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ESR-2845

Reissued 05/2018
This report is subject to renewal 05/2020.

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:

MKT METALL-KUNSTSTOFF-TECHNIK

AUF DEM IMMEL 2
WEILERBACH 67685
GERMANY

EVALUATION SUBJECT:

MKT VME/VM-ME EPOXY ADHESIVE ANCHOR SYSTEM IN CRACKED AND UNCRACKED CONCRETE

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

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

REPORT HOLDER:

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EVALUATION SUBJECT:

MKT VME/VM-ME EPOXY ADHESIVE ANCHOR SYSTEM IN CRACKED AND UNCRACKED CONCRETE

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)

Property evaluated:

Structural

2.0 USES

General:

The MKT VME/VM-ME epoxy adhesive anchors are used to resist static, wind or earthquake (IBC Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normal-weight concrete 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 and uncracked normal-weight concrete only with $^1/_2$-, $^5/_8$-, $^3/_4$-, $^7/_8$- and 1-inch-diameter (12.7, 15.9, 19.1, 22.2 and 25.4 mm) threaded steel rods and No. 4 through No. 8 steel reinforcing bars in core 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).

The anchor system complies with anchors as 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 Sections 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 MKT VME/VM-ME Epoxy Adhesive Anchor System is comprised of a two-component epoxy adhesive filled in cartridges, static mixing nozzles, dispensing tools, hole cleaning equipment and adhesive injection accessories.

MKT VME/VM-ME epoxy adhesive may be used with continuously threaded steel rods or deformed steel reinforcing bars. The primary components of the MKT VME/VM-ME Epoxy Adhesive Anchor System, including the epoxy adhesive cartridge, static mixing nozzle, the nozzle extension tube, dispensing tool and typical steel anchor elements, are shown in Figure 1 of this report. Manufacturer's printed installation instructions (MPII) and parameters, as included with each adhesive unit package, are replicated in Figure 2 of this report.

3.2 Materials:

3.2.1 MKT VME/VM-ME Epoxy Adhesive: MKT VME/VM-ME epoxy adhesive is an injectable two-component epoxy. The two components are separated by means of a labelled dual-cylinder cartridge. The two components combine and react when dispensed through a static mixing nozzle, supplied by, MKT which is attached to the cartridge. A nozzle extension tube is also packaged with the cartridge. The VME/VM-ME epoxy adhesive is available in 13-ounce (385 mL), 20-ounce (585 mL), and 47-ounce (1400 mL) cartridges. Each cartridge label is marked with the adhesive expiration date. The shelf life, as indicated by the expiration date, applies to an unopened cartridge when stored in accordance with the MPII, as illustrated in Figure 2 of this report.

3.2.2 Hole Cleaning Equipment: Hole cleaning equipment is comprised of steel wire brushes and air pump

supplied by MKT, and a compressed air nozzle. The equipment is shown in Figure 2 of this report.

3.2.3 Dispensers: VME/VM-ME epoxy adhesive must be dispensed with manual, pneumatic dispensers, or electric powered dispensers supplied by MKT.

3.2.4 Steel Anchor Elements:

3.2.4.1 Threaded Steel Rods: Threaded steel rods must be clean and continuously threaded (all-thread) in diameters as described in Table 4 and Figure 2 of this report. Specifications for grades of threaded rod, including the mechanical properties and corresponding nuts and washers, are described 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, SC1; or a minimum 0.0021-inch-thick (0.053 mm) mechanically deposited zinc coating complying with ASTM B695, Class 55; or hot dip galvanized zinc coating complying with ASTM A153, Class C or D. The stainless steel threaded rods must comply with ASTM F593. Steel grades and material types (carbon, stainless) of the washers and nuts must be matched to the threaded rods. Threaded steel rods must be straight and free of indentations or other defects along their length. The embedded end may be either flat cut or cut on the bias to a chisel point.

3.2.4.2 Steel Reinforcing Bars: Steel reinforcing bars are deformed reinforcing bars (rebars), as described in Table 3 of this report. Table 4 and Figure 2 of this report 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 the 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 the reduction of area must be at least 30 percent. Steel elements with a tested elongation of less than 14 percent or a reduction of area less than 30 percent, or both, are considered brittle. Values for various steel materials are provided in Tables 2 and 3 of this report. Where values are nonconforming or unstated, the steel element must be considered brittle.

3.3 Concrete:

Normal-weight concrete 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).

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 and 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 (ACI 318) 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 based on ACI 318-14 for use with the 2015 IBC and ACI 318-11 for use with the 2012, 2009 and 2006 IBC unless noted otherwise in Section 4.1.1 through 4.1.11 of this report.

Design parameters are provided in Tables 4 through Table 7. 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 IBC, ACI 318-15 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 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are provided in Table 4 of this report for the anchor element types included in this report. See Table 1.

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 318-14 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 given in the tables 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. See Table 1. For anchors in lightweight concrete see ACI 318-14 17.2.6 or ACI 318-11 D.3.6, as applicable. The value of f'_c used for calculation must be limited to 8,000 psi (55 MPa) in accordance with ACI 318-14 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, as applicable. Bond strength values are a function of concrete compressive strength, concrete state (cracked, uncracked), drilling method (hammer-drill, core drilling) and installation conditions (dry concrete, water-saturated concrete, water-filled holes).

Bond strength values shall be multiplied by the associated strength reduction factor ϕ_{nn} and must be modified with the factor κ_{nn} for cases where holes are drilled in water-saturated concrete (κ_{ws}) or where the holes are water-filled at the time of anchor installation (κ_{wf}), as follows:

CONCRETE STATE	DRILLING METHOD	PERMISSIBLE INSTALLATION CONDITIONS	BOND STRENGTH	ASSOCIATED STRENGTH REDUCTION FACTOR
Cracked	Hammer-drill	Dry concrete	$\tau_{k,cr}$	ϕ_d
		Water-saturated concrete	$\tau_{k,cr} \cdot K_{ws}$	ϕ_{ws}
		Water-filled hole (flooded)	$\tau_{k,cr} \cdot K_{wf}$	ϕ_{wf}
Uncracked	Hammer-drill	Dry concrete	$\tau_{k,uncr}$	ϕ_d
		Water-saturated concrete	$\tau_{k,uncr} \cdot K_{ws}$	ϕ_{ws}
		Water-filled hole (flooded)	$\tau_{k,uncr} \cdot K_{wf}$	ϕ_{wf}
Uncracked	Core Drill	Dry concrete	$\tau_{k,uncr}$	ϕ_d
		Water-saturated concrete	$\tau_{k,uncr} \cdot K_{ws}$	ϕ_{ws}
		Water-filled hole (flooded)	$\tau_{k,uncr} \cdot K_{wf}$	ϕ_{wf}

The bond strength values in Table 6, for hammer-drilled holes, and in Table 7, for core drilled holes, 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 55.2 MPa), the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.12}$ [For **SI**: $(f'_c / 17.2)^{0.12}$]. 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 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 factors, ϕ, in accordance with ACI 318-14 17.2.3 or ACI 318-11 D.4.3, as applicable, are given in Table 4 of this report for the anchor element types included in this report. See Table 1.

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 of this report. See Table 1. 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 Table 4 of this report 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 must 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 5 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:

MAXIMUM TORQUE SUBJECT TO EDGE DISTANCE			
NOMINAL ANCHOR SIZE, d	MIN. EDGE DISTANCE, c_{min}	MIN. ANCHOR SPACING, s_{min}	MAXIMUM TORQUE, T_{max}
all sizes	5d	5d	$1.0 \cdot T_{max}$
$^3/_8$ in. to 1 in. (9.5 mm to 25.4 mm)	1.75 in. (45 mm)	5d	$0.45 \cdot T_{max}$
$1^1/_4$ in. (31.8 mm)	2.75 in. (70 mm)		

For values of T_{max}, see Table 8 and Figure 2 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 or Eq. D-27a for ACI 318-11)

where

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

$\tau_{k,uncr}$ = 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 Table 4 for the anchor element types included in this report. The nominal bond strength $\tau_{k,cr}$ need not be adjusted by $\alpha_{N,seis}$ since for the MKT VME/VM-ME,$\alpha_{N,seis}$ = 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 Table 8 of this report. Installation must be in accordance with ACI 318 D.9.1 and D.9.2. Anchor locations must comply with this report and the plans and specifications approved by the code official. Installation of the MKT VME/VM-ME Epoxy Adhesive Anchor System must be in accordance with the Manufacturer's printed installation instructions (MPII) included in each unit package as described in Figure 2 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, Section 1704.15 and Table 1704.4 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 dimensions, concrete type, concrete compressive strength, hole dimensions, adhesive identification and expiration date, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque and adherence to the manufacturer's printed installation instructions (MPII).

The special inspector must verify the initial installations of each type and size of adhesive anchor by construction personnel on the site. Subsequent installations of the same anchor type and size by the same cons
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 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 MKT VME/VM-ME Epoxy 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. NSF/ANSI Standard 61 listing is provided by NSF International.

5.0 CONDITIONS OF USE

The MKT VME/VM-ME Epoxy Adhesive Anchor System described in this report complies with or is a suitable alternative to what is specified in, the codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 MKT VME/VM-ME epoxy adhesive anchors must be installed in accordance with the Manufacturer's printed installation instructions (MPII) as attached to each cartridge and described in Figure 2 of this report.

5.2 The anchors described in this report must be installed in cracked or 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).

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 installation instructions provided in Figure 2 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 MKT VME/VM-ME epoxy adhesive anchors are recognized for use to resist short- and long-term loads, including wind and earthquake loads, subject to the conditions of this report.

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

5.8 The anchors 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 may be installed in normal-weight concrete that is cracked or that may be expected to crack during the service life of the anchor when installed in hammer-drilled holes. The anchors with $^3/_8$-inch-diameter (9.5 mm) and No. 3 steel reinforcing bars are limited to installation in uncracked concrete when installed in hammer-drilled holes. The anchors with $^1/_2$-, $^5/_8$-, $^3/_4$-, $^7/_8$- and 1-inch-diameter (12.7, 15.9, 19.1, 22.2 and 25.4 mm) threaded steel rods and No. 4 through No. 8 steel reinforcing bars are limited to installation in uncracked concrete when installed in core drilled holes. See Table 1 of this report.

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

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

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

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

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

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

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

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

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

5.17 Periodic special inspection must be provided in accordance with Section 4.3 of this report. Continuous special inspection for anchors installed in horizontal or upwardly inclined orientations must be provided in accordance with Section 4.3 of this report.

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

5.19 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**.**

5.20 MKT VME/VM-ME epoxy 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 October 2017, which incorporates requirements in ACI 355.4-11, including, but not limited to, tests under freeze/thaw conditions (Table 3.2, test series 6), tests under sustained load (Table 3.2, test series 7), tests for installation direction (Table 3.2, test series 8), tests for resistance to alkalinity (Table 3.2, test series 13a) and tests for resistance to sulfur (Table 3.2, test series 13b).

7.0 IDENTIFICATION

MKT VME/VM-ME epoxy adhesive is identified by packaging labeled with the MKT VME/VM-ME name and address, the product name, the lot number, the expiration date, and the evaluation report number (ESR-2845). 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 Table 2 and Table 3 of this report.

TABLE 1—DESIGN TABLE INDEX

DESIGN STRENGTH[1]			THREADED ROD (FRACTIONAL)	DEFORMED REINFORCING BAR
Steel	N_{sa}, V_{sa}		Table 4	Table 4
Concrete	N_{cb}, N_{cbg}, V_{cb}, V_{cbg}, V_{cp}, V_{cpg}		Table 5	Table 5
Bond[2]	N_a, N_{ag}	Hammer-drilled holes	Table 6	Table 6
		Diamond cored holes	Table 7	Table 7

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

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

THREADED ROD SPECIFICATION		UNITS	MINIMUM SPECIFIED ULTIMATE STRENGTH, f_{uta}	MIN. SPECIFIED YIELDSTRENGTH 0.2 PERCENT OFFSET, f_{ya}	$\frac{f_{uta}}{f_{ya}}$	ELONGATION MINIMUM PERCENT[6]	REDUCTION OF AREA MINIMUM PERCENT	NUT SPECIFICATION[7]
Carbon Steel	ASTM A36[2] and F1554[3] Grade 36	psi (MPa)	58,000 (400)	36,000 (248)	1.61	23	40[8]	ASTM A194/A563 Grade A
	ASTM A193[4] Grade B7	psi (MPa)	125,000 (860)	105,000 (720)	1.19	16	50	ASTM A194/A563 Grade DH
Stainless Steel (Types 304 and 316)	ASTM F593[5] CW1 ($^3/_8$ to $^5/_8$ inch dia.)	psi (MPa)	100,000 (690)	65,000 (450)	1.54	20	-[9]	ASTM F594 Alloy Group 1, 2 or 3
	ASTM F593[5] CW2 ($^3/_4$ to $1^1/_4$ inch dia.	psi (MPa)	85,000 (590)	45,000 (310)	1.89	25	-[9]	

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

[1]Adhesive must be used with continuously threaded carbon or stainless steels (all-thread) that have thread characteristics comparable with ANSI B1.1 UNC Coarse Thread Series. Tabulated values correspond to anchor diameters included in this report.
[2]*Standard Specification for Carbon Structural Steel.*
[3]*Standard Specification for Anchor Bolts, Steel, 36-ksi Yield Strength.*
[4]*Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.*
[5]*Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.*
[6]Based on 2-inch (50 mm) gauge length except ASTM A193, which are based on a gauge length of 4d.
[7]Nuts of other grades and style having specified proof load stress greater than the specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than the minimum tensile strength of the specified threaded rod. Material types of the nuts and washers must be matched to the threaded rods.
[8]Minimum percent reduction of area reported in ASTM A36 is 50 percent.
[9]Minimum percent reduction of area not reported in the referenced ASTM standard.

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

REINFORCING SPECIFICATION	UNITS	MINIMUM SPECIFIED ULTIMATE STRENGTH, f_{uta}	MINIMUM SPECIFIED YIELD STRENGTH, f_{ya}
ASTM A615[2], A767[4], Grade 60	psi (MPa)	90,000 (620)	60,000 (414)
ASTM A706[3], A767[4], Grade 60	psi (MPa)	80,000 (550)	60,000 (414)

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

[1]Adhesive must be used with specified deformed reinforcing bars. Tabulated values correspond to bar sizes included in this report.
[2]*Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.* Bars may be considered ductile elements provided the actual yield strength based on mill tests does not exceed f_{ya} by more than 18,000 psi and the ratio of the actual tensile strength to actual yield strength is not less than 1.25.
[3]*Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.* Bars furnished to specification are considered ductile elements.
[4]*Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement*. Bars furnished to specification are considered brittle elements unless evidence is otherwise shown to the satisfaction of the registered design professional and code official in accordance with Section 3.2.4.3 of this report.

FIGURE 1—MKT VME/VM-ME EPOXY ADHESIVE ANCHOR SYSTEM INCLUDING TYPICAL STEEL ANCHOR ELEMENTS

TABLE 4—STEEL DESIGN INFORMATION FOR FRACTIONAL THREADED ROD AND REINFORCING BARS

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL ROD DIAMETER (inch)[1]						
				$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
Threaded rod nominal outside diameter		d	inch (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.250 (31.8)
Threaded rod effective cross-sectional area		A_{se}	inch² (mm²)	0.0775 (50)	0.1419 (92)	0.2260 (146)	0.3345 (216)	0.4617 (298)	0.6057 (391)	0.9691 (625)
ASTM A36 and F1554, Grade 36	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (kN)	4,495 (20.0)	8,230 (36.6)	13,110 (58.3)	19,400 (86.3)	26,780 (119.1)	35,130 (156.3)	56,210 (250.0)
		V_{sa}	lbf (kN)	2,245 (10.0)	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}	lbf (kN)	9,685 (43.1)	17,735 (78.9)	28,250 (125.7)	41,810 (186.0)	57,710 (256.7)	75,710 (336.8)	121,135 (538.8)
		V_{sa}	lbf (kN)	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 (Types 304 and 316)	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (kN)	7,750 (34.5)	14,190 (63.1)	22,600 (100.5)	28,430 (126.5)	39,245 (174.6)	51,485 (229.0)	82,370 (366.4)
		V_{sa}	lbf (kN)	3,875 (17.2)	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						

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL REINFORCING BAR SIZE (REBAR)							
				No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
Rebar nominal outside diameter		d	inch (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.125 (28.7)	1.250 (32.3)
Rebar effective cross-sectional area		A_{se}	inch² (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, Grade 60	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (kN)	9,900 (44.0)	18,000 (80.1)	27,900 (124.1)	39,600 (176.1)	54,000 (240.2)	71,100 (316.3)	90,000 (400.3)	114,300 (508.4)
		V_{sa}	lbf (kN)	5,940 (26.4)	10,800 (48.0)	16,740 (74.5)	23,760 (105.7)	32,400 (144.1)	42,660 (189.8)	54,000 (240.2)	68,580 (305.0)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	Not applicable	0.70	0.70	0.70	0.70	0.75	0.75	0.75
	Strength reduction factor for tension[2]	ϕ	-	0.65							
	Strength reduction factor for shear[2]	ϕ	-	0.60							
ASTM A706, Grade 60	Nominal strength as governed by steel strength (for a single anchor)	N_{sa}	lbf (kN)	8,800 (39.1)	16,000 (71.2)	24,800 (110.3)	35,200 (156.6)	48,000 (213.5)	63,200 (281.1)	80,000 (355.9)	101,600 (452.0)
		V_{sa}	lbf (kN)	5,280 (23.5)	9,600 (42.7)	14,880 (66.2)	21,120 (94.0)	28,800 (128.1)	37,920 (168.7)	48,000 (213.5)	60,960 (271.2)
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	Not applicable	0.70	0.70	0.70	0.70	0.75	0.75	0.75
	Strength reduction factor for tension[2]	ϕ	-	0.75							
	Strength reduction factor for shear[2]	ϕ	-	0.65							

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

[1]Values provided for fractional steel element 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 must be appropriate for the rod, as listed in Table 2 of this report.

[2]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 Section 9.2, as applicable, are used in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 5—CONCRETE BREAKOUT AND PRYOUT DESIGN INFORMATION FOR FRACTIONAL THREADED ROD AND REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT OR A CORE DRILL AND DIAMOND CORE BIT[1]

DESIGN INFORMATION	SYMBOL	UNITS	NOMINAL ROD DIAMETER (inch) / REINFORCING BAR SIZE							
			$^3/_8$ or #3	$^1/_2$ or #4	$^5/_8$ or #5	$^3/_4$ or #6	$^7/_8$ or #7	1 or #8	#9	$1^1/_4$ or #10
Effectiveness factor for cracked concrete	$k_{c,cr}$	- (SI)	Not Applicable	17 (7.1)						
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	- (SI)	24 (10.0)							
Minimum embedment	$h_{ef,min}$	inch (mm)	$2^3/_8$ (60)	$2^3/_4$ (70)	$3^1/_8$ (79)	$3^1/_2$ (89)	$3^1/_2$ (89)	4 (102)	$4^1/_2$ (114)	5 (127)
Maximum embedment	$h_{ef,max}$	inch (mm)	$4^1/_2$ (114)	6 (152)	$7^1/_2$ (191)	9 (229)	$10^1/_2$ (267)	12 (305)	$13^1/_2$ (343)	15 (381)
Minimum anchor spacing	s_{min}	inch (mm)	$1^7/_8$ (48)	$2^1/_2$ (64)	$3^1/_8$ (79)	$3^3/_4$ (95)	$4^3/_8$ (111)	5 (127)	$5^5/_8$ (143)	$6^1/_4$ (159)
Minimum edge distance	c_{min}	inch (mm)	5d;or see Section 4.1.9 of this report for design with reduced minimum edge distances							
Minimum member thickness	h_{min}	inch (mm)	h_{ef} + $1^1/_4$ (h_{ef} + 30)	h_{ef} + $2d_o$ [3]						
Critical edge distance—splitting (for uncracked concrete)	c_{ac}	inch (mm)	See Section 4.1.10 of this report							
Strength reduction factor for tension, concrete failure modes, Condition B[2]	ϕ	-	0.65							
Strength reduction factor for shear, concrete failure modes, Condition B[2]	ϕ	-	0.70							

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

[1]Additional setting information is described in the installation instructions, Figure 2 of this report.
[2]Condition A requires supplemental reinforcement, while Condition B applies where supplemental reinforcement is not provided or where pryout governs, as set forth in ACI 318-14 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 in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.
[3] d_o = hole diameter; for installation parameters see Table 8 of this report.

TABLE 6—BOND STRENGTH DESIGN INFORMATION FOR FRACTIONAL THREADED ROD AND REINFORCING BARS IN HOLES DRILLED WITH A HAMMER DRILL AND CARBIDE BIT[1]

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL ROD DIAMETER (inch) / REINFORCING BAR SIZE							
				$^3/_8$ or #3	$^1/_2$ or #4	$^5/_8$ or #5	$^3/_4$ or #6	$^7/_8$ or #7	1 or #8	#9	$1^1/_4$ or #10
Minimum embedment		$h_{ef,min}$	inch (mm)	$2^3/_8$ (60)	$2^3/_4$ (70)	$3^1/_8$ (79)	$3^1/_2$ (89)	$3^1/_2$ (89)	4 (102)	$4^1/_2$ (114)	5 (127)
Maximum embedment		$h_{ef,max}$	inch (mm)	$4^1/_2$ (114)	6 (152)	$7^1/_2$ (191)	9 (229)	$10^1/_2$ (267)	12 (305)	$13^1/_2$ (343)	15 (381)
Temperature Range A [2,3,4]	Characteristic bond strength in cracked concrete[6]	$\tau_{k,cr}$	psi (N/mm^2)	Not applicable	440 (3.0)	362 (2.5)	337 (2.3)	318 (2.2)	318 (2.2)	318 (2.2)	318 (2.2)
	Characteristic bond strength in uncracked concrete[7]	$\tau_{k,uncr}$	psi (N/mm^2)	968 (6.7)	909 (6.3)	870 (6.0)	834 (5.8)	807 (5.6)	783 (5.4)	763 (5.3)	748 (5.2)
Temperature Range B [2,3,4]	Characteristic bond strength in cracked concrete[6]	$\tau_{k,cr}$	psi (N/mm^2)	Not applicable	557 (3.8)	458 (3.2)	426 (2.9)	402 (2.8)	402 (2.8)	402 (2.8)	402 (2.8)
	Characteristic bond strength in uncracked concrete[7]	$\tau_{k,uncr}$	psi (N/mm^2)	1,225 (8.5)	1,151 (7.9)	1,101 (7.6)	1,056 (7.3)	1,021 (7.0)	991 (6.8)	966 (6.7)	946 (6.5)
Permissible Installation Conditions[5]	Dry concrete	ϕ_d	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	Water-saturated concrete	ϕ_{ws}	-	0.55	0.55	0.55	0.45	0.45	0.45	0.45	0.45
		κ_{ws}	-	1.0	1.0	1.0	1.0	1.0	1.0	0.99	0.97
	Water-filled hole (flooded)	ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
		κ_{ws}	-	0.89	0.80	0.73	0.68	0.63	0.60	0.57	0.55
Reduction factor for seismic tension		$\alpha_{N,seis}$	-	1.0							

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

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. For concrete compressive strength, f'_c between 2,500 psi and 8,000 psi, the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.12}$ [For **SI:** $(f'_c / 17.2)^{0.12}$]. See Section 4.1.4 of this report.
[2]**Temperature Range A**: Maximum long-term temperature = 110°F (43°C), maximum short-term temperature = 176°F (80°C). **Temperature Range B**: Maximum long-term temperature = 110°F (43°C), maximum short-term temperature = 140°F (60°C). The maximum short-term temperature may be increased to 162°F (72°C) for Temperature Range B provided characteristic bond strength are reduced by 10 percent.
[3]Short-term elevated concrete temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.
[4]Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short-term loads only such as wind or seismic, bond strengths may be increased by 75 percent for Temperature Range A and Temperature Range.
[5]Permissible installation conditions include dry concrete, water-saturated concrete and water-filled holes. Water-filled holes include applications in dry or water-saturated concrete where the drilled holes contain standing water at the time of anchor installation. For installation instructions see Figure 2 of this report.
[6]For structures assigned to Seismic Design Categories C, D, E or F, bond strength values for cracked concrete do not require an additional reduction factor applied ($\alpha_{N,seis}$ = 1.0). See Section 4.1.11 of this report.
[7]Bond strength values for uncracked concrete are applicable for structures assigned to Seismic Design Categories A and B only.

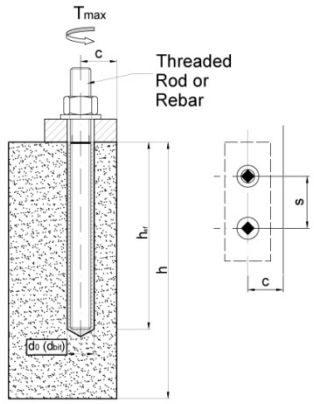
TABLE 7—BOND STRENGTH DESIGN INFORMATION FOR FRACTIONAL THREADED ROD AND REINFORCING BARS IN HOLES DRILLED WITH A CORE DRILL AND DIAMOND CORE BIT[1]

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL ROD DIAMETER (inch) / REINFORCING BAR SIZE				
				1/2 or #4	**5/8 or #5**	**3/4 or #6**	**7/8 or #7**	**1 or #8**
Minimum embedment		$h_{ef,min}$	inch (mm)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 1/2 (89)	4 (102)
Maximum embedment		$h_{ef,max}$	inch (mm)	6 (152)	7 1/2 (191)	9 (229)	10 1/2 (267)	12 (305)
Temperature Range A[2,3,4]	Characteristic bond strength in uncracked concrete[6]	$\tau_{k,uncr}$	psi (N/mm^2)	895 (6.2)	849 (5.9)	816 (5.6)	791 (5.5)	770 (5.3)
Temperature Range B[2,3,4]	Characteristic bond strength in uncracked concrete[6]	$\tau_{k,uncr}$	psi (N/mm^2)	1,133 (7.8)	1,075 (7.4)	1,033 (7.1)	1,002 (6.9)	975 (6.7)
Permissible Installation Conditions[5]	Dry concrete	ϕ_d	-	0.55	0.45	0.45	0.45	0.45
	Water-saturated concrete	ϕ_{ws}	-	0.55	0.45	0.45	0.45	0.45
		κ_{ws}	-	1.0	1.0	1.0	1.0	1.0
	Water-filled hole (flooded)	ϕ_{wf}	-	0.45	0.45	0.45	0.45	0.45
		κ_{wf}	--	0.94	0.95	0.95	0.95	0.96
Reduction factor for seismic tension		$\alpha_{N,seis}$		1.0				

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

[1]Bond strength values correspond to concrete compressive strength f'_c = 2,500 psi. For concrete compressive strength, f'_c between 2,500 psi and 8,000 psi, the tabulated characteristic bond strength may be increased by a factor of $(f'_c / 2{,}500)^{0.12}$ [For **SI:** $(f'_c / 17.2)^{0.12}$]. See Section 4.1.4 of this report.
[2]**Temperature Range A**: Maximum long-term temperature = 110°F (43°C), maximum short-term temperature = 176°F (80°C). **Temperature Range B**: Maximum long-term temperature = 110°F (43°C), maximum short-term temperature = 140°F (60°C). The maximum short-term temperature may be increased to 162°F (72°C) for Temperature Range B provided characteristic bond strength are reduced by 10 percent.
[3]Short-term elevated concrete temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling. Long-term concrete temperatures are roughly constant over significant periods of time.
[4]Characteristic bond strengths are for sustained loads including dead and live loads. For load combinations consisting of short-term loads only such as wind or seismic, bond strengths may be increased by 67 percent for Temperature Range A and for Temperature Range B.
[5]Permissible installation conditions include dry concrete, water-saturated concrete and water-filled holes. Water-filled holes include applications in dry or water-saturated concrete where the drilled holes contain standing water at the time of anchor installation. For installation instructions see Figure 2 of this report.
[6]Bond strength values for uncracked concrete are applicable for structures assigned to Seismic Design Categories A and B only.

TABLE 8—INSTALLATION PARAMETERS FOR FRACTIONAL THREADED ROD AND REINFORCING BARS



PARAMETER	SYMBOL	UNITS	NOMINAL ROD DIAMETER (inch) / REINFORCING BAR SIZE								
			3/8 or #3	**1/2 or #4**	**5/8 or #5**	**3/4 or #6**	**7/8 or #7**	**1 or #8**	**#9**	**1 1/4**	**#10**
Threaded rod outside diameter	d	inch (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	N/A[1]	1.250 (31.8)	N/A[1]
Rebar nominal outside diameter	d	inch (mm)	0.375 (9.5)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)	0.875 (22.2)	1.000 (25.4)	1.125 (28.7)	N/A[1]	1.250 (31.8)
Carbide drill bit nominal size	d_o (d_{bit})	inch	7/16	9/16	11/16 or 3/4	7/8	1	1 1/8	1 3/8	1 3/8	1 1/2
Diamond core bit nominal size	d_o (d_{bit})	inch	N/A[1]	5/8	3/4	7/8	1	1 1/8	N/A[1]	N/A[1]	N/A[1]
Minimum embedment	$h_{ef,min}$	inch (mm)	2 3/8 (60)	2 3/4 (70)	3 1/8 (79)	3 1/2 (89)	3 1/2 (89)	4 (102)	4 1/2 (114)	5 (127)	5 (127)
Maximum embedment	$h_{ef,max}$	inch (mm)	4 1/2 (114)	6 (152)	7 1/2 (191)	9 (229)	10 1/2 (267)	12 (305)	13 1/2 (343)	15 (381)	15 (381)
Max. torque	T_{max}	ft-lbs	15	33	60	105	125	165	165	280	280
Max. torque[2] (low strength rod)	T_{max}	ft-lbs	10	25	50	90					
Minimum anchor spacing	s_{min}	inch (mm)	1 7/8 (48)	2 1/2 (64)	3 1/8 (79)	3 3/4 (95)	4 3/8 (111)	5 (127)	5 5/8 (143)	6 1/4 (159)	6 1/4 (159)
Minimum edge distance	c_{min}	inch (mm)	5d;or see Section 4.1.9 of this report for installation parameters with reduced minimum edge distances								
Minimum member thickness	h_{min}	inch (mm)	h_{ef} + 1 1/4 (h_{ef} + 30)		h_{ef} + 2d_o						

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

[1]N/A = Not Applicable.
[2]These values apply to ASTM A36 / F1554, Grade 36 threaded rods.

MKT VME / VM-ME Instruction Card

DESCRIPTION:
VME / VM-ME is an easy dispensing, high strength, 100% solids epoxy anchoring adhesive which is formulated for use in anchoring applications by trained professionals. Please refer to MKT 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 95°F (35°C). Keep away from excessive heat and flame. Keep partially used containers closed when not in use. Protect from damage. Store away from heat and light.

Note expiration date on product label before use. Do not use expired product. Cartridge temperature must be between 41°F - 104°F (5°C - 40°C) when in use. Partially used cartridges may be stored with hardened adhesive in the attached mixing nozzle. If the cartridge is reused, attach a new mixing nozzle and discard the initial quantity of the anchor adhesive as described in the setting instructions (steps #3 and #5).

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5. Adhesive piston plugs

Threaded rod diameter (inch)	Rebar size (no.)	ANSI drill bit diameter (inch)	Plug No	Plastic Plug (Cat. #)	Horizontal and overhead installations
5/8	#5	11/16	11/16	85918201	
		3/4	3/4	85920201	
3/4	#6	7/8	7/8	85922101	
7/8	#7	1	1	85925201	
1	#8	1-1/8	1-1/8	85928101	
1-1/4	#9	1-3/8	1-3/8	85935201	
-	#10	1-1/2	1-1/2	85938201	

A plastic extension tube (3/8" dia. Cat #85952101) must be used with piston plugs.

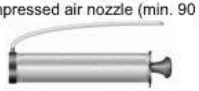
1. Hole cleaning tools - wire brushes and air blowers

Threaded rod diameter (inch)	Rebar size (no.)	Hammer-drill bit / core bit diameter (inch)	Min. brush dia., D_{min} (inches)	Brush length, L (inches)	Steel wire brush (Cat. #)
3/8	#3	7/16	0.475	6-3/4	33512101
1/2	-	9/16	0.600	6-3/4	33514101
-	#4	5/8	0.708	6-3/4	33516101
5/8	#5	11/16	0.735	7-7/8	33518101
		3/4	0.790	7-7/8	33520101
3/4	#6	7/8	0.920	7-7/8	33522101
7/8	#7	1	1.045	11-7/8	33526101
1	#8	1-1/8	1.175	11-7/8	33528101
1-1/4	#9	1-3/8	1.425	11-7/8	33535101
-	#10	1-1/2	1.550	11-7/8	33537101

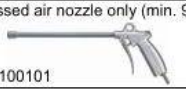
A brush extension (Cat.#33968101) must be used with a steel wire brush for holes drilled deeper than the listed brush length.

Air blowers

Hand pump (volume 25 fl. oz.), Cat #33200101 or compressed air nozzle (min. 90 psi)



Compressed air nozzle only (min. 90 psi)



Cat #33100101

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

2. Gel (working) times and curing times

Temperature of base material		Gel (working) time	Full curing time
41°F	5°C	180 minutes	50 hours
50°F	10°C	120 minutes	30 hours
68°F	20°C	30 minutes	10 hours
86°F	30°C	20 minutes	6 hours
95°F	35°C	15 minutes	5 hours
105°F[2]	40°C[2]	12 minutes	4 hours

[2] Only valid for vertical downwards installation

3. Installation parameters - Specifications for installation of threaded rods and reinforcing bars

Anchor property / Setting information	Threaded rod (inch) / reinforcing bar size (rebar)									
	3/8 or #3	1/2	#4	5/8 or #5	3/4 or #6	7/8 or #7	1 or #8	#9	1-1/4	#10
d = Threaded rod outside diameter (in.)	0.375	0.500	0.500	0.625	0.750	0.875	1.000	-	1.250	-
d = Nominal rebar diameter (in.)	0.375	0.500	0.500	0.625	0.750	0.875	1.000	1.125	-	1.250
d_o (d_{bit}) = Nominal ANSI drill bit size (in.)	$^7/_{16}$	$^9/_{16}$	$^5/_8$	$^{11}/_{16}$ or $^3/_4$	$^7/_8$	1	$1^1/_8$	$1^3/_8$	$1^3/_8$	$1^1/_2$
d_o (d_{bit}) = Nominal diamond core bit size (in.)	$^7/_{16}$	$^9/_{16}$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_8$	$1^3/_8$	$1^3/_8$	$1^1/_2$
$h_{ef,min}$ = Minimum embedment (inches)	$2^3/_8$	$2^3/_4$	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^1/_2$	4	$4^1/_2$	5	5
$h_{ef,max}$ = Maximum embedment (inches)	$4^1/_2$	6	6	$7^1/_2$	9	$10^1/_2$	12	$13^1/_2$	15	15
s_{min} = Minimum spacing (inches)	$1^7/_8$	$2^1/_2$	$2^1/_2$	$3^1/_8$	$3^3/_4$	$4^3/_8$	5	$5^5/_8$	$6^1/_4$	$6^1/_4$
c_{min} = Minimum edge distance (inches)	$1^3/_4$	$1^3/_4$	$1^3/_4$	$1^3/_4$	$1^3/_4$	$1^3/_4$	$1^3/_4$	$2^3/_4$	$2^3/_4$	$2^3/_4$
h_{min} = Minimum member thickness (inches)	h_{ef} + 1-1/4			h_{ef} + $2d_o$						
T_{max} = Maximum torque (ft.-lb.)	15	33	33	60	105	125	165	165	280	280
T_{max} = Maximum torque (ft.-lb.) for low strength steel **only**	10	25	25	50	90	125	165	165	280	280

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.

4. VME / VM-ME epoxy adhesive anchor system selection table

Injection tool	Plastic cartridge system	Extra mixing nozzle
VME / VM-ME 13 fl. oz. manual dispenser Cat. #28353015 or 28353201	VME / VM-ME 13 fl. oz. dual cartridge w/mixing nozzle and extension tube - Cat. #28255501	Mixing nozzle and extension tube Cat. #28305201 and 85952101
VME / VM-ME 13 & 20 fl. oz. manual dispenser Cat. #28353201	VME / VM-ME 20 fl. oz. dual cartridge w/mixing nozzle and extension tube - Cat. #28255601	Mixing nozzle and extension tube Cat. #28305201 and 85952101

A plastic extension tube (3/8" dia., Cat# 85952101) must be used for embedment depths greater than 7-1/2 inches.

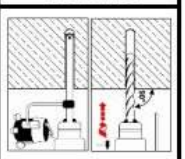
FIGURE 2—INSTALLATION INSTRUCTIONS

MKT VME / VM-ME – Instruction Card

Setting instructions for solid base material – For any application not covered by this document please contact MKT GmbH & Co.KG **ESR-2845**

SELECT HAMMER DRILLING OR CORE DRILLING AS SUITABLE FOR APPLICATION

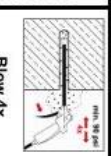
HAMMER DRILLING



1. Drill a hole into the base material with rotary hammer drill to the size and embedment required by the selected steel hardware element (see Table 3). Tolerances of carbide drill bits must meet ANSI Standard B212.15. Precaution: Wear suitable eye and skin protection. Avoid inhalation of dusts during drilling and/or removal. (see dust extraction equipment by MKT to minimize dust emissions)

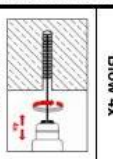
Note: In case of standing water in the drilled bore hole (flooded hole), all the water has to be removed from the hole (e.g. vacuum, compressed air, etc.) prior to cleaning.

HOLE CLEANING HAMMER DRILLED HOLES



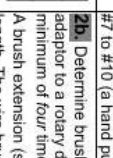
2a. Starting from the bottom or back of the drilled anchor hole, blow the hole clean (free of noticeable dust) a minimum of *four* times (**4x**).

Use a compressed air nozzle (min. 90 psi) **or** a hand pump (min. volume 25 fl. oz. supplied by MKT) for anchor rod 3/8" to 3/4" diameter or reinforcing bar (rebar) sizes #3 to #6. Use a compressed air nozzle only (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 large anchor sizes).



2b. Determine brush diameter (see Table 1) 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**).

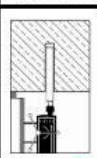
A brush extension (supplied by MKT) must be used for holes drilled deeper than the listed brush length. The wire brush diameter must be checked periodically during use ($Ø_{brush} > D_{min.}$, see Table 1). The brush should resist insertion into the drilled hole, if not the brush is too small and must be replaced with the proper brush diameter.



2c. **Repeat Step 2a** again by blowing the hole clean a minimum of *four* times (**4x**).

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

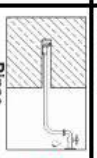
CORE DRILLING



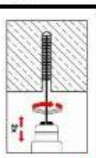
1. Drill a hole into the base material with core drill to the size and embedment required by the selected steel hardware element (see Table 3).

Precaution: Wear suitable eye and skin protection. Avoid inhalation of dusts during drilling and/or removal.

HOLE CLEANING CORE DRILLED HOLES

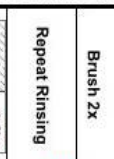


2a. Starting from the bottom or back of the drilled anchor hole, rinse the hole clean with water (water line pressure) until clear water comes out.



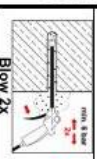
2b. Determine brush diameter (see Table 1) for the drilled hole and attach the brush with adaptor to a rotary drill tool or battery screw gun. Brush the hole with the selected wire brush a minimum of *two* times (**2x**).

A brush extension (supplied by MKT) must be used for holes drilled deeper than the listed brush length. The wire brush diameter must also be checked periodically during use ($Ø_{brush} > D_{min.}$, see Table 1). 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. **Repeat Step 2a** again by rinse the hole clean with water.

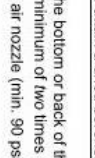
Following this remove all standing water completely (e.g. vacuum, compressed air, etc.) prior to further cleaning. To attain a dried borehole a MKT compressed air nozzle is recommended.



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

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

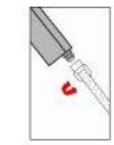
2e. **Repeat Step 2b** again by brushing the hole with a wire brush a minimum of *two* times (**2x**).



2f. **Repeat Step 2d** again by blowing the hole clean a minimum of *two* times (**2x**).

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

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 41°F - 104°F (5°C - 40°C) when in use. Review published working and cure times. Consideration should be given to the reduced gel (working) time of the adhesive in warm temperatures. For the permitted range of the base material temperature see Table 2.

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

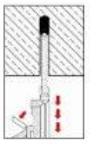
Note: *Always use a new mixing nozzle with new cartridges of adhesive and also for all work interruptions exceeding the published gel (working) time of the adhesive.*

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

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

Review and note the published working and cure times (see Table 2) prior to injection of the mixed adhesive into the cleaned anchor hole.

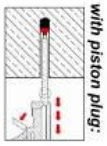
INSTALLATION



6. Fill the cleaned hole approximately two-thirds full with mixed adhesive starting from the bottom or back of the anchor hole. Slowly withdraw the mixing nozzle as the hole fills to avoid creating air pockets or voids. For each application a plastic extension tube supplied by MKT must be used with the mixing nozzle (see Table 4).

Piston plugs (see Table 5) must be used with and attached to mixing nozzle and extension tube for horizontal and overhead installations with anchor rod from 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 MKT. Contact MKT for details prior to use.*

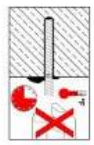


7. The anchor should be free of dirt, grease, oil or other foreign material. Push clean threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. Observe the gel (working) time.

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). Max installation temperature for overhead and horizontal instruction is 95°F (35°C)

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 2).

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 3) by using a calibrated torque wrench.

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

FIGURE 2—INSTALLATION INSTRUCTIONS (Continued)

ICC-ES Evaluation Report

ESR-2845 FBC Supplement

Reissued May 2018

This report is subject to renewal May 2020.

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

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

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EVALUATION SUBJECT:

MKT VME/VM-ME EPOXY ADHESIVE ANCHOR SYSTEM IN CRACKED AND UNCRACKED CONCRETE

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the MKT VME/VM-ME epoxy adhesive anchors, recognized in ICC-ES master evaluation report ESR-2845, has also been evaluated for compliance with the codes noted below.

Applicable code editions:

- 2014 *Florida Building Code—Building*
- 2014 *Florida Building Code—Residential*

2.0 CONCLUSIONS

The MKT VME/VM-ME epoxy adhesive anchors, described in Sections 2.0 through 7.0 of the master evaluation report ESR-2845, comply with the *Florida Building Code—Building* and the *Florida Building Code—Residential*, provided the design and installation are in accordance with the *International Building Code®* (IBC) provisions noted in the master report, and the following conditions:

- Design wind loads must be based on Section 1609 of the *Florida Building Code—Building* or Section 301.2.1.1 of the *Florida Building Code—Residential*, as applicable.
- Load combinations must be in accordance with Section 1605.2 or Section 1605.3 of the *Florida Building Code—Building*, as applicable.

Use of the MKT VME/VM-ME epoxy adhesive anchors with stainless steel threaded rod materials has also been found to be in compliance with the High-Velocity Hurricane Zone provisions of the *Florida Building Code—Building* and the *Florida Building Code—Residential* when the following conditions are met:

- The design wind loads for use of the anchors in the High-velocity Hurricane Zone are based on Section 1620 of the *Florida Building Code—Building,* as applicable.

Use of the MKT VME/VM-ME epoxy adhesive anchors with carbon steel threaded rod materials and reinforcing bars for compliance with the High-velocity Hurricane Zone provisions of the *Florida Building Code—Building* and the *Florida Building Code—Residential* has not been evaluated and is outside the scope of this supplemental report.

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

This supplement expires concurrently with the master report, reissued May 2018.