ICC-ES Evaluation Report

ESR-2786

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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:

fischer FIS V ADHESIVE ANCHORING SYSTEM FOR UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2009, 2006 and 2003 *International Building Code*® (IBC)
- 2009, 2006 and 2003 *International Residential Code*® (IRC)

Property evaluated:

Structural

2.0 USES

fischer FIS V Adhesive Anchors are used to resist static, wind, or earthquake (Seismic Design Categories A and B), tension and shear loads and seismic loads in uncracked normal-weight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

The anchor system is an alternative to cast-in-place anchors described in Sections 1911 and 1912 of the 2009 and 2006 IBC, and Sections 1912 and 1913 of the 2003 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 fischer FIS V Adhesive Anchor System is comprised of the following components:

- fischer FIS V adhesive packaged in cartridges
- Adhesive mixing and dispensing equipment
- Equipment for hole cleaning and adhesive injection

fischer FIS V adhesive may be used with continuously threaded rods or deformed steel reinforcing bars. The primary components of the fischer Adhesive Anchor System, including the fischer FIS V Adhesive, mixer and anchoring elements, are shown in Figure 2 of this report.

The manufacturer's printed installation instructions (MPII), included with each adhesive unit package, are replicated in Figure 3 of this report. The adhesive is referred to as "mortar" in the installation instructions.

3.2 Materials:

3.2.1 fischer FIS V Adhesive: fischer FIS V Adhesive is an injectable, vinylester adhesive. The two components are contained in a dual-chambered cartridge. The two components combine and react when dispensed through a static mixer attached to the manifold. The system is labeled FISCHER FIS V 360S [12.2 oz. (360 mL)] or FISCHER FIS V 950S [31.1 oz. (950 mL)]. In this report, both systems are denoted fischer FIS V. The cartridge is stamped with the adhesive expiration date. The shelf life, as indicated by the expiration date, assumes an unopened pack stored in a dry, dark environment. Storage temperature of the adhesive 41°F to 77°F (5°C to 25°C). Under these conditions the shelf life is 18 months.

3.2.2 Hole Cleaning Equipment: Hole cleaning equipment must be in accordance with Figure 3 of this report.

3.2.3 Dispensers: fischer FIS V adhesive must be dispensed with manual dispensers or pneumatic dispensers provided by fischerwerke.

3.2.4 Anchor Elements:

3.2.4.1 Threaded Steel Rods: Threaded steel rods must be clean, continuously threaded rods (all-thread) in diameters noted in Table 5 of this report. Specifications for permissible grades of threaded rods and associated nuts are provided in Table 2 and Table 3. Carbon steel threaded rods must be furnished with a 5 µm thick zinc electroplate coating complying with ASTM B633 SC 1. Threaded steel rods must be straight and free of indentations or other defects along their length. The end may be stamped with identifying marks and the embedded end may be flat cut or cut on the bias (chisel point).

3.2.4.2 Steel Reinforcing Bars: Steel reinforcing bars must be deformed reinforcing bars as described in Table 4 of this report. Table 8 summarizes reinforcing bar sizes. The embedded portions of reinforcing bars must be

straight, and free of mill scale, rust, mud, oil and other coatings 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 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 element to be considered ductile, the tested elongation must be at least 14 percent and reduction of area must be at least 30 percent. Steel elements with a tested elongation of less than 14 percent or a reduction of area of less than 30 percent, or both, are considered brittle. Values for various common steel materials are provided in Table 2 and Table 3. Where values are nonconforming or unstated, the steel must be considered brittle.

3.3 Concrete:

Normal-weight concrete must comply with Sections 1903 and 1905 of the IBC. The specified compressive strength of the concrete must be from 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: The design strength of anchors under the 2009, 2006 and 2003 IBC, as well as the 2009, 2006 and 2003 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.

Design parameters are based on the ACI 318-11 for use with the 2009, 2006 and 2003 IBC unless noted otherwise in Sections 4.1.1 through 4.1.11 of this report.

Design parameters are provided in Tables 5 through Table 10. Strength reduction factors, ϕ, as given in ACI 318-11 D.4.3 must be used for load combinations calculated in accordance with Section 1605.2 of the 2009 or 2006 IBC or Section 9.2 of ACI 318. Strength reduction factors, ϕ, 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 Section D.5.1.2 and the associated strength reduction factors, ϕ, in accordance with ACI 318 D.4.3 are provided in Tables 5 and 8 for the corresponding anchor steel.

4.1.3 Static Concrete Breakout Strength in Tension: The nominal static concrete breakout strength of a single anchor or a 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 $k_{c,uncr}$ as provided in Tables 6 and Table 9 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 318-11 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 318-11 D.5.5. Bond strength values are a function of the concrete compressive strength, the concrete temperature range, and the installation conditions (dry, water-saturated concrete). The resulting characteristic bond strength shall be multiplied by the associated strength reduction factor ϕ_{nn} as follows:

CONCRETE TYPE	PERMISSIBLE INSTALLATION CONDITIONS	BOND STRENGTH	ASSOCIATED STRENGTH REDUCTION FACTOR
Uncracked	Dry	τ_{uncr}	ϕ_d
	Water-saturated	τ_{uncr}	ϕ_{ws}

Strength reduction factors for determination of the bond strength are given in Tables 7 and 10 of this report. See Table 1. Adjustments to the bond strength may also be taken for increased concrete compressive strength as noted in the footnotes to the corresponding tables.

4.1.5 Static Steel Strength in Shear: The nominal static strength of an anchor in shear as governed by the steel, V_{sa}, in accordance with ACI 318 D.6.1.2 and strength reduction factor, ϕ, in accordance with ACI 318 D.4.3 are given in the tables outlined in Table 1 for the corresponding anchor steel.

4.1.6 Static Concrete Breakout Strength in Shear: The nominal static concrete breakout strength of a single anchor or group of anchors in shear, V_{cb}, or V_{cbg} must be calculated in accordance with ACI 318 D.6.2 based on information given in the tables outlined in 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 the tables outlined in Table 1 of this report for the corresponding anchor steel in lieu of d_a (2009 IBC) and d_0 (2006 IBC). In addition, h_{ef} must be substituted for ℓ_e. In no case shall ℓ_e exceed *8d.* The value of f'_c shall be limited to a maximum of 8,000 psi (55 MPa) in accordance with ACI 318 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 must be calculated in accordance with ACI 318 D.7.

4.1.9 Minimum Member Thickness h_{min}, Anchor Spacing s_{min} and 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 (see Table 6 and Table 9) must be observed for anchor design and installation. In lieu of ACI 318 D.8.5, the minimum member thickness, h_{min}, described in this report (see Table 6 and Table 9), must be observed for anchor design and installation. For adhesive anchors that will remain untorqued, ACI 318 D.8.4 applies.

4.1.10 Critical Edge Distance c_{ac}: In lieu of ACI 318 D.8.6, c_{ac} must be determined as follows:

$$c_{ac}=h_{ef}\cdot\left(\frac{\tau_{uncr}}{1160}\right)^{0.4}\cdot\left[3.1-0.7\frac{h}{h_{ef}}\right] \qquad \text{(D-43)}$$

where

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

τ_{uncr} = characteristic bond strength stated in the table of this report where by τ_{uncr} need not be taken as larger than:

$$\tau_{uncr} = \frac{k_{uncr}\sqrt{h_{ef} f_c'}}{\pi \cdot d_a}$$

4.1.11 Requirements for Seismic Design: The anchors may be used to resist seismic loads for structures classified under Seismic Design Categories A and B of the IBC or IRC only.

4.2 Installation:

Installation parameters are illustrated in Figure 1. Installation must be in accordance with ACI 318-11 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 fischer FIS V Adhesive Anchor System must conform to the manufacturer's printed installation instructions included in each unit package, as described in Figure 3 of this report.

4.3 Special Inspection:

Periodic special inspection must be performed where required in accordance with Sections 1704.4 and 1704.15 of the 2009 IBC or Section 1704.13 of the 2006 or 2003 IBC and this report.

The special inspector must be on the jobsite initially during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, adhesive identification and expiration date, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque and adherence to the manufacturer's published installation instructions. The special inspector must verify the initial installations of each type and size of adhesive anchor by construction personnel on-site. Subsequent installations of the same anchor type and size by the same construction personnel shall be 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 shall 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 shall 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.

5.0 CONDITIONS OF USE

The fischer FIS V Adhesive Anchor System described in this report is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 fischer FIS V adhesive anchors must be installed in accordance with the manufacturer's printed installation instructions included in the adhesive packaging and provided in Figure 3 of this report.

5.2 Anchors are limited to installation in concrete that is uncracked and may be expected to remain uncracked for the service life of the anchor. The anchors must be installed in uncracked normal-weight concrete having a specified compressive strength f'_c = 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

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

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

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

5.6 fischer FIS V adhesive anchors are recognized for use to resist short- and long-term loads, including wind and earthquake (Seismic Design Categories A and B only), subject to the conditions of this report.

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

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

5.9 Prior to 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.

5.10 Anchors are not permitted to support fire-resistive construction. Where not otherwise prohibited by the code, fischer FIS V adhesive anchors are permitted for installation in fire-resistive construction provided that at least one of the following conditions is fulfilled:

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

5.11 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.

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

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

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

5.15 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 to resist sustained tension loads must be provided in accordance with Section 4.3 of this report.

5.16 Installation of anchors in horizontal or upwardly inclined orientations to resist sustained tension loads

shall be performed by personnel certified by an applicable certification program in accordance with ACI 318 D.9.2.2 or D.9.2.3.

5.17 fischer FIS V adhesive is manufactured by fischerwerke GmbH & Co KG, Denzlingen, 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 February 2013.

7.0 IDENTIFICATION

7.1 fischer FIS V adhesive is identified by packaging labeled with the manufacturer's name (fischerwerke) and address, product name, lot number, expiration date, and evaluation report number (ESR-2786).

7.2 Threaded rods, nuts, washers, bolts, cap screws, and deformed reinforcing bars are standard elements and must conform to applicable national or international specifications as set forth in Tables 2 and 3 of this report.

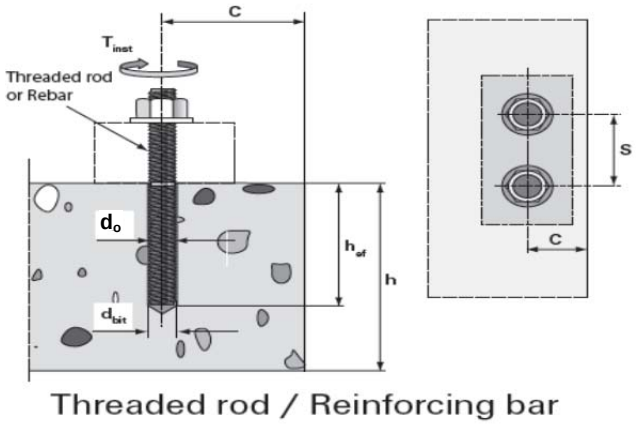

FIGURE 1—INSTALLATION PARAMETERS

TABLE 1—DESIGN TABLE INDEX

DESIGN STRENGTH[1]		THREADED ROD	DEFORMED REINFORCEMENT
		metric	fractional
Steel	N_{sa}, V_{sa}	Table 5	Table 8
Concrete	N_{cbg}, V_{cb}, V_{cbg}, V_{cp}, V_{cpg}	Table 6	Table 9
Bond[2]	N_a, N_{ag}	Table 7	Table 10

[1]Ref. ACI 318-11 D.4.1.1

[2]See Section 4.1 of this evaluation report

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

THREADED ROD SPECIFICATION		MINIMUM SPECIFIED ULTIMATE STRENGTH f_{UTA}	MINIMUM SPECIFIED YIELD STRENGTH 0.2% OFFSET f_{YA}	f_{UTA}/f_{YA}	ELONGATION, MIN.[4]	REDUCTION OF AREA, MIN.	SPECIFICATION FOR NUTS[5]
ISO 898-1[2] Class 5.8	MPa	500	400	1.25	10	35	DIN 934 (8-A2K) (Metric)
	psi	72,519	58,015				
ISO 898-1[3] Class 8.8	MPa	800	640	1.25	12	52	DIN 934 (8-A2K)
	psi	116,030	92,824				

[1]fischer FIS V must be used with continuously threaded carbon steel rod (all-thread) have thread characteristics comparable with ANSI B1.1 UNC Coarse Thread Series or ANSI B1.13M M Profile Metric Thread Series. Values for threaded rod types and associated nuts supplied by fischer are provided in this table.

[2]Standard Specifications for Carbon and Alloy Steel Externally Threaded Metric Fasteners.

[3]Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs.

[4]Based on 2-in. (50 mm) gauge length which are based on the gauge length of 4d and ISO 898, which is based on 5d.

[5]Nuts of other grades and styles having specified proof load stresses greater than the specified grade and style are also suitable. Nuts must have specified proof load stresses equal or greater than the minimum tensile strength of the specific threaded rods.

TABLE 3—SPECIFICATIONS AND PHYSICAL PROPERTIES OF COMMON STAINLESS STEEL THREADED ROD MATERIALS[1]

THREADED ROD SPECIFICATION		MINIMUM SPECIFIED ULTIMATE STRENGTH f_{UTA}	MINIMUM SPECIFIED YIELD STRENGTH 0.2% OFFSET f_{YA}	f_{UTA}/f_{YA}	ELONGATION, MIN.	REDUCTION OF AREA, MIN.	SPECIFICATION FOR NUTS[3]
ISO 3506-1[2] A4-70 M12 – M36	MPa	700	450	1.56	40	-	ISO 4032
	psi	101,780	65,430				

[1]fischer FIS V must be used with continuously threaded stainless steel rod (all-thread) have thread characteristics comparable with ANSI B1.1 UNC Coarse Thread Series or ANSI B1.13M M Profile Metric Thread Series. Values for threaded rod types and associated nuts supplied by fischer are provided in this table.

[2]Mechanical properties of corrosion resistant stainless steel fasteners – Part 1: Bolts, screws and studs.

[3]Nuts of other grades and styles having specified proof load stresses greater than the specified grade and style are also suitable. Nuts must have specified proof load stresses equal or greater than the minimum tensile strength of the specific threaded rods.

TABLE 4—SPECIFICATIONS AND PHYSICAL PROPERTIES OF COMMON STEEL REINFORCING BARS[1]

REINFORCING BAR SPECIFICATION		MINIMUM SPECIFIED ULTIMATE STRENGTH f_{UTA}	MINIMUM SPECIFIED YIELD STRENGTH f_{YA}
ASTM A615[1] Gr. 60	MPa	620	420
	psi	90,000	60,000

[1]Standard Specifications for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.

TABLE 5—STEEL DESIGN INFORMATION FOR METRIC THREADED ROD[1]

DESIGN INFORMATION		Symbol	Units	Nominal rod diameter (mm)						
				M8	M10	M12	M16	M20	M24	M30
ROD OUTSIDE DIAMETER		d	mm	8	10	12	16	20	24	30
			in.	0.31	0.39	0.47	0.63	0.79	0.94	1.18
ROD effective cross-sectional area		A_{se}	mm²	36.6	58.0	84.3	157	245	352	561
			in².	0.057	0.090	0.131	0.243	0.380	0.546	0.870
ISO 898-1 Class 5.8	Nominal strength as governed by steel strength	N_{sa}	kN	18.3	29	42.1	78.3	122.4	176.2	280.3
			lb	4,114	6,519	9,464	17,603	27,517	39,611	63,014
		V_{sa}	kN	9.1	14.3	21.1	39.2	61.2	88.1	140.2
			lb	2,046	3,215	4,743	8,813	13,758	19,806	31,518
	Strength reduction factor ϕ for tension[2]	ϕ	-	0.65						
	Strength reduction factor for ϕ for shear[2]	ϕ	-	0.60						
ISO 898-1 Class 8.8	Nominal strength as governed by steel strength	N_{sa}	kN	29.2	46.4	67.4	125.3	195.8	282	448.5
			lb	6,564	10,431	15,152	28,169	44,018	63,396	100,827
		V_{sa}	kN	14.6	23.2	33.7	62.7	97.9	141	224.2
			lb	3,282	5,216	7,576	14,096	22,009	31,698	50,402
	Strength reduction factor ϕ for tension[2]	ϕ	-	0.65						
	Strength reduction factor for ϕ for shear[2]	ϕ	-	0.60						
ISO 3506-1 Class A4 Stainless	Nominal strength as governed by steel strength	N_{sa}	kN	25.6	40.6	59.0	109.7	171.4	246.7	392.4
			lb	5,755	9,127	13,264	24,662	38,532	55,460	88,215
		V_{sa}	kN	12.8	20.3	29.5	54.8	85.7	123.4	196.2
			lb	2,878	4,564	6,632	12,320	19,266	27,741	44,108
	Strength reduction factor ϕ for tension[2]	ϕ	-	0.65						
	Strength reduction factor for ϕ for shear[2]	ϕ	-	0.60						

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

[1]Values provided for common rod material types are based on specified strength and calculated in accordance with ACI 318-11 Eq. (D-2) and Eq. (D-29). Nuts and washers must be appropriated for the rod.

[2]For use with load combinations of ACI 318 Section 9.2 as set forth in ACI 318 D.4.3.

TABLE 6—CONCRETE BREAKOUT DESIGN INFORMATION FOR METRIC THREADED ROD

DESIGN INFORMATION	SYMBOL	UNITS	NOMINAL ROD DIAMETER (MM)						
			M8	M10	M12	M16	M20	M24	M30
Embedment depth	$h_{ef,min}$	mm	64	80	96	128	160	192	240
		in.	$2^4/_8$	$3^1/_8$	$3^6/_8$	5	$6^2/_8$	$7^4/_8$	$9^4/_8$
	$h_{ef,max}$	mm	96	120	144	192	240	288	360
		in.	$3^6/_8$	$4^6/_8$	$5^5/_8$	$7^4/_8$	$9^4/_8$	$11^3/_8$	$14^1/_8$
Effectiveness factor for uncracked concrete	$k_{c,uncr}$	SI	10						
		in.-lb	24						
Maximum tightening torque	T_{inst}	Nm	10	20	40	50	120	150	300
		ft-lbs	7.5	15	30	45	90	110	220
Minimum anchor spacing	s_{min}	mm	40	45	55	62.5	85	105	140
		in.	$1^5/_8$	$1^6/_8$	$2^1/_8$	$2^4/_8$	$3^3/_8$	$4^1/_8$	$5^4/_8$
Minimum edge distance	c_{min}	mm	40	45	55	62.5	85	105	140
		in.	$1^5/_8$	$1^6/_8$	$2^1/_8$	$2^4/_8$	$3^3/_8$	$4^1/_8$	$5^4/_8$
Minimum member thickness	h_{min}	mm	$h_{min} \approx h_{ef} + \Delta d$ with Δd = max (30 mm, $2d_o$)$\geq$ 100 mm						
		in.	$h_{min} = h_{ef} + \Delta d$ with Δd = max (1.25 in, $2d_o$) $\geq$ 3.9 inches						
Critical edge distance – splitting (uncracked concrete)	c_{ac}	mm (in.)	See Section 4.1.10 of this report.						
Strength reduction factor for tension, concrete failure modes, Condition B[1]	ϕ	-	0.65						
Strength reduction factor for shear, concrete failure modes, Condition B[1]	ϕ	-	0.70						

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

[1] Values provided for post-installed anchors with category as determined from ACI 355.4 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 D4.3, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2., or ACI 318 Section 9.2 as set forth in ACI 318 D4.3. If the load combinations of ACI 318, Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D4.4.

TABLE 7—BOND STRENGTH DESIGN INFORMATION FOR METRIC THREADED ROD[1]

DESIGN INFORMATION		SYMBOL	UNITS	NOMINAL ROD DIAMETER (MM)						
				M8	M10	M12	M16	M20	M24	M30
Embedment depth		$h_{ef,min}$	mm	64	80	96	128	160	192	240
			in.	$2^4/_8$	$3^1/_8$	$3^6/_8$	5	$6^2/_8$	$7^4/_8$	$9^4/_8$
		$h_{ef,max}$	mm	96	120	144	192	240	288	360
			in.	$3^6/_8$	$4^6/_8$	$5^5/_8$	$7^4/_8$	$9^4/_8$	$11^3/_8$	$14^1/_8$
Temperature range A[3]	Characteristic bond strength in uncracked concrete[2]	$\tau_{k,uncr}$	N/mm²	12.3	12.3	11.7	10.7	10	9.4	8.8
			psi	1,784	1,784	1,697	1,552	1,450	1,363	1,276
Temperature range B[3]	Characteristic bond strength in uncracked concrete[2]	$\tau_{k,uncr}$	N/mm²	8	8	7.6	7	6.5	6.1	5.7
			psi	1,160	1,160	1,102	1,015	942	884	826
Strength reduction factor for permissible installation conditions	Dry concrete	Anchor category	-	1						
		ϕ_{dry}	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	Water saturated concrete	Anchor category	-	2			1			
		ϕ_{ws}	-	0.55	0.55	0.55	0.65	0.65	0.65	

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

[1]Bond strength values correspond to concrete compressive strength in the range 2,500 psi$\leq f'_c \leq$4,500 psi. For the range 4,500 psi$\leq f'_c \leq$6,500 psi tabulated characteristic bond strength may be increased by 9 percent and range 6,500 psi$\leq f'_c \leq$8,000 psi tabulated characteristic bond strength may be increased by 15 percent.

[2]Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind, bond strength may be increased 27 percent.

[3]Temperature range A: Maximum short term temperature = 176°F (80°C), Maximum long term Temperature = 122°F (50°C). Temperature range B: Maximum short term temperature = 248°F (120°C), Maximum long term Temperature = 162°F (72°C). Short term elevated concrete temperatures are those that occur over brief intervals, e.g., as a results of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

TABLE 8—STEEL DESIGN INFORMATION FOR U.S.: CUSTOMARY UNIT REINFORCING BARS[1]

DESIGN INFORMATION		SYMBOL	UNITS	BAR SIZE								
				#3	#4	#5	#6	#7	#8	#9	#10	#11
Nominal bar diameter		d	in.	$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_8$	$1^1/_4$	$1^3/_8$
			mm	9.5	12.7	15.9	19.1	22.2	25.4	28.6	31.8	34.9
Bar effective cross-sectional area		A_{se}	in².	0.11	0.2	0.31	0.44	0.6	0.78	1.0	1.27	1.48
			mm²	71	129	200	284	387	510	645	791	956
ASTM A 615 Gr. 60	Nominal strength as governed by steel strength	N_{sa}	kN	44.2	78.5	122.7	176.7	240.5	314.2	397.6	490.9	593.1
			lb	9,937	17,647	27,584	39,724	54,067	70,635	89,384	110,359	133,334
		V_{sa}	kN	26.5	47.1	73.6	106	144.3	188.5	238.6	294.5	355.8
			lb	5,957	10,588	16,546	23,830	32,440	42,376	53,639	66,206	79,987
	Strength reduction factor ϕ for tension[2)]	ϕ	0.65									
	Strength reduction factor ϕ for shear[2]	ϕ	0.60									

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

[1]Values provided for common reinforcement bars based on specified strength and calculated in accordance with ACI 318-11 Eq. (D-2) and Eq. (D-29). Nuts and washers must be appropriate for the rod.

[2]For use with the load combination of ACI 318, as set forth in ACI 318 D.4.3.

TABLE 9—CONCRETE BREAKOUT STRENGTH DESIGN INFORMATION FOR U.S.: CUSTOMARY UNIT REINFORCING BARS[1]

DESIGN INFORAMTION	SYMBOL	UNITS	BAR SIZE								
			#3	#4	#5	#6	#7	#8	#9	#10	#11
Embedment depth	$h_{ef,min}$	in.	3	4	5	6	7	8	9	10	11
		mm	76	101.6	127.2	152.8	177.6	203.2	228.8	254.4	279.2
	$h_{ef,max}$	in.	$4^4/_8$	6	$7^4/_8$	9	$10^4/_8$	12	$13^4/_8$	15	$16^4/_8$
		mm	114	152.4	190.8	229.2	266.4	304.8	343.2	381.6	418.8
Effectiveness factor	$k_{c,uncr}$	SI	10								
		in.-lb	24								
Minimum anchor spacing	s_{min}	mm	42.5	57.5	70	85	135	150	160	175	190
		in.	$1^5/_8$	$1^7/_8$	$2^6/_8$	$3^3/_8$	$5^3/_8$	$5^7/_8$	$6^2/_8$	$6^7/_8$	$7^4/_8$
Minimum edge distance	c_{min}	mm	42.5	57.5	70	85	135	150	160	175	190
		in.	$1^5/_8$	$1^7/_8$	$2^6/_8$	$3^3/_8$	$5^3/_8$	$5^7/_8$	$6^2/_8$	$6^7/_8$	$7^4/_8$
Member thickness	h_{min}	mm	$h_{min} = h_{ef} + \Delta d$ with Δd = max (30 mm, $2d_o$) ≥ 100 mm								
		in.	$h_{min} = h_{ef} + \Delta d$ with Δd = max (1.25 in, $2d_o$) ≥ 3.9 inches								
Critical edge distance – splitting (uncracked concrete)	c_{ac}	mm	See Section 4.1.10 of this report.								
		in.									
Strength reduction factor for tension, concrete failure modes, Condition B[1]	ϕ	-	0.65								
Strength reduction factor for shear, concrete failure modes, Condition B[1]	ϕ	-	0.70								

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

[1] Values provided for post-installed anchors with category as determined from ACI 355.4 given for Condition B. Condition B applies without supplementary reinforcement or where pullout (bond) or pryout govern, as set forth in ACI 318 Section D4.3, while condition A requires supplemental reinforcement. Values are for use with the load combinations of IBC Section 1605.2 or ACI 318 Section 9.2 as set forth in ACI 318 Section D4.3. If the load combinations of ACI 318, Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 Section D4.4.

TABLE 10—BOND STRENGTH DESIGN INFORMATION FOR U.S: CUSTOMARY UNIT REINFORCING BARS[1]

DESIGN INFORMATION		SYMBOL	UNITS	BAR SIZE								
				#3	#4	#5	#6	#7	#8	#9	#10	#11
Embedment depth		$h_{ef,min}$	in.	3	4	5	6	7	8	9	10	11
			mm	76	101.6	127.2	152.8	177.6	203.2	228.8	254.4	279.2
		$h_{ef,max}$	in.	$4^4/_8$	6	$7^4/_8$	9	$10^4/_8$	12	$13^4/_8$	15	$16^4/_8$
			mm	114	152.4	190.8	229.2	266.4	304.8	343.2	381.6	418.8
Temperature range A [3]	Characteristic bond strength in uncracked concrete[2]	$\tau_{k,uncr}$	N/mm²	12.3	11.5	10.7	10.1	9.6	9.3	8.9	8.6	8.4
			psi.	1.784	1.668	1.552	1.465	1.392	1.349	1.291	1.247	1.218
Temperature range B [3]	Characteristic bond strength in uncracked concrete[2]	$\tau_{k,uncr}$	N/mm²	8	7.5	7	6.6	6.3	6	5.8	5.6	5.4
			psi.	1,160	1,088	1,015	957	914	870	841	812	783
Strength reduction factor for permissible installation conditions	Dry concrete	Anchor category	-	1								
		ϕ_{dry}	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	Water saturated concrete	Anchor category	-	2		1						
		ϕ_{ws}		0.55	0.55	0.65	0.65	0.65	0.65	0.65	0.65	0.65

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

[1]Bond strength values correspond to concrete compressive strength in the range 2,500 psi≤ f'_c ≤4,500 psi. For the range 4,500 psi≤ f'_c ≤6,500 psi tabulated characteristic bond strength may be increased by 9 percent and range 6,500 psi≤ f'_c ≤8,000 psi tabulated characteristic bond strength may be increased by 15 percent.

[2]Characteristic bond strengths are for sustained loads including dead and live loads. For short-term loads including wind, bond strength may be increased 27 percent.

[3]Temperature range A: Maximum short term temperature = 176°F (80°C), Maximum long term Temperature = 122°F (50°C). Temperature range B: Maximum short term temperature = 248°F (120°C), Maximum long term Temperature = 162°F (72°C). Short term elevated concrete temperatures are those that occur over brief, e.g., as a results of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.

FIGURE 2—FIS V ANCHORING SYSTEM AND STEEL ELEMENTS

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FIS V 360 S
FIS V 950 S

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FIS V 360 S

FIS V 950 S

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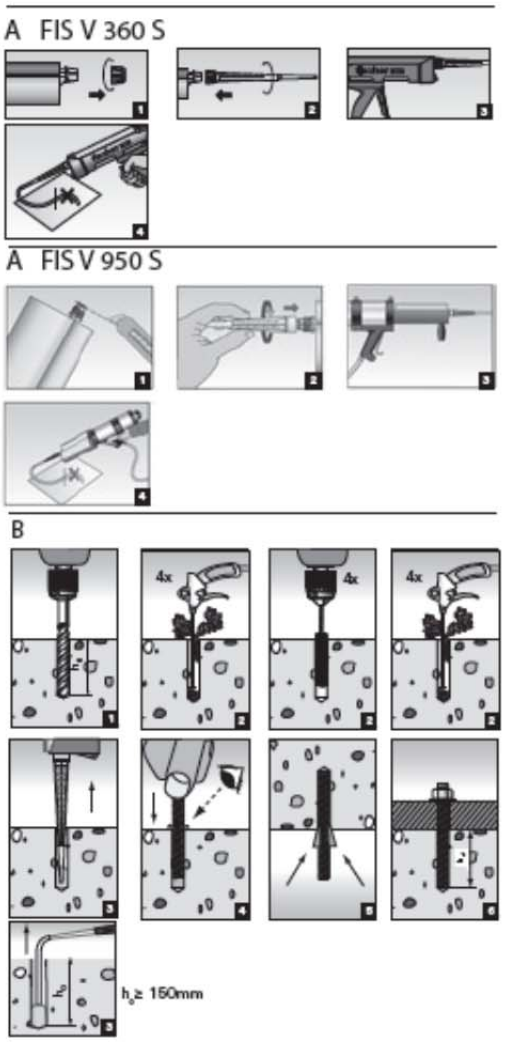
FIGURE 3—FIS V INSTALLATION INFORMATION



3

ENGLISH

fischer Injection - Mortar FIS V 360 S
fischer Injection - Mortar FIS V 950 S

A Preparing the cartridge

1. Remove the cap by turning it to left and pulling it off (FIS V 360 S) or cut off cap (FIS V 950 S).
2. Insert the static mixer and lock it in place (turn to the right). The spiral mixer in the static mixer must be clearly visible. Never use without the static mixer!
3. Place the cartridge in the application gun.
4. Press approx. 10 cm of material out until the resin mortar comes out evenly grey in colour. Mortar which is not grey colour will not cure and must be disposed of.
5. After finishing work, leave the static mixer attached to the cartridge, or remove the static mixer and replace the cap (FIS V 360 S).

Important: If the processing time is exceeded, use a new static mixer and if necessary remove encrusted material in the cartridge mouth.

B Installation

Important: Installation instructions - follow the pictograms 1 - 6 for the sequence of operating and refer to Tables I - III for setting details. The construction drawings must be adhered. For any applications not covered by this document contact fischer.

1. Drill hole with a hammer drill set. Observe the correct hole diameter and depth according to Table I, Table II and Table III.
2. Allowable installation conditions: dry concrete, water saturated concrete. Standing water in bore holes must be completely removed by blowing out before cleaning the bore hole. The drill hole must blown out four times with compressed air (oil-free ≥ 6 bar), brushed four times and then again blown out four times with compressed air (oil-free ≥ 6 bar). The drill holes are brushed four times starting from the bottom of the hole with special steel brushes by hand. The diameters of the brushes are given in Table I. Clean dirty brushes. Check brushes for wear with brush gauge (brush Ø ≥ drill hole Ø).
3. The temperature of the cartridge must be at least 5 °C. Fill approx. ⅔ of the hole with mortar starting from the bottom of the hole. For drill hole depth > 150 mm use an extention tube.
4. Anchoring element must be straight and free from surface damage, oil and other contaminants. Press the anchoring element down to the bottom of the hole, turning it slightly while so doing. After insert the anchoring element, excess mortar must emerge from the mouth of the hole. If no mortar appears at the surface, remove the anchoring element immediately and inject more FIS V mortar.
5. For overhead installation use wedges (only allowed for sizes ≤ M30 or # 11, and cartridge temperature ≥ 25°C).
6. Do not apply load or installation torque moment (given in Table II) to the anchor until the prescribed curing times are elapsed. The allowable working time and the minimum curing time are given in Table IV.

Store mortar in a cool dry place.

Table IV
Processing and curing times

Temperature in the anchorage base	Working time/ processing time	Curing time
+ 5 °C	1.5 min	180 min
+ 10 °C	9 min	90 min
+ 20 °C	5 min	60 min
+ 30 °C	4 min	45 min
+ 40 °C	2 min	35 min

Storage temperature: + 5 °C – + 25 °C

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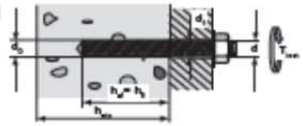
Table I

Drill bit		Rods	Rebar	Brush
d [inch]	d [mm]	d [mm]	No.	≥ d [mm]
⅜	10	M8	.	10.5
7/16	12	M10	.	12.5
9/16	14	M12	# 3	16
⅝	16	.	#4	16.5
11/16	18	M16	.	18.5
13/16	20	.	#5	22
15/16	24	M20	#6	25
1 1/16	28	M24	#7	28
1 3/16	30	M27	#8	31
1 ⅛	33	M30	#9	36
1 5/16	40	M35*	#10	42
1 ⅜	45	.	#11	47

* not commend by ESR

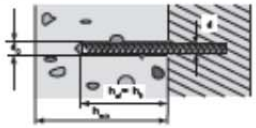
Table II Threaded rod



d	d_o		h_{ef}		d_f		$T_{inst,max}$		h_{min}	
	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[Nm]	[ft - lb]	[mm]	[inch]
M8	10	⅜	80	3 1/8	9	11/32	10	7.5	110	4 ⅜
M10	12	7/16	90	3 ½	12	15/32	20	15	120	4 ¾
M12	14	9/16	110	4 ⅜	14	9/16	40	30	140	5 ½
M16	18	11/16	125	5	18	11/16	90	65	160	6 ¼
M20	24	15/16	170	6 ¾	22	⅞	120	88	210	8 ¼
M24	28	1 ⅛	210	8 ⅜	26	1 1/16	150	110	280	10 ⅞
M30	35	1 ⅜	280	11 ⅛	33	1 5/16	300	220	340	13 ⅜
M35*	40	1 9/16	330	13 ⅛	40	1 9/16	500	370	410	16 ⅛

* not commend by ESR

Table III Rebars



d	d_o		h_{ef}		h_{min}	
No.	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
#3	14	9/16	115	4 ½	145	5 ¾
#4	16	⅝	150	6	180	7
#5	20	13/16	200	7 ⅞	220	8 ⅝
#6	24	15/16	330	8 ⅛	310	10 ¼
#7	28	1 1/16	310	10 ¼	315	12 ⅜
#8	30	1 3/16	300	12	365	14
#9	35	1 ⅜	340	13 ½	400	15 ¾
#10	40	1 9/16	380	15	460	17 ¾
#11	45	1 11/16	420	16 ½	480	19 ¼

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FIGURE 3—FIS V INSTALLATION INFORMATION (Continued)