5, 7, and 8 for the corresponding anchor steel in lieu of d_a (2015, 2012 and 2009 IBC) and d_o (2006 IBC). In addition, h_{ef} must be substituted for ℓ_e. In no case must ℓ_e exceed 8d. The value of f'_c shall be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

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

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

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

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

INSTALLATION TORQUE SUBJECT TO EDGE DISTANCE			
NOMINAL ANCHOR SIZE, *D*	**MINIMUM EDGE DISTANCE, c_{min}**	**MINIMUM ANCHOR SPACING, s_{min}**	**MAXIMUM TORQUE, T_{max}**
all sizes	5*d*	5*d*	$1.0 \cdot T_{max}$
$^3/_8$ in. to 1 in.	1.75 in. (44.5 mm)	5*d*	$0.45 \cdot T_{max}$
$1^1/_4$ in.	2.75 in. (70 mm)		

For values of T_{max}, see Figure 3 of this report.

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

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

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

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

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

where

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

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

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

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

The nominal steel shear strength, V_{sa}, must be adjusted by $\alpha_{V,seis}$ as given in Tables 4 and 7 for the corresponding anchor steel. The nominal bond strength $\tau_{k,cr}$ must be adjusted by $\alpha_{N,seis}$ as given in Tables 6 and 9 for threaded rods. An adjustment to the nominal bond strength $\tau_{k,cr}$ is not required for reinforcing bars ($\alpha_{N,seis}$ = 1.0.)

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

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

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

1. For the calculation of the in-plane shear strength of anchor bolts attaching wood sill plates of bearing or non-bearing walls of light-frame wood structures to foundations or foundation stem walls, the in-plane shear strength in accordance with ACI 318-11 D.6.2 and D.6.3 need not be computed and ACI 318-11 D.3.3.5.3 need not apply provided all of the following are satisfied:

1.1. The allowable in-plane shear strength of the anchor is determined in accordance with AF&PA NDS Table 11E for lateral design values parallel to grain.

1.2. The maximum anchor nominal diameter is $^5/_8$ inch (16 mm).

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

1.4. Anchor bolts are located a minimum of $1^3/_4$ inches (45 mm) from the edge of the concrete parallel to the length of the wood sill plate.

1.5. Anchor bolts are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the wood sill plate.

1.6. The sill plate is 2-inch or 3-inch nominal thickness.

2. For the calculation of the in-plane shear strength of anchor bolts attaching cold-formed steel track of bearing or non-bearing walls of light-frame construction to foundations or foundation stem walls, the in-plane shear strength in accordance with ACI 318-11 D.6.2 and D.6.3 need not be computed and ACI 318-11 D.3.3.5.3 need not apply provided all of the following are satisfied:

2.1. The maximum anchor nominal diameter is $^5/_8$ inch (16 mm).

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

2.3. Anchors are located a minimum of $1^3/_4$ inches (45 mm) from the edge of the concrete parallel to the length of the track.

2.4. Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.

2.5. The track is 33 to 68 mil designation thickness.

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

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

4.2 Installation:

Installation parameters are illustrated in Figure 1 of this report. Installation must be in accordance with ACI 318-14 17.8.1 and 17.8.2 or ACI 318-11 D.9.1 and D.9.2, as applicable. Anchor locations must comply with this report and the plans and specifications approved by the code official. Installation of the Mungo MIT-SE Plus Adhesive Anchor System must conform to the manufacturer's printed installation instructions included in each unit package as described in Figure 3 of this report.

The adhesive anchor system may be used for floor (vertically down), wall (horizontal), and overhead applications with $^3/_8$-inch through $1^1/_4$-inch diameter threaded steel rods and No. 3 through No. 10 steel reinforcing bars. The installation shall be injected directly to the end of the hole using a piston plug attached to the end of the mixing nozzle with an extension tube for the $^5/_8$-inch through $1^1/_4$-inch diameter threaded steel rods and No. 5 through No. 10 steel reinforcing bars as described in Figure 3 of this report. The $^3/_8$-inch and $^1/_2$-inch diameter threaded steel rods, and No. 3 and No. 4 steel reinforcing bars may be installed by filling the hole using the mixing nozzle only.

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

4.3 Special Inspection:

Periodic special inspection must be performed where required in accordance with Section 1705.1.1 and Table 1705.3 of the 2015 and 2012 IBC, Sections 1704.4 and 1704.15 of the 2009 IBC or Section 1704.13 of the 2006 IBC and this report. The special inspector must be on the jobsite initially during anchor installation to verify the anchor type, adhesive expiration date, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque, and adherence to the manufacturers printed installation instructions.

The special inspector must verify the initial installations of each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same construction personnel are permitted to be performed in the absence of the special inspector. Any change in the anchor product being installed or the personnel performing the installation requires an initial inspection. For ongoing installations over an extended period, the special inspector must make regular inspections to confirm correct handling and installation of the product.

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

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

4.4 Compliance with NSF/ANSI Standard 61:

The Mungo MIT-SE Plus Adhesive Anchor System complies with the requirements of NSF/ANSI Standard 61, as referenced in Section 605 of the 2009 and 2006 *International Plumbing Code*® (IPC) and is certified for use as an anchoring adhesive for installing threaded rods less than or equal to 1.3 inches (33 mm) in diameter in concrete for water treatment applications.

5.0 CONDITIONS OF USE

The Mungo MIT-SE Plus Adhesive Anchor System described in this report complies with or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Mungo MIT-SE Plus adhesive anchors must be installed in accordance with the manufacturer's printed installation instructions included with each cartridge and provided in Figure 3 of this report.

5.2 Anchors [$^1/_2$-, $^5/_8$-, $^3/_4$-, $^7/_8$-, 1-, and $1^1/_4$ diameter (12.7, 15.9, 19.1, 22.2, 25.4 and 31.8 mm) threaded steel rods and No. 4 through No. 10 steel reinforcing bars] described in this report must be installed in cracked and uncracked normal-weight concrete having a specified compressive strength f'_c = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa). Anchors [$^3/_8$-inch-diameter (9.5 mm)] threaded steel rods and No. 3 steel reinforcing bars in hammer-drilled holes must be installed in uncracked normal-weight concrete having a specified compressive strength f'_c = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

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

5.4 Anchors must be installed in concrete base materials in holes predrilled in accordance with the instructions provided in Figure 3 of this report.

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

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

5.7 Mungo MIT-SE Plus adhesive anchors are permitted to be installed in concrete that is cracked or that may be expected to crack during the service life of the anchor, subject to the conditions of this report. Exception see Section 5.2 of this report.

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

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

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

5.11 Anchors are not permitted to support fire-resistive construction. Where not otherwise prohibited by the code, Mungo MIT-SE Plus adhesive anchors are permitted for installation in fire-resistive construction provided that at least one of the following conditions is fulfilled:

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

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

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

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

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

5.16 Periodic special inspection must be provided in accordance with Section 4.3 in this report. Continuous special inspection for anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads must be provided in accordance with Section 4.3 of this report.

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

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

5.19 Mungo MIT-SE Plus adhesive is manufactured in Willich, Germany, under a quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors in Concrete (AC308), dated June 2019, which incorporates requirements in ACI 355-4-11.

7.0 IDENTIFICATION

7.1 Mungo MIT-SE Plus adhesive is identified by packaging labeled with the manufacturer's name (Mungo Befestigungstechnik AG) and address, anchor name, the lot number, the expiration date, and the evaluation report number (ESR-3410). Threaded rods, nuts, washers, and deformed reinforcing bars are standard steel anchor elements and must conform to applicable national or international specifications as set forth in Tables 2 and 3 of this report.

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

MUNGO BEFESTIGUNGSTECHNIK AG
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TABLE 1—DESIGN TABLE INDEX

DESIGN STRENGTH[1]		THREADED ROD	DEFORMED REINFORCING BAR
Steel	N_{sa}, V_{sa}	Table 4	Table 7
Concrete	N_{pn}, N_{sb}, N_{sbg}, N_{cb}, N_{cbg}, V_{cb}, V_{cbg}, V_{cp}, V_{cpg}	Table 5	Table 8
Bond[2]	N_a, N_{ag}	Table 6	Table 9

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

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

THREADED ROD SPECIFICATION			MINIMUM SPECIFIED ULTIMATE STRENGTH, f_{uta}	MINIMUM SPECIFIED YIELD STRENGTH 0.2 PERCENT OFFSET, f_{ya}	f_{uta}/f_{ya}	ELONGATION, MIN. PERCENT[5]	REDUCTION OF AREA, MIN. PERCENT	SPECIFICATION FOR NUTS[6]	SPECIFICATION FOR WASHERS[6]
CARBON STEEL	ASTM A193[2] Grade B7 all sizes	psi (MPa)	125,000 (862)	105,000 (724)	1.19	16	50	ASTM A563 Grade D	ASTM F436
	ASTM A36[3] / F1554, Grade 36 all sizes	psi (MPa)	58,000 (400)	36,000 (250)	1.61	23	50	ASTM A563 Grade A	ASTM B18.22.1 Type A Plain
STAINLESS STEEL (304/316)	ASTM F593[4] CW1 $^3/_8$ to $^5/_8$ in.	psi (MPa)	100,000 (690)	65,000 (450)	1.54	40	-[7]	ASTM F594 Alloy Group 1, 2 or 3	ASTM B18.22.1 Type A Plain
	ASTM F593[4] CW2 $^3/_4$ to $1^1/_4$ in.	psi (MPa)	85,000 (590)	45,000 (310)	1.89	40	-[7]		

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

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

REINFORCING SPECIFICATION	UNITS	MINIMUM SPECIFIED ULTIMATE STRENGTH, f_{uta}	MINIMUM SPECIFIED YIELD STRENGTH, f_{ya}
ASTM A615[1], A767[3], A996[4] Grade 60	psi (MPa)	90,000 (620)	60,000 (414)
ASTM A615[1], Grade 40	psi (MPa)	60,000 (415)	40,000 (275)

[1]Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
[2]Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
[3]Standard specification for Zinc-Coated (Galvanized) steel Bars for Concrete Reinforcement.
[4]Standard specification for Rail-Steel and Axle-steel Deformed bars for Concrete Reinforcement.

TABLE 4—STEEL DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD[1]

DESIGN INFORMATION		Symbol	Units	Nominal Rod Diameter (inch)						
				$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
Threaded rod O.D.		d	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.250 (31.8)
Threaded rod effective cross-sectional area		A_{se}	in.² (mm²)	0.0775 (50)	0.1419 (92)	0.2260 (146)	0.3345 (216)	0.4617 (298)	0.6057 (391)	0.9691 (625)
ASTM A36/F1554, Grade 36	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	4,495 (20.0)	8,230 (36.6)	13,110 (58.3)	19,400 (86.3)	26,780 (119.1)	35,130 (156.3)	56,210 (250.0)
		V_{sa}	lb (kN)	2,695 (12.0)	4,940 (22.0)	7,860 (35.0)	11,640 (51.8)	16,070 (71.4)	21,080 (93.8)	33,725 (150.0)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	Not applicable	0.85	0.85	0.85	0.85	0.80	0.80
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ASTM A193 Grade B7	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	9,685 (43.1)	17,735 (78.9)	28,250 (125.7)	41,810 (186.0)	57,710 (256.7)	75,710 (336.8)	121,135 (538.8)
		V_{sa}	lb (kN)	4,845 (21.5)	10,640 (7.3)	16,950 (75.4)	25,085 (111.6)	34,625 (154.0)	45,425 (202.1)	72,680 (323.3)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	Not applicable	0.85	0.85	0.85	0.85	0.80	0.80
	Strength reduction factor for tension[2]	ϕ	-	0.75						
	Strength reduction factor for shear[2]	ϕ	-	0.65						
ASTM F593 CW Stainless	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	28,430 (126.5)	39,245 (174.6)	51,485 (229.0)	82,370 (366.4)
		V_{sa}	lb (kN)	4,650 (20.7)	8,515 (37.9)	13,560 (60.3)	17,060 (75.9)	23,545 (104.7)	30,890 (137.4)	49,425 (219.8)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	Not applicable	0.85	0.85	0.85	0.85	0.80	0.80
	Strength reduction factor for tension[2]	ϕ	-	0.65						
	Strength reduction factor for shear[2]	ϕ	-	0.60						

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

[1]Values provided for common rod material types based on specified strengths and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 17.5.1.2b or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable. Nuts and washers must comply with requirements for the rod.
[2]The tabulated value of ϕ applies when the load combinations of Section 1605.2of the IBC, ACI 318-14 5.3 or ACI 318-11.9.2, as applicable, are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 5—CONCRETE BREAKOUT DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION	Symbol	Units	Nominal Rod Diameter (inch)						
			3/8	1/2	5/8	3/4	7/8	1	1 1/4
Effectiveness factor for cracked concrete	$k_{c,cr}$	in-lb (SI)	n.a.	17 (7)					
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	in-lb (SI)	24 (10)						
Min. anchor spacing	s_{min}	in. (mm)	1 7/8 (48)	2 1/2 (64)	3 1/8 (79)	3 3/4 (95)	4 3/8 (111)	5 (127)	6 1/4 (159)
Min. edge distance	c_{min}	in. (mm)	See Section 4.1.9 of this report.						
Min. member thickness	h_{min}	in. (mm)	h_{ef} + 1 1/4 (h_{ef} + 30)		h_{ef} + 2d_0 [3]				
Critical edge distance - splitting (for uncracked concrete)[2]	c_{ac}	-	See Section 4.1.10 of this report.						
Critical anchor spacing – splitting	s_{ac}	-	2·c_{ac}						
Strength reduction factor for tension, concrete failure modes, Condition B[2]	ϕ	-	0.65						
Strength reduction factor for shear, concrete failure modes, Condition B[2]	ϕ	-	0.70						

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

[1]Additional setting information is described in Figure 3, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11.9.2, as applicable, are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.
[3] d_0 = hole diameter.

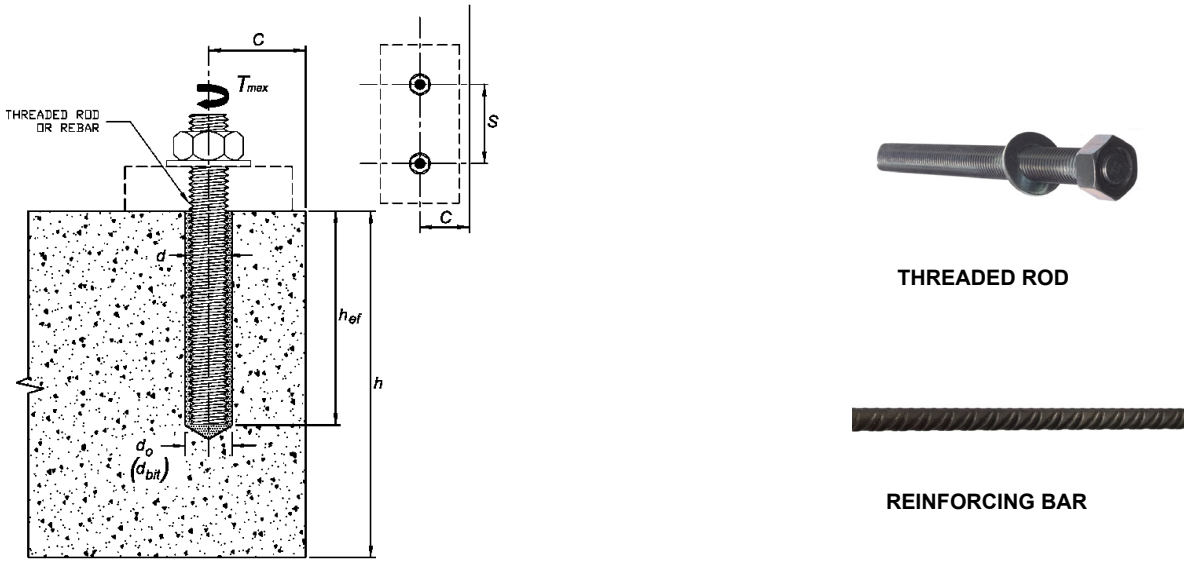


FIGURE 1—INSTALLATION PARAMETERS FOR THREADED RODS AND REINFORCING BARS

TABLE 6—BOND STRENGTH DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT THREADED ROD IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION			Symbol	Units	Nominal Rod Diameter (inch)						
					3/8	1/2	5/8	3/4	7/8	1	1 1/4
Minimum embedment			$h_{ef,min}$	in. (mm)	2 3/8 (60.3)	2 3/4 (69.9)	3 1/8 (79.4)	3 1/2 (88.9)	3 1/2 (88.9)	4 (101.6)	5 (127.0)
Maximum embedment			$h_{ef,max}$	in. (mm)	4 1/2 (114)	6 (152)	7 1/2 (191)	9 (229)	10 1/2 (267)	12 (305)	15 (381)
Dry concrete	**Temperature range A[2,3]:**	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	823 (5.7)	823 (5.7)	823 (5.7)	823 (5.7)	823 (5.7)	743 (5.1)	588 (4.1)
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	498 (3.4)	519 (3.6)	519 (3.6)	519 (3.6)	519 (3.6)	525 (3.6)
	Temperature range B[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	405 (2.8)	405 (2.8)	405 (2.8)	405 (2.8)	405 (2.8)	366 (2.5)	Not applicable
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	245 (1.7)	255 (1.8)	255 (1.8)	255 (1.8)	255 (1.8)	255 (1.8)
	Strength reduction factor		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Water-saturated concrete	**Temperature range A[2,3]:**	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	823 (5.7)	823 (5.7)	823 (5.7)	823 (5.7)	823 (5.7)	743 (5.1)	588 (4.1)
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	498 (3.4)	519 (3.6)	519 (3.6)	519 (3.6)	519 (3.6)	525 (3.6)
	Temperature range B[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	405 (2.8)	405 (2.8)	405 (2.8)	405 (2.8)	405 (2.8)	366 (2.5)	Not applicable
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	245 (1.7)	255 (1.8)	255 (1.8)	255 (1.8)	255 (1.8)	255 (1.8)
	Strength reduction factor		ϕ_{ws}	-	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Water-filled hole (flooded)	**Temperature range A[2,3]:**	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	642 (4.4)	642 (4.4)	642 (4.4)	642 (4.4)	576 (4.0)	Not applicable	
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	388 (2.7)	405 (2.8)	405 (2.8)	363 (2.5)	358 (2.5)	352 (2.4)
	Temperature range B[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	316 (2.2)	316 (2.2)	316 (2.2)	316 (2.2)	Not applicable		
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	191 (1.3)	199 (1.4)	199 (1.4)	179 (1.3)	176 (1.2)	171 (1.2)
	Strength reduction factor		ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Reduction factor for seismic tension			$\alpha_{N,seis}$	-	0.95						

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

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. For concrete compressive strength, f'_c between 2,500 psi and 8,000 psi [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1], the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2500)^{0.13}$. See Section 4.1.4 of this report.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C) Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C)
Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[3]Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short-term loads only such as wind, bond strengths may be increased by 43 percent for temperature range A and 122 percent for temperature range B.

TABLE 7—STEEL DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING BARS [1]

DESIGN INFORMATION		Symbol	Units	Nominal Bar Size							
				No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
Reinforcing bar O.D.		d	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.125 (28.6)	1.250 (31.8)
Reinforcing bar effective cross-sectional area		A_{se}	in.² (mm²)	0.110 (71)	0.200 (129)	0.310 (200)	0.440 (284)	0.600 (387)	0.790 (510)	1.000 (645)	1.270 (819)
ASTM A615, A706, A767, A996 Grade 60	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	9,900 (44.0)	18,000 (80.1)	27,900 (124.1)	39,600 (176.1)	54,00 (240.2)	71,100 (316.3)	90,000 (400.3)	114,300 (508.4)
		V_{sa}	lb (kN)	5,940 (26.4)	10,800 (48.0)	16,740 (74.5)	23,760 (105.7)	32,400 (144.1)	42,660 (189.8)	54,000 (240.2)	68,580 (305.0)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	Not applicable	0.70	0.70	0.70	0.70	0.70	0.70	0.70
	Strength reduction factor for tension[2]	ϕ	-	0.65							
	Strength reduction factor for shear[2]	ϕ	-	0.60							
ASTM A615 Grade 40[3]	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lb (kN)	6,600 (29.4)	12,000 (53.4)	18,600 (82.7)	26,400 (117.4)	In accordance with ASTM A615, Grade 40 bars are furnished only in sizes No. 3 through No. 6			
		V_{sa}	lb (kN)	3,960 (17.6)	7,200 (32.0)	11,160 (49.6)	15,840 (70.5)				
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	Not applicable	0.70	0.70	0.70				
	Strength reduction factor for tension[2]	ϕ	-	0.65							
	Strength reduction factor for shear[2]	ϕ	-	0.60							

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

[1]Values provided for common bar material types based on specified strengths and calculated in accordance with ACI 318-14 Eq. 17.4.1.2 and Eq. 7.5.1.2b, or ACI 318-11 Eq. (D-2) and Eq. (D-29), as applicable.
[2]For the tabulated value of ϕ applies when the load combinations of Section 1605.2. of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.
[3]In accordance with ASTM A615, Grade 40 bars are furnished only in sizes No. 3 through No. 6.

TABLE 8—CONCRETE BREAKOUT DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION	Symbol	Units	Nominal Bar Size							
			No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
Effectiveness factor for cracked concrete	$k_{c,cr}$	in-lb (SI)	n.a.	17 (7)						
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	in.-lb. (SI)	24 (10)							
Min. anchor spacing	s_{min}	in. (mm)	$1^7/_8$ (48)	$2^1/_2$ (64)	$3^1/_8$ (79)	$3^3/_4$ (95)	$4^3/_8$ (111)	5 (127)	$5^5/_8$ (143)	$6^1/_4$ (159)
Min. edge spacing	c_{min}	in. (mm)	See Section 4.1.9 of this report.							
Min. member thickness	h_{min}	in. (mm)	$h_{ef} + 1^1/_4$ (h_{ef} + 30)		$h_{ef} + 2d_0$[3]					
Critical edge spacing – splitting (for uncracked concrete)[2]	c_{ac}	-	See Section 4.1.10 of this report.							
Critical anchor spacing – splitting	s_{ac}	-	$2 \cdot c_{ac}$							
Strength reduction factor for tension, concrete failure modes, Condition B[2]	ϕ	-	0.65							
Strength reduction factor for shear, concrete failure modes, Condition B[2]	ϕ	-	0.70							

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

[1]Additional setting information is described in Figure 3, installation instructions.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pullout or pryout governs, as set forth in ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. The tabulated value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 17.3.3 or ACI 318-11 9.2, as applicable, are used. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.
[3]d_0 = hole diameter.

TABLE 9—BOND STRENGTH DESIGN INFORMATION FOR U.S. CUSTOMARY UNIT REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION			Symbol	Units	Nominal Bar Size							
					No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
Minimum embedment			$h_{ef,min}$	in. (mm)	$2^3/_8$ (60.3)	$2^3/_4$ (69.9)	$3^1/_8$ (79.4)	$3^1/_2$ (88.9)	$3^1/_2$ (88.9)	4 (101.6)	$4^1/_2$ (114)	5 (127.0)
Maximum embedment			$h_{ef,max}$	in. (mm)	$4^1/_2$ (114)	6 (152)	$7^1/_2$ (191)	9 (229)	$10^1/_2$ (267)	12 (305)	$13^1/_2$ (343)	15 (381)
Dry concrete	**Temperature range A[2,3]:**	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	823 (5.7)	823 (5.7)	823 (5.7)	823 (5.7)	823 (5.7)	743 (5.1)	668 (4.6)	588 (4.1)
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	331 (2.3)	345 (2.4)	345 (2.4)	345 (2.4)	345 (2.4)	349 (2.4)	349 (2.4)
	Temperature range B[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	405 (2.8)	405 (2.8)	405 (2.8)	405 (2.8)	405 (2.8)	366 (2.5)	329 (2.3)	Not applicable
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	163 (1.1)	170 (1.2)	170 (1.2)	170 (1.2)	170 (1.2)	172 (1.2)	172 (1.2)
	Strength reduction factor		ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Water-saturated concrete	**Temperature range A[2,3]:**	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	823 (5.7)	823 (5.7)	823 (5.7)	823 (5.7)	823 (5.7)	743 (5.1)	668 (4.6)	588 (4.1)
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	331 (2.3)	345 (2.4)	345 (2.4)	345 (2.4)	345 (2.4)	349 (2.4)	349 (2.4)
	Temperature range B[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	405 (2.8)	405 (2.8)	405 (2.8)	405 (2.8)	405 (2.8)	366 (2.5)	329 (2.3)	Not applicable
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	163 (1.1)	170 (1.2)	170 (1.2)	170 (1.2)	170 (1.2)	172 (1.2)	172 (1.2)
	Strength reduction factor		ϕ_{ws}	-	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Water-filled hole (flooded)	**Temperature range A[2,3]:**	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	642 (4.4)	642 (4.4)	642 (4.4)	642 (4.4)	576 (4.0)	Not applicable		
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	258 (1.8)	269 (1.9)	269 (1.9)	242 (1.7)	238 (1.7)	237 (1.6)	234 (1.6)
	Temperature range B[2,3]:	Characteristic bond strength in uncracked concrete	$\tau_{k,uncr}$	psi (N/mm²)	316 (2.2)	316 (2.2)	316 (2.2)	316 (2.2)	Not applicable			
		Characteristic bond strength in cracked concrete	$\tau_{k,cr}$	psi (N/mm²)	Not applicable	127 (0.9)	133 (0.9)	133 (0.9)	119 (0.8)	117 (0.8)	117 (0.8)	115 (0.8)
	Strength reduction factor		ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Reduction factor for seismic tension			$\alpha_{N,seis}$	-	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 inches, 1 N = 0.2248 lbf, 1 MPa = 145.0 psi.

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. For concrete compressive strength f'_c between 2,500 psi and 8,000 psi [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1], tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.13}$. See Section 4.1.4 of this report.
[2]Temperature range A: Maximum short term temperature = 176°F (80°C), maximum long term temperature = 122°F (50°C) Temperature range B: Maximum short term temperature = 248°F (120°C), maximum long term temperature = 161°F (72°C)
Short term elevated concrete temperatures are those that occur over brief intervals, e.g. as result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[3]Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short term loads only, such as wind and seismic, bond strengths may be increased by 42 percent for temperature range A and 122 percent for temperature range B.

DIFFERENT TWO-COMPONENT CARTRIDGE ADHESIVE

STATIC MIXING NOZZLE

FIGURE 2—MUNGO MIT-SE PLUS ADHESIVE ANCHOR SYSTEM

Mungo MIT-SE Plus - Instruction Card

1. Setting instructions for solid base material - For any application not covered by this document please contact Mungo Befestigungstechnik AG

Drilling

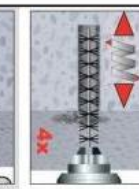
1 Drill a hole into the base material with a hammer drill tool to the size and embedment required by the selected steel hardware element (see Table 4.1 or Table 4.2). The tolerances of the carbide drill bit must meet the requirements of ANSI Standard B212.15.
Precaution: Wear suitable eye and skin protection. Avoid inhalation of dusts during drilling and/or removal. Note: In case of standing water in the drilled bore hole, all the water has to be removed from the hole (e.g. vacuum, compressed air, etc.) prior to cleaning.

Hole cleaning → In order: *Blow 4x, Brush 4x, Blow 4x*

2a. In case of standing water in the drilled bore hole, all the water has to be removed from the hole (e.g. vacuum, compressed air, etc.) prior to cleaning.
Starting from the bottom or back of the anchor hole, blow the hole clean a minimum of *four* times (4x).

- Use a compressed air nozzle (min. 90 psi) **or** a hand pump (min. volume 25 fl. oz. supplied by Mungo) for anchor rod 3/8" to 3/4" diameter or reinforcing bar (rebar) sizes #3 to #6.
- Use a compressed air nozzle (min. 90 psi) for anchor rod 7/8" to 1-1/4" diameter and rebar sizes #7 to #10. A hand pump must not be used with these anchor sizes.

2b. Determine brush diameter (see Table 2) for the drilled hole and attach the brush with adaptor to a rotary drill tool or battery screw gun. Brush the hole with the selected wire brush a minimum of *four* times (4x). A brush extension (supplied by Mungo) must be used for holes drilled deeper than the listed brush length.
The wire brush diameter must be checked periodically during use ($Ø_{brush} > D_{min}$, see Table 2). The brush should resist insertion into the drilled hole - if not the brush is too small and must be replaced with the proper brush diameter.

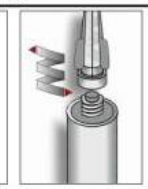


2c. Finally, blow the hole clean again a minimum of *four* times (4x).

- Use a compressed air nozzle (min. 90 psi) **or** a hand pump (min. volume 25 fl. oz. supplied by Mungo Befestigungstechnik AG) for anchor rod 3/8" to 3/4" diameter or reinforcing bar (rebar) sizes #3 to #6.
- Use a compressed air nozzle (min. 90 psi) for anchor rod 7/8" to 1-1/4" diameter and rebar sizes #7 to #10. A hand pump must not be used with these anchor sizes.

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

Preparing

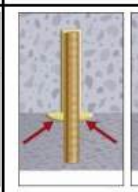


3. Check adhesive expiration date on cartridge label. Do not use expired product. Review Material Safety Data Sheet (MSDS) before use. Cartridge temperature must be between 32°F - 95°F (0°C - 35°C) when in use except as noted in Table 3.. Review working and cure times. Consideration should be given to the reduced gel (working) time of the adhesive in warm temperatures.
For the permitted range of the base material temperature see Table 3.
Attach a supplied mixing nozzle to the cartridge. Do not modify the mixer in any way and make sure the mixing element is inside the nozzle. Load the cartridge into the correct dispensing tool.
Note: *Always use a new mixing nozzle with new cartridges of adhesive and also for all work interruptions exceeding the published gel (working) time of the adhesive.*

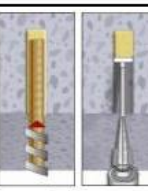
4 Prior to inserting the anchor rod or rebar into the filled bore hole, the position of the embedment depth has to be marked on the anchor. Verify anchor element is straight and free of surface damage.

5. Adhesive must be properly mixed to achieve published properties. Prior to dispensing adhesive into the drilled hole, separately dispense at least three full strokes of adhesive through the mixing nozzle until the adhesive is a consistent gray color.
Review and note the published working and cure times (see Table 3) prior to injection of the mixed adhesive into the cleaned anchor hole.

Installation



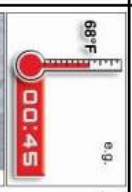
6. Fill the cleaned hole approximately two-thirds full with mixed adhesive starting from the bottom or back of the anchor hole. Slowly withdraw the mixing nozzle as the hole fills to avoid creating air pockets or voids. . If the bottom or back of the anchor hole is not reached with the mixing nozzle only an extension nozzle supplied by Mungo (3/8" dia.. Cat# 1710064) must be used with the mixing nozzle.
Piston plugs (see Table 6) must be used with and attached to mixing nozzle and extension tube for horizontal and overhead installations with anchor rod 1/2" to 1-1/4" diameter and rebar sizes #4 to #10. Insert piston plug to the back of the drilled hole and inject as described in the method above. During installation the piston plug will be naturally extruded from the drilled hole by the adhesive pressure. **Attention!** Do not install anchors overhead without proper training and installation hardware provided by Mingo. Contact Mungo for details prior to use.



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

8. Be sure that the anchor is fully seated at the bottom of the hole and that some adhesive has flowed from the hole and all around the top of the anchor. If there is not enough adhesive in the hole, the installation must be repeated. For overhead applications and applications between horizontal and overhead the anchor must be secured from moving/falling during the cure time (e.g. wedges). Minor adjustments to the anchor may be performed during the gel time but the anchor shall not be moved after placement and during cure.

Curing and fixture

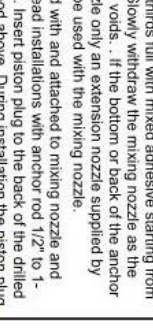


9. Allow the adhesive anchor to cure to the specified full curing time prior to applying any load (see Table 3).
Do not disturb, torque or load the anchor until it is fully cured.

10. After full curing of the adhesive anchor, a fixture can be installed to the anchor and tightened up to the maximum torque (shown in Table 4.1) by using a calibrated torque wrench.
Take care not to exceed the maximum torque for the selected anchor.

2. Hole cleaning tools - wire brushes and air blowers

Threaded rod diameter (inch)	Rebar size (no.)	ANSI drill bit diameter[2] (inches)	Min. brush diameter, D_{min} (inches)	Brush length, L[1] (inches)	Steel wire brush (Cat. #)
					Air blowers
3/8	#3	7/16	0.475	6-3/4	1690040
1/2	-	9/16	0.600	6-3/4	1690041
-	#4	5/8	0.708	6-3/4	1690042
5/8	#5	11/16	0.735	7-7/8	1690044
		3/4	0.790	7-7/8	1690045
3/4	#6	7/8	0.920	7-7/8	1690053
7/8	#7	1	1.045	11-7/8	1690054
1	#8	1-1/8	1.175	11-7/8	1690047
1-1/4	#9	1-3/8	1.425	11-7/8	1690049
-	#10	1-1/2	1.550	11-7/8	1690050



Hand pump (volume 25 fl. oz.) or compressed air nozzle (min. 90 psi)

Hand pump - Cat. #1690011

Compressed air nozzle only (min. 90 psi)

#1690008 Compressed air nozzle

[1] A brush extension (Cat. #1690051) must be used with a steel wire brush for holes drilled deeper than the listed brush length.

[2] For installations with 5/8-inch threaded rod and #5 rebar size, the preferred ANSI drill bit diameter is 3/4-inch. If an 11/16-inch ANSI drill bit is used the user must check before injecting the adhesive to verify that the steel anchor element can be inserted into the cleaned borehole without resistance.

FIGURE 3—INSTALLATION INSTRUCTIONS

Mungo MIT-SE Plus
Instruction Card

DESCRIPTION:
MIT-SE Plus is an easy dispensing, rapid-curing, high strength anchoring adhesive which is formulated for use by trained professionals. Please refer to installation instructions and MSDS for additional detailed information.

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

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

HANDLING AND STORAGE:
Store in a cool, dry, well ventilated area at temperatures between 32°F (0°C) and 86°F (30°C). Keep away from excessive heat and flame. Keep partially used containers closed when not in use. Protect from damage. Store away from heat and light.
Before use see expiration date on product label.

Do not use expired product. Partially used cartridges may be stored with hardened adhesive in the attached mixing nozzle.
Note: *If the cartridge is reused, attach a new mixing nozzle and discard the initial quantity of the anchor adhesive as described in the setting instructions (steps #3 and #5).*

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6. Adhesive Piston Plugs

Threaded rod diameter (inch)	Rebar size (no.)	ANSI drill bit diameter (inch)	Plug Size (inch)	Plastic Plug (Cat. #)	Horizontal and overhead installations
5/8	#5	11/16	11/16	1710072	
		3/4	3/4	1710073	
3/4	#6	7/8	7/8	1710074	
7/8	#7	1	1	1710079	
1	#8	1-1/8	1-1/8	1710080	
1-1/4	#9	1-3/8	1-3/8	1710085	
-	#10	1-1/2	1-1/2	1710071	

A plastic extension tube (3/8" dia., Cat# 1710064) must be used with piston plugs.

3. Gel (working) times and curing times

Temperature of base material		Gel (working) time	Full curing time
14°F	-10°C	90 minutes	24 hours
23°F	-5°C	90 minutes	14 hours
32°F	0°C	45 minutes	7 hours
41°F	5°C	25 minutes	2 hours
50°F	10°C	15 minutes	90 minutes
68°F	20°C	6 minutes	45 minutes
86°F	30°C	4 minutes	25 minutes
95°F	35°C	2 minutes	20 minutes
104°F	40°C	1.5 minutes	15 minutes

For installations in base material temperature between 14°F and 23°F the cartridge temperature must be conditioned to between 68°F and 95°F (20°C - 35°C).

4. Setting parameters

Table 4.1 Specifications for installation of threaded rods

Anchor property / Setting information	Nominal threaded rod size						
	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1-1/4"
d = Nominal anchor rod diameter (in.)	0.375	0.500	0.625	0.750	0.875	1.000	1.250
A_{se} = Nominal area of threaded rod (in.²)	0.078	0.142	0.226	0.335	0.462	0.606	0.969
d_o (d_{bit}) = Nominal ANSI drill bit size (in.)	7/16	9/16	11/16 or 3/4	7/8	1	1-1/8	1-3/8
T_{inst} = Maximum torque (ft.-lb.) for A193 B7 carbon steel rod or F593 SS rod	16	33	60	105	125	165	280
T_{inst} = Maximum torque (ft.-lb.) for A36/A307 carbon steel rod **only**	10	25	50	90			
$h_{ef,min}$ = Minimum embedment (inches)	2-3/8	2-3/4	3-1/8	3-1/2	3-1/2	4	5
$h_{ef,max}$ = Maximum embedment (inches)	4-1/2	6	7-1/2	9	10-1/2	12	15
s_{min} = Minimum spacing (inches)	1-7/8	2-1/2	3-1/8	3-3/4	4-3/8	5	6-1/4
c_{min} = Minimum edge distance (inches)	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	2-3/4
h_{min} = Minimum member thickness (inches)	h_{ef} + 1-1/4		h_{ef} + $2d_o$				

For installations between the minimum edge distance and 5 anchor diameters, the tabulated maximum torque must be reduced (multiplied) by a factor of 0.45.

Table 4.2 Specifications for installation of deformed steel reinforcing bars

Anchor property / Setting information	Reinforcing bar size							
	#3	#4	#5	#6	#7	#8	#9	#10
d = Nominal bar diameter (in.)	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4
d_o (d_{bit}) = Nominal ANSI drill bit size (in.)	7/16	5/8	11/16 or 3/4	7/8	1	1-1/8	1-3/8	1-1/2
$h_{ef,min}$ = Minimum embedment (inches)	2-3/8	2-3/4	3-1/8	3-1/2	3-1/2	4	4-1/2	5
$h_{ef,max}$ = Maximum embedment (inches)	4-1/2	6	7-1/2	9	10-1/2	12	13-1/2	15
s_{min} = Minimum spacing (inches)	1-7/8	2-1/2	3-1/8	3-3/4	4-3/8	5	5-5/8	6-1/4
c_{min} = Minimum edge distance (inches)	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4	2-3/4	2-3/4
h_{min} = Minimum member thickness (inches)	h_{ef} + 1-1/4		h_{ef} + $2d_o$					

5. MIT-SE Plus adhesive anchor system selection table

Injection tools		Plastic cartridge system	Extra mixing nozzles
MIT-SE Plus 6 fl. oz. caulking guns	Cat. #1710029 - standard all-metal Cat. #1710034 - High performance	MIT-SE Plus 6 fl. oz. w/nozzle Cat. #1710024	MIT-SE Plus mixing nozzle Cat. #1710014
MIT-SE Plus 10 fl. oz. caulking guns	Cat. #1710029 - standard all-metal Cat. #1710034 - High performance	MIT-SE Plus10 fl. oz. w/nozzle Cat. #1710017	MIT-SE Plus mixing nozzle Cat. #1710014
MIT-SE Plus 12 fl. oz. manual dispenser	Cat. #1710033 - Standard all-metal Cat. #1710035 - High performance	MIT-SE Plus 12 fl. oz. w/nozzle Cat. #1710025	MIT-SE Plus mixing nozzle Cat. #1710014
MIT-SE Plus 14 fl. oz Manual dispenser	Cat. #1710009 - standard all-metal Cat. #1710036 - High performance	MIT-SE Plus 14 fl. oz. w/nozzle Cat. #1710026	MIT-SE Plus mixing nozzle Cat. #1710014
MIT-SE Plus 29 fl. oz. manual and powered dispensers	Cat. #1710031 - Pneumatic tool	MIT-SE Plus 29 fl. oz. with long mixing nozzle and extension tube Cat #1710022	MIT-SE Plus long mixing nozzle and nozzle extension tube Cat. #1710014

A plastic extension tube (3/8" dia., Cat# 16009) must be used for embedment depths greater than 7-1/2 inches.

FIGURE 3—INSTALLATION INSTRUCTIONS (Continued)

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

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

REPORT HOLDER:

MUNGO BEFESTIGUNGSTECHNIK AG

EVALUATION SUBJECT:

MUNGO MIT-SE PLUS

1.0 REPORT PURPOSE AND EVALUATION SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that Mungo MIT-SE Plus Adhesive Anchor System in Cracked and Uncracked Concrete, recognized in ICC-ES master evaluation report ESR-3410, has also been evaluated for compliance with the codes noted below.

Compliance with the following codes:

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

2.0 PURPOSE OF THIS SUPPLEMENT

The Mungo MIT-SE Plus Adhesive Anchor System in Cracked and Uncracked Concrete, described in Sections 2.0 through 7.0 of the master evaluation report ESR-2539, complies with the 2010 *Florida Building Code—Building* and the 2010 *Florida Building Code—Residential*, provided the design and installation are in accordance with the 2009 *International Building Code*® (IBC) provisions noted in the master report and the following provisions apply:

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

Use of the Chemofast STVK Adhesive Anchor System in Uncracked Concrete for compliance with the High-Velocity Hurricane Zone provisions of the 2010 *Florida Building Code—Building* and the 2010 *Florida Building Code—Residential* has not been evaluated, and is outside the scope of this report.

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

This supplement expires concurrently with the evaluation report, reissued February 2021.