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# ICC-ES Report

# ESR-3411

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Reissued 05/2017
This report is subject to renewal 05/2018.

**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

**BORNFELDSTRASSE 2**
**CH-4603 OLTEN**
**SWITZERLAND**

**EVALUATION SUBJECT:**

## MUNGO MIT 600RE

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# ICC-ES Evaluation Report

**ESR-3411**

*Reissued May 2017*

*This report is subject to renewal May 2018.*

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**BORNFELDSTRASSE 2**
**CH-4603 OLTEN**
**SWITZERLAND**
**+41 62 206 75 75**
**www.mungo.ch**

**EVALUATION SUBJECT:**

**MUNGO MIT 600RE**

## 1.0 EVALUATION SCOPE

**Compliance with the following codes:**

- 2012, 2009 and 2006 *International Building Code*® (IBC)
- 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

### 2.1 General:

The Mungo MIT 600RE 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) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

The anchor system complies with anchors as described in Section 1909 of the 2012 IBC and is an alternative to cast-in-place anchors described in 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 Mungo MIT 600RE 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.

Mungo MIT 600RE epoxy adhesive may be used with continuously threaded steel rods or deformed steel reinforcing bars. The primary components of the Mungo MIT 600RE Epoxy Adhesive Anchor System, including the epoxy adhesive cartridge, static mixing nozzle, the nozzle extension tube, dispensing tool and typical steel anchor elements, are shown in Figure 2 of this report. Manufacturer's printed installation instructions (MPII) and parameters, as included with each adhesive unit package, are replicated in Figure 2 of this report.

### 3.2 Materials:

**3.2.1 Mungo MIT 600RE Epoxy Adhesive:** MIT 600RE epoxy adhesive is an injectable two-component epoxy. The two components are separated by means of a labeled dual-cylinder cartridge. The two components combine and react when dispensed through a static mixing nozzle, supplied by Mungo Befestigungstechnik AG, which is attached to the cartridge. A nozzle extension tube is also packaged with the cartridge. The Mungo MIT 600RE 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 Mungo Befestigungstechnik AG, and a compressed air nozzle. The equipment is shown in Figure 2 of this report.

**3.2.3 Dispensers:** Mungo MIT 600RE epoxy adhesive must be dispensed with manual, pneumatic dispensers, or electric powered dispensers supplied by Mungo Befestigungstechnik AG.

**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 Section 7.3.2 of ACI 318, with the additional condition that the bars must be bent cold, and heating of the reinforcing bars to facilitate field bending is not permitted.

**3.2.4.3 Ductility:** In accordance with ACI 318 D.1, in order for a steel anchor element to be considered ductile, the tested elongation must be at least 14 percent and the reduction of area must be at least 30 percent. Steel elements with a tested elongation of less than 14 percent or a reduction of area less than 30 percent, or both, are considered brittle. Values for various steel materials are provided in Tables 2 and 3 of this report. Where values are nonconforming or unstated, the steel element must be considered brittle.

**3.3 Concrete:**

Normal-weight concrete must comply with Sections 1903 and 1905 of the IBC, as applicable. The specified compressive strength of the concrete must be from 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa) [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 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 D.4.1, except as required in ACI 318 D.3.3.

Design parameters are based on 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, $\phi$, as given in ACI 318-11 D.4.3 must be used for load combinations calculated in accordance with Section 1605.2 of the IBC or Section 9.2 of ACI 318. Strength reduction factors, $\phi$, as given in ACI 318 D.4.4 must be used for load combinations calculated in accordance with ACI 318 Appendix C.

**4.1.2 Static Steel Strength in Tension:** The nominal static steel strength of a single anchor in tension, $N_{sa}$, in accordance with ACI 318 D.5.1.2 and the associated strength reduction factors, $\phi$, in accordance with ACI D.4.3, 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 D.5.2 with the following addition:

The basic concrete breakout strength of a single anchor in tension, $N_b$, must be calculated in accordance with ACI 318 D.5.2.2 using the values of $k_{c,cr}$ and $k_{c,uncr}$ as given in the tables of this report. Where analysis indicates no cracking in accordance with ACI 318 D.5.2.6, $N_b$ must be calculated using $k_{c,uncr}$ and $\Psi_{c,N}$ = 1.0. See Table 1. For anchors in lightweight concrete see ACI 318 D.3.6. The value of $f'_c$ used for calculation must be limited to 8,000 psi (55 MPa) in accordance with ACI 318 D.3.7. Additional information for the determination of nominal bond strength in tension is given in Section 4.1.4 of this report.

**4.1.4 Static Bond Strength in Tension:** The nominal static bond strength of a single adhesive anchor or group of adhesive anchors in tension, $N_a$ or $N_{ag}$, must be calculated in accordance with ACI 318 D.5.5. 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 must be multiplied by the associated strength reduction factor $\phi_{nn}$ and must be modified with the factor $\kappa_{nn}$ for cases where holes are drilled in water-saturated concrete ($\kappa_{ws}$) or where the holes are water-filled at the time of anchor installation ($\kappa_{wf}$), as follows:

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

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) [minimum of 24 MPa is required

under ADIBC Appendix L, Section 5.1.1]. For concrete compressive strength, $f'_c$ between 2,500 psi and 8,000 psi (17.2 MPa and 55.2 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 $(f'_c / 2{,}500)^{0.12}$ [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 Equations (D-21) and (D-22).

**4.1.5 Static Steel Strength in Shear:** The nominal static steel strength of a single anchor in shear as governed by the steel, $V_{sa}$, in accordance with ACI 318 D.6.1.2 and strength reduction factors, $\phi$, in accordance with ACI 318 D.4.3 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 D.6.2 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 D.6.2.2 using the values of $d$ given in Table 4 of this report for the corresponding anchor steel in lieu of $d_a$ (2012 and 2009 IBC) and $d_o$ (2006 IBC). In addition, $h_{ef}$ must be substituted for $\ell_e$. In no case shall $\ell_e$ exceed 8$d$. The value of $f'_c$ must be limited to a maximum of 8,000 psi (55 MPa), in accordance with ACI 318 D.3.7.

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

**4.1.8 Interaction of Tensile and Shear Forces:** For designs that include combined tension and shear, the interaction of tension and shear loads must be calculated in accordance with ACI 318 D.7.

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

For anchors that will be torqued during installation, the maximum torque, $T_{max}$, must be reduced for edge distances less than 5 anchor diameters (5$d$). $T_{max}$ 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 | 5$d$ | 5$d$ | 1.0·$T_{max}$ |
| $^3/_8$ in. to 1 in. (9.5 mm to 25.4 mm) | 1.75 in. (45 mm) | 5$d$ | 0.45·$T_{max}$ |
| $1^1/_4$ 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 D.5.5.5, except as noted below:

For all cases where $c_{Na}/c_{ac}<1.0$, $\psi_{cp,Na}$ determined from ACI 318 Eq. D-27 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. D-27a, in lieu of ACI 318 D.8.6.

$$c_{ac}=h_{ef}\cdot\left(\frac{\tau_{k,uncr}}{1160}\right)^{0.4}\cdot\left[3.1 - 0.7\frac{h}{h_{ef}}\right] \qquad \text{(Eq. D-27a)}$$

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 D.3.3.

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 Mungo MIT 600RE, $\alpha_{N,seis}$ = 1.0.

As an exception to ACI 318 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 D.3.3.4.3(d).

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

The following exceptions apply to ACI 318 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 D.6.2 and D.6.3 need not be computed and ACI 318 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 D.6.2 and D.6.3 need not be computed and ACI 318 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 D.3.3.5.3(a) through (c) when the design strength of the anchors is determined in accordance with ACI 318 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 Mungo MIT 600RE 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.

**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 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, 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 construction personnel are permitted to be performed in the absence of the special inspector. Any change in the anchor product being installed or the personnel performing the installation requires an initial inspection. For ongoing installations over an extended period, the special inspector must make regular inspections to confirm correct handling and installation of the product.

Continuous special inspection of adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads must be performed in accordance with ACI 318 D.9.2.4.

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

**4.4 Compliance with NSF/ANSI Standard 61:**

The Mungo MIT 600RE 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 Mungo MIT 600RE 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** Mungo MIT 600RE 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 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) [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 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** Mungo MIT 600RE epoxy adhesive anchors are recognized for use to resist short- and long-term loads, including wind and earthquake, subject to the conditions of this report.

**5.7** 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, Mungo MIT 600RE 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 D.9.2.2 or D.9.2.3.

**5.19** Anchors shall not be used for applications 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** Mungo MIT 600RE 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 January 2016, 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

Mungo MIT 600RE epoxy adhesive is identified by packaging labeled with the Mungo Befestigungstechnik AG name and address, the product name, the lot number, the expiration date, and the evaluation report number (ESR-3411). 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 318-11 D.4.1.1.
[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—MUNGO MIT 600RE 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] | $\phi$ | - | 0.75 | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 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] | $\phi$ | - | 0.75 | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 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] | $\phi$ | - | 0.65 | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 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] | $\phi$ | - | 0.65 | | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 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] | $\phi$ | - | 0.75 | | | | | | | |
| | Strength reduction factor for shear[2] | $\phi$ | - | 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 318-11 Eq. (D-2) and Eq. (D-29). Nuts must be appropriate for the rod, as listed in Table 2 of this report.

[2]The tabulated value of $\phi$ applies when the load combinations of Section 1605.2 of the IBC, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318 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) | 5*d*;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] | $\phi$ | - | 0.65 | | | | | | | |
| Strength reduction factor for shear, concrete failure modes, Condition B[2] | $\phi$ | - | 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 D.4.3. The tabulated value of $\phi$ applies when the load combinations of Section 1605.2 of the IBC, or ACI 318 Section 9.2 are used in accordance with ACI 318 D.4.3. If the load combinations of ACI 318 Appendix C are used, the appropriate value of $\phi$ must be determined in accordance with ACI 318 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 | $\phi_d$ | - | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| | Water-saturated concrete | $\phi_{ws}$ | - | 0.55 | 0.55 | 0.55 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| | | $\kappa_{ws}$ | - | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.99 | 0.97 |
| | Water-filled hole (flooded) | $\phi_{wf}$ | - | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| | | $\kappa_{wf}$ | - | 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 [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1]. 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 $(f'_c / 2{,}500)^{0.12}$ [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 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]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.

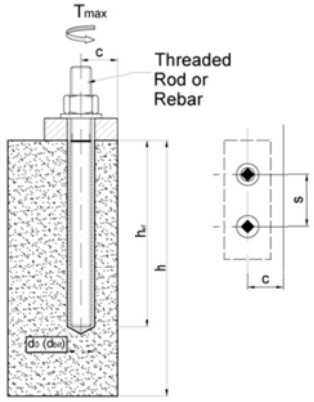
**TABLE 7—BOND STRENGTH DESIGN INFORMATION FOR FRACTIONAL THREADED ROD AND REINFORCING BARS IN HOLES DRILLED WITH A CORE DRILL AND DIAMOND CORE BIT[1]**

| 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 | $\phi_d$ | - | 0.55 | 0.45 | 0.45 | 0.45 | 0.45 |
| | Water-saturated concrete | $\phi_{ws}$ | - | 0.55 | 0.45 | 0.45 | 0.45 | 0.45 |
| | | $\kappa_{ws}$ | - | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| | Water-filled hole (flooded) | $\phi_{wf}$ | - | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| | | $\kappa_{wf}$ | -- | 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 [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1]. 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 $(f'_c / 2{,}500)^{0.12}$ [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 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) | 5$d$; 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.

# Mungo MIT600RE

# Instruction Card

**DESCRIPTION:**
MIT600RE 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 Chemofast 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 Size (inch) | Plastic Plug (Cat. #) | Horizontal and overhead installations |
|---|---|---|---|---|---|
| 1/2 | | 9/16 | 9/16 | 1710087 |  |
| | #4 | 5/8 | 5/8 | 1710088 | |
| 5/8 | #5 | 3/4 | 3/4 | 1710089 | |
| 3/4 | #6 | 7/8 | 7/8 | 1710090 | |
| 7/8 | #7 | 1 | 1 | 1710084 | |
| 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 | 1710086 | |

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

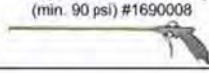
## 1. Hole cleaning tools - wire brushes and air blowers

| 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 | 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 | #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 |

**Air blowers**

Hand pump (volume 25 fl. oz.), Cat #1590011
or compressed air nozzle (min. 90 psi)

Compressed air nozzle only (min. 90 psi) #1690008



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

[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. C-RE 385 epoxy adhesive anchor system selection table

| Injection tool | Plastic cartridge system | Extra mixing nozzle |
|---|---|---|
| MIT600RE 13 fl. oz. manual dispenser Cat. #1710019 | MIT600RE 13 fl. oz. dual cartridge w/mixing nozzle and extension tube - Cat. #1710001 | Mixing nozzle and extension tube Cat. #1710064 |
| MIT600RE 13 & 20 fl. oz. manual dispenser Cat. #1710019 | MIT600RE 20 fl. oz. dual cartridge w/mixing nozzle and extension tube - Cat. #1710010 | Mixing nozzle and extension tube Cat. #1710064 |
| MIT600RE 47 fl. oz pneumatic tool Cat. #1710049 | MIT600RE 47 fl. Oz dual cartridge w/mixing nozzle and extension tube - Cat. #1710012 | Mixing nozzle and extension tube Cat. # 1710064 |

A plastic extension tube (3/8" dia., Cat# 1710064) must be used for embedment depths greater than 7-1/2 inches.

**FIGURE 2—MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII)**

**Setting instructions for solid base material – For any application not covered by this document please contact Mungo Befestigungstechnik AG**

**Mungo MIT600RE - Instruction Card**

**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 III). Tolerances of carbide drill bits must meet ANSI Standard B212.15. Precaution: Wear suitable eye and skin protection. Avoid inhalation of dusts during drilling and/or removal.

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**

*Blow 4x*

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 Mungo) 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).

*Brush 4x*

2b. Determine brush diameter (see Table I) 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 ($\varnothing_{brush} > D_{min}$, see Table I). 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.

*Repeat Blowing 4x*

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 III).

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

**HOLE CLEANING CORE DRILLED HOLES**

*Rinse*

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

*Brush 2x*

2b. Determine brush diameter (see Table I) 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 Mungo) must be used for holes drilled deeper than the listed brush length. The wire brush diameter must also be checked periodically during use ($\varnothing_{brush} > D_{min}$, see Table I). 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.

*Repeat Rinsing*

2c. **Repeat Step 2a** again by rinse/flushing 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 Powers compressed air nozzle is recommended.

*Blow 2x*

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).

*Repeat Brushing 2x*

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

*Repeat Blowing 2x*

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

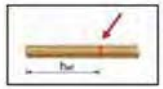
When finished the hole should be clean and free of dust, debris, ice, grease, oil or other foreign material. **→ Next go to Step 3.**

**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 II.

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

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



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

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

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

**INSTALLATION**

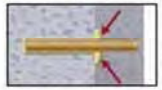
6. Fill the cleaned hole approximately two-thirds full with mixed adhesive starting from the bottom or back of the anchor hole. Slowly withdraw the mixing nozzle as the hole fills to avoid creating air pockets or voids. For embedment depths greater than 7-1/2" a plastic extension tube supplied by Mungo must be used with the mixing nozzle (see Table IV).

***with piston plug:***

Piston plugs (see Table V) 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 Mungo. 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). 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 ful curing time prior to applying any load (see Table II).

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

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

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

**FIGURE 2—MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII) (Continued)**