CITY OF LOS ANGELES
CALIFORNIA

DEPARTMENT OF
BUILDING AND SAFETY
201 NORTH FIGUEROA STREET
LOS ANGELES, CA 90012

RAYMOND S. CHAN, C.E., S.E.
SUPERINTENDENT OF BUILDING
INTERIM GENERAL MANAGER

ITW Red Head
700 High Grove Blvd
Glendale Heights, IL 60139

Attn: Amy Kolczak
(800) 848-5611

RESEARCH REPORT: RR 25940
(CSI # 03 16 00)

BASED UPON ICC EVALUATION SERVICE
REPORT NO. ESR-1137

REEVALUATION DUE
DATE: September 1, 2015
Issued Date: October 1, 2013
Code: 2011 LABC

GENERAL APPROVAL – Reevaluation/Clerical Modification— ITW Red Head EPCON G5 Adhesive Anchoring System for Cracked and Uncracked Concrete

DETAILS

The above assemblies and/or products are approved when in compliance with the description, use, identification and findings of Report No. ESR-1137, reissued February 1, 2013, revised March 2013 of the ICC Evaluation Service, Incorporated. The report, in its entirety, is attached and made part of this general approval.

The parts of Report No. ESR-1137 which are marked by the asterisks are deleted or revised by the Los Angeles City Building Department from this approval.

The approval is subject to the following conditions:

1. The design information listed in the attached report and tables are valid for the fasteners only. Connected members shall be checked for their capacity (which may govern).

2. The anchors shall be identified by labels on the packaging indicating the manufacturer's name and product designation.

3. Design information, edge distance, spacing and minimum embedment requirements shall be per Tables in ICC-ES Report No. ESR-1137.

4. Special inspection in accordance with Section 1704 of the 2011 Los Angeles City Building Code shall be provided for anchor installations.

5. The anchors shall be installed as per the attached manufacturer's instructions except as otherwise stated in this report. Copies of the installation instructions shall be available at each job site.

6. Adhesive anchors are not approved for overhead installations

7. The adhesive anchors shall not be used to support fire-resistive construction, except when at least one of the conditions specified in Section 5.13 of the ICC-ES Report No. ESR-1137 is fulfilled.

8. Minimum concrete cover per Chapter 7 of the ACI 318-08 shall be followed whenever applicable.

DISCUSSION

The clerical modification is to change to address, contact person and phone number.

The report is in compliance with the 2011 Los Angeles City Building Code.

This approval is based on load tests. The anchors have been tested in accordance with ASTM E488 and the ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors in Concrete (AC308), dated October 2007. Creep tests were carried out in accordance with the ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors in Concrete (AC308), dated October 2007.

This general approval will remain effective provided the Evaluation Report is maintained valid and unrevised with the issuing organization. Any revision to the report must be submitted to this Department for review with appropriate fee to continue the approval of the revised report.

Addressee to whom this Research Report is issued is responsible for providing copies of it, complete with any attachments indicated, to architects, engineers and builders using items approved herein in design or construction which must be approved by Department of Building and Safety Engineers and Inspectors.

ITW Red Head
RE: ITW Red Head EPCON G5 Adhesive Anchoring System for Cracked and Uncracked Concrete

This general approval of an equivalent alternate to the Code is only valid where an engineer and/or inspector of this Department has determined that all conditions of this Approval have been met in the project in which it is to be used.

ALLEN PEERY, Chief
Engineering Research Section
201 N. Figueroa St., Room 880
Los Angeles, CA 90012
Phone- 213-202-9812
Fax- 213-202-9943

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Attachment: ICC ES Report No. ESR-1137 (13 Pages)

ICC EVALUATION SERVICE

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ICC-ES Evaluation Report

ESR-1137*

Reissued February 1, 2013

This report is subject to renewal March 1, 2015.

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

REPORT HOLDER:

ITW RED HEAD
2171 EXECUTIVE DRIVE, SUITE 100
ADDISON, ILLINOIS 60101
(800) 899-7890
www.itw-redhead.com
techsupport@itw-redhead.com

EVALUATION SUBJECT:

ITW RED HEAD EPCON G5 ADHESIVE ANCHORING SYSTEM FOR CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

* ■ 2009, 2006, ~~2003 and 2000~~ *International Building Code®* (IBC)
- ■ 2009, ~~2006, 2003 and 2000~~ *International Residential Code®* (IRC)
- ■ ~~1997 *Uniform Building Code*™ (UBC)~~

Property evaluated:

Structural

2.0 USES

The ITW Red Head EPCON G5 Adhesive Anchoring System is a post-installed adhesive anchorage system used to resist static, wind or earthquake (Seismic Design Categories A through F) tension and shear loads when installed in cracked and uncracked normal-weight concrete having a specified compressive strength, f'_c, of 2500 psi to 8,500 psi (17.2 MPa to 58.6 MPa). The anchoring system is an alternative to anchors described in Sections 1911 and
* 1912 of the 2009 and 2006 IBC, ~~Sections 1912 and 1913 of the 2003 and 2000 IBC, and Section 1923 of the UBC.~~ The anchoring system may also be used where an engineered design is submitted in accordance with Section
* R301.1.3 of the 2009, ~~2006, and 2003 IRC, or Section R301.1.2 of the 2000 IRC~~.

3.0 DESCRIPTION

3.1 General:

The ITW Red Head EPCON G5 Adhesive Anchoring System is a two-component, extended working time, structural epoxy adhesive, used with stud-type threaded rods installed in normal-weight concrete. The primary components of the ITW Red Head EPCON G5 Adhesive Anchoring System are shown in Figure 1a of this report.

Installation information and parameters are included with the adhesive package and are shown in Figure 2 of this report. The adhesive system must be used with the threaded rods described in Section 3.2.4.1 of this report.

3.2 Materials:

3.2.1 Adhesive: The Epcon G5 adhesive consists of two components, an epoxy resin and an amine-based hardener, packaged in 22-fluid-ounce (0.6 L) dual component cartridges. The adhesive components are mixed to a 1:1 ratio, by volume, using the nozzle supplied by ITW Red Head. The original, unopened cartridges have an 18-month shelf life, as indicated by the "best used by" date stamped on the cartridge, when stored in a cool, dry, ventilated area at temperatures between 40°F and 90°F (5°C and 32°C).

3.2.2 Hole Cleaning Equipment: Hole cleaning equipment consists of wire brushes and air nozzles, as described in Figure 1a and Figure 2 of this report.

3.2.3 Dispensing Tools: Epcon G5 adhesive must be dispensed with manual or pneumatic dispensing tools provided by ITW Red Head as described in Figure 1a.

3.2.4 Anchor Elements:

3.2.4.1 Threaded Steel Rods: The threaded steel rods must be clean, continuously threaded rods (all-thread) ranging from $^3/_8$ inch through $1^1/_4$ inches (9.5 mm through 31.75 mm) in diameter. Carbon steel threaded rods must comply with minimum ASTM A36 [minimum F_u = 58,000 psi (400 MPa)] or ASTM A193, Grade B7 [minimum F_u = 125,000 psi (860 MPa)]. Stainless steel threaded rods must comply with ASTM F593 (Alloy Type 300) [minimum F_u = 75,000 psi (517 MPa)]. Table 1 notes steel properties for the threaded rods. Carbon steel threaded rods must be furnished with a 0.0002-inch-thick (5 µm) zinc electroplated coating complying with ASTM B 633 SC1 or must be hot-dipped galvanized complying with ASTM A153, Class C or D.

Threaded steel rods must be straight and free from indentations or other defects along their length.

3.2.4.2 Ductility: In accordance with ACI 318 D.1, for the steel element to be considered ductile, the threaded rod elongation must be at least 14 percent and reduction of area must be at least 30 percent. Steel elements used for anchoring with an elongation of less than 14 percent or a reduction of area of less than 30 percent, or both, are

where:

A_{Na} is the projected area of the failure surface for the single anchor or group of anchors that shall be approximated as the base of the rectilinear geometrical figure that results from projecting the failure surface outward a distance, $c_{cr,Na}$ from the centerline of the anchor, or in the case of a group of anchors, from a line through a row of adjacent anchors. A_{Na} shall not exceed nA_{Na0} where n is the number of anchors in tension in the group. In ACI 318 Figures RD.5.2.1(a) and RD.5.2.1(b), the terms $1.5h_{ef}$ and $3.0h_{ef}$ shall be replaced with $c_{cr,Na}$ and $s_{cr,Na}$, respectively.

A_{Na0} is the projected area of the failure surface of a single anchor without the influence of proximate edges in accordance with Eq. (D-16c):

$$A_{Na0} = (s_{cr,Na})^2 \qquad \text{(D-16c)}$$

with

$s_{cr,Na}$ = as given by Eq. (D-16d)

D.5.3.8—The critical spacing ($s_{cr,Na}$) and critical edge ($c_{cr,Na}$) distance shall be calculated as follows:

$$s_{cr,Na} = 20 \cdot d \cdot \sqrt{\frac{\tau_{k,uncr}}{1,450}} \le 3 \cdot h_{ef} \qquad \text{(D-16d)}$$

$$c_{cr,Na} = \frac{s_{cr,Na}}{2} \qquad \text{(D-16e)}$$

D.5.3.9—The basic strength of a single adhesive anchor in tension in cracked concrete shall not exceed:

$$N_{a0} = \tau_{k,cr} \cdot \pi \cdot d \cdot h_{ef} \qquad \text{(D-16f)}$$

where $\tau_{k,cr}$ is the bond strength in cracked concrete

D.5.3.10—The modification factor for the influence of the failure surface of a group of adhesive anchors is

$$\Psi_{g,Na} = \Psi_{g,Na0} + \left[\left(\frac{s}{s_{cr,Na}}\right)^{0.5} \cdot (1 - \Psi_{g,Na0})\right] \qquad \text{(D-16g)}$$

where:

s = spacing of anchors (see Table 2 for s_{min} requirements

$$\Psi_{g,Na0} = \sqrt{n} - \left[(\sqrt{n} - 1) \cdot \left(\frac{\tau_{k,cr}}{\tau_{k,max,cr}}\right)^{1.5}\right] \ge 1.0 \qquad \text{(D-16h)}$$

where:

n = the number of tension-loaded adhesive anchors in a group.

$$\tau_{k,max,cr} = \frac{k_{c,cr}}{\pi \cdot d} \sqrt{h_{ef} \cdot f'_c} \qquad \text{(D-16i)}$$

The value of f'c must be limited to a maximum value of 8,000 psi (55 MPa) in accordance with ACI 318 D.3.5.

D.5.3.11—The modification factor for eccentrically loaded adhesive anchor groups is

$$\Psi_{ec,Na} = \frac{1}{1 + \frac{2e'_N}{s_{cr,Na}}} \le 1.0 \qquad \text{(D-16j)}$$

Eq. (D-16j) is valid for $e'_N \le \frac{s}{2}$

If the loading on an anchor group is such that only certain anchors are in tension, only those anchors that are in tension shall be considered when determining the eccentricity, e'_N, for use in Eq. (D-16j).

In the case where eccentric loading exists about two orthogonal axes, the modification factor $\Psi_{ec,Na}$ shall be computed for each axis individually and the product of these factors used as $\Psi_{ec,Na}$ in Eq. (D-16b).

D.5.3.12—The modification factor for the edge effects for single adhesive anchors or anchor groups loaded in tension is:

for $c_{a,min} \ge c_{cr,Na}$:

$$\Psi_{ed,Na} = 1.0 \qquad \text{(D-16l)}$$

for $c_{a,min} < c_{cr,Na}$:

$$\Psi_{ed,Na} = \left(0.7 + 0.3 \cdot \frac{c_{a,min}}{c_{cr,Na}}\right) \le 1.0 \qquad \text{(D-16m)}$$

D.5.3.13—When an adhesive anchor or group of anchors is located in a region of a concrete member where analysis indicates no cracking at service load levels, the nominal strength, N_a or N_{ag}, of a single adhesive anchor or group of adhesive anchors shall be determined according to Eq. (D-16a) and Eq. (D-16b) with $\tau_{k,uncr}$ substituted for $\tau_{k,cr}$ in the calculation of the basic strength N_{ao} in accordance with Eq. (D-16f). The factor $\Psi_{g,Nao}$ shall be calculated in accordance with Eq. (D-16h) whereby the value of $\tau_{k,max,uncr}$ shall be calculated in accordance with Eq. (D-16n) and substituted for $\tau_{k,max,cr}$ in Eq. (D-16h).

$$\tau_{k,max,uncr} = \frac{k_{c,uncr}}{\pi \cdot d} \sqrt{h_{ef} \cdot f'_c} \qquad \text{(D-16n)}$$

D.5.3.14— When an adhesive anchor or group of anchors is located in a region of a concrete member where analysis indicated that no cracking at service load levels, the modification factor $\Psi_{p,Na}$ shall be taken as:

$$\Psi_{p,Na} = 1.0 \text{ when } c_{a,min} \ge c_{ac} \qquad \text{(D-16o)}$$

$$\Psi_{p,Na} = \frac{\max(c_{a,min}; c_{cr,Na})}{c_{ac}} \text{ when } c_{a,min} < c_{ac} \qquad \text{(D-16p)}$$

where c_{ac} must be determined in accordance with Section 4.1.10 of this report.

For all other cases, $\Psi_{p,Na}$ = 1.0 (e.g. when cracked concrete is considered).

Additional information for the determination of nominal bond strength in tension is given in Section 4.1.8 of this report.

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 the corresponding strength reduction factor, ϕ, in accordance with ACI 318 D.4.4, are given in Table 1 of this report for the corresponding anchor steel.

4.1.6 Static Concrete Breakout Strength in Shear: The nominal concrete breakout strength in shear, V_{cb} or V_{cbg}, must be calculated in accordance with ACI 318 D.6.2 based on information given in Table 2 of this report. 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 and h_{ef} given in this report in lieu of d_a (2009 IBC), d_o (2006 IBC) and l_e, respectively. In no case shall l_e exceed $8d$. The value of f'c must be limited to a maximum value of 8,000 psi (55 MPa) in accordance with ACI 318 D.3.5.

4.1.7 Static Concrete Pryout Strength in Shear: In lieu of determining the nominal pryout strength in accordance

of 110°F and maximum long-term temperature of 70°F. Temperature range B: Maximum short-term temperature of 110°F and maximum long-term temperature of 110°F. The concrete temperature shall not exceed the maximum long-term concrete temperature for the applicable temperature range during the service life of the anchor. Short-term elevated concrete temperatures are those that occur over brief intervals, e.g., as a result of daily cycling. Long-term concrete temperatures are roughly constant over significant periods of time. The footnotes to Table 3 provide additional information regarding short-term and long-term concrete temperatures.

The adhesive anchoring system may be used for floor (vertically down) and wall (horizontal) applications. Horizontal applications are limited to use with the $^3/_8$-inch-(9.5 mm) through $^3/_4$-inch-diameter (19.1 mm) threaded rods.

The ITW Red Head working and cure times are shown in Figure 1.

4.4 Special Inspection:

Installations may be made under continuous special inspection or periodic special inspection, as determined by the registered design professional. Table 3 of this report provides strength reduction factors, ϕ, corresponding to the type of inspection provided.

Installations made under continuous special inspection with an on-site proof loading program must be performed in accordance with Sections 1704.4 and 1704.15 of the * 2009 IBC, Sections 1704.4 and 1704.13 of the 2006, ~~2003 and 2000~~ IBC, ~~and Section 1701.5 of the UBC,~~ whereby periodic special inspection is defined in Section 1702.1 of * the IBC, ~~Section 1701.6.2 of the UBC,~~ and this report. The special inspector must be on the jobsite continuously during anchor installation to verify anchor type, adhesive expiration date, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque, and adherence to the manufacturer's printed installation instructions.

The proof loading program must be established by the registered design professional. As a minimum, the following requirements must be addressed in the proof loading program:

1. Frequency of proof loading based on anchor type, diameter, and embedment.
2. Proof loads by anchor type, diameter, embedment,, and location.
3. Acceptable displacements at proof load.
4. Remedial action in the event of a failure to achieve proof load, or excessive displacement.

Unless otherwise directed by the registered design professional, proof loads must be applied as confined tension tests. Proof load levels must not exceed the lesser of 50 percent of expected peak load based on adhesive bond strength, or 80 percent of the anchor yield strength. The proof load shall be maintained at the required load level for a minimum of 10 seconds.

Periodic special inspection must be performed where required in accordance with Sections 1704.4 and 1704.15 of the 2009 IBC, Sections 1704.4 and 1704.13 of the 2006, * ~~2003 and 2000~~ IBC, ~~and Section 1701.5 of the UBC,~~ whereby periodic special inspection is defined in Section 1702.1 of the IBC, Section 1701.6.2 of the UBC, and this report. The special inspector must be on the jobsite initially during anchor installation to verify anchor type, adhesive expiration date, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque, and adherence to the manufacturer's printed installation instructions. 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.

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 ITW Red Head EPCON G5 Adhesive Anchoring System described in this report 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 The Epcon G5 Adhesive must be installed in accordance with the manufacturer's published installation instructions, as included with the adhesive packaging and described in Figure 2 of this report.

5.2 The anchors must be installed in cracked and uncracked normal-weight concrete having a specified compressive strength of f_c'= 2500 psi to 8500 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 holes predrilled into concrete using a carbide-tipped masonry drill bit manufactured within the range of the maximum and minimum drill-tip dimensions of ANSI B212.15-1994.

5.5 For strength design, loads applied to the anchors must be adjusted in accordance with Section 1605.2 of the IBC or Section 1612.3 ~~or 1909.2 of the UBC~~. * For allowable stress design, loads must be adjusted in accordance with Section 1605.3 of the IBC ~~or~~ * ~~Section 1612.3 of the UBC~~.

5.6 Epcon G5 adhesive anchors are recognized for use in resisting short and long-term loads, including wind and earthquake, subject to the conditions of this report.

5.7 In structures assigned to Seismic Design Category C, D, E or F under the IBC or IRC, anchor strength must be adjusted in accordance with 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16.

5.8 Epcon G5 adhesive anchors are permitted to be installed in concrete that is cracked or that may be expected to crack during the service life of the anchor, subject to the conditions of this report.

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

5.10 Allowable stress design values must be established in accordance with Section 4.2 of this report.

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

TABLE 1—STEEL DESIGN INFORMATION FOR THREADED ROD

CHARACTERISTIC		SYMBOL	UNITS	NOMINAL ROD DIAMETER, *d* (inch)						
				$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
Threaded rod effective cross-sectional area		A_{se}	inch²	0.078	0.142	0.226	0.335	0.462	0.606	0.969
Carbon Steel A36	Nominal steel strength in tension	N_{sa}	lb	4,500	8,230	13,110	19,400	26,780	35,130	56,210
	Nominal steel strength in shear	V_{sa}	lb	2,250	4,940	7,870	11,640	16,070	21,080	33,730
	Strength reduction factor for tension, steel failure mode[1]	ϕ	-	0.75	0.75	0.75	0.75	0.75	0.75	0.75
	Strength reduction factor for shear, steel failure mode[1]	ϕ	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Carbon Steel A193 B7	Nominal steel strength in tension	N_{sa}	lb	9,690	17,740	28,250	41,810	57,710	75,710	121,140
	Nominal steel strength in shear	V_{sa}	lb	4,845	10,640	16,950	25,090	34,630	45,430	72,680
	Strength reduction factor for tension, steel failure mode[1]	ϕ	-	0.75	0.75	0.75	0.75	0.75	0.75	0.75
	Strength reduction factor for shear, steel failure mode[1]	ϕ	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Stainless Steel F593	Nominal steel strength in tension	N_{sa}	lb	5,810	10,640	16,950	25,090	34,630	45,430	72,680
	Nominal steel strength in shear	V_{sa}	lb	2,905	6,390	10,170	15,050	20,780	27,260	43,610
	Strength reduction factor for tension, steel failure mode[1]	ϕ	-	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	Strength reduction factor for shear, steel failure mode[1]	ϕ	-	0.60	0.60	0.60	0.60	0.60	0.60	0.60
	Reduction factor for seismic shear	$\alpha_{V,seis}$	-	0.70	0.70	0.70	0.70	0.70	0.70	0.70

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N

* [1] The tabulated value of ϕ applies when the load combinations of Section 1605.2.1 of the IBC, ~~Section 1612.2.1 of the UBC,~~ or ACI 318 Section 9.2 are used as set forth in ACI 318 D.4.4. If the load combinations of ~~Section 1909.2 of the UBC or~~ ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.5.

* Deleted by the City of Los Angeles

TABLE 3—G5 ADHESIVE ANCHOR BOND STRENGTH DESIGN INFORMATION[1]

CHARACTERISTIC		SYMBOL	UNITS	NOMINAL ROD DIAMETER (inch)						
				$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_4$
Anchor embedment depth - minimum		$h_{ef,min}$	in.	$2^3/_8$	$2^3/_4$	$3^1/_8$	$3^1/_2$	$3^1/_2$	4	5
Anchor embedment depth - maximum		$h_{ef,max}$	in.	$3^3/_8$	$4^1/_2$	$5^5/_8$	$6^3/_4$	$7^7/_8$	9	$11^1/_4$
Temperature Range A[2,4,5]	Characteristic Bond Strength for Uncracked Concrete	$\tau_{k,uncr}$	psi	1,620	1,620	1,620	1,620	1,620	1,620	1,620
	Characteristic Bond Strength for Cracked Concrete[6]	$\tau_{k,cr}$	psi	665	785	785	785	785	785	785
Temperature Range B[3,4,5]	Characteristic Bond Strength for Uncracked Concrete	$\tau_{k,uncr}$	psi	1,245	1,245	1,245	1,245	1,245	1,245	1,245
	Characteristic Bond Strength for Cracked Concrete[6]	$\tau_{k,cr}$	psi	510	605	605	605	605	605	605
Continuous Inspection	Strength Reduction Factor - Dry Concrete	$\phi_{dry,ci}$	-	0.65	0.65	0.65	0.65	0.55	0.55	0.55
	Strength Reduction Factor - Saturated Concrete	$\phi_{sat,ci}$	-	0.65	0.65	0.65	0.65	0.55	0.55	0.55
	Strength Reduction Factor - Water-Filled Holes	$\phi_{wf,ci}$	-	0.65	0.65	0.65	0.65	0.55	0.55	0.55
	Strength Reduction Factor - Submerged Concrete	$\phi_{sub,ci}$	-	0.65	0.65	0.65	0.65	0.55	0.55	0.55
Periodic Inspection	Strength Reduction Factor - Dry Concrete	$\phi_{dry,ci}$	-	0.55	0.55	0.55	0.55	0.45	0.45	0.45
	Strength Reduction Factor - Saturated Concrete	$\phi_{sat,ci}$	-	0.55	0.55	0.55	0.55	0.45	0.45	0.45
	Strength Reduction Factor - Water-Filled Holes	$\phi_{wf,ci}$	-	0.55	0.55	0.55	0.55	0.45	0.45	0.45
	Strength Reduction Factor - Submerged Concrete	$\phi_{sub,ci}$	-	0.55	0.55	0.55	0.55	0.45	0.45	0.45
Reduction factor for seismic tension		$\phi_{N,seis}$	-	0.80						

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356 N-M, 1 psi = 0.006895 MPa.

[1] Bond strength values correspond to concrete compressive strength range 2,500 psi to 8,500 psi.
[2] Temperature range A: Maximum short term temperature of 110 degrees F and maximum long term temperature of 70 degrees F.
[3] Temperature range B: Maximum short term temperature of 110 degrees F and maximum long term temperature of 110 degrees F.
[4] Short term elevated concrete temperatures are those that occur over brief interval, e.g., as a result of diurnal cycling. Long term concrete temperatures are roughly constant over significant periods of time.
[5] For load combinations consisting of only short-term loads, such as wind or seismic loads, bond strengths may be increased by 5% for Temperature Range A and by 36% for Temperature Range B.
* [6] For structures assigned to IBC or IRC Seismic Design Category C, D, E, or F, ~~or UBC Seismic Zone 2b, 3, or 4,~~ bond strength values must be multiplied by $\alpha_{N,seis}$.

* Deleted by the City of Los Angeles

Illustrative Procedure to Calculate Allowable Stress Design Tension Value:
Epcon G5 Adhesive Anchor $^{1}/_{2}$-inch diameter, using an embedment of $4^{1}/_{2}$-inches, assuming the conditions given in Table 4.

	PROCEDURE		CALCULATION
Step 1	Calculate steel strength of a single anchor in tension per ACI 318 D 5.1.2, Table 1 of this report	ϕN_{sa}	$= \phi N_{sa}$ =0.75*8,230 **=6,173 lbs steel strength**
Step 2	Calculate concrete breakout strength of a single anchor in tension per ACI 318 D 5.2, Table 2 of this report	N_b	$= k_{c,uncr}\sqrt{f'_c}\ h_{ef}^{1.5}$ $= 24*\sqrt{2,500}*4.5^{1.5}$ = 11,455 lbs
		ϕN_{cb}	$=\phi\ A_{NC}/A_{NC0}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ = 0.65*1.0*1.0*1.0*1.0*11,455 = 0.65*11,455 **= 7,446 lbs concrete breakout strength**
Step 3	Calculate bond strength of a single anchor in tension per Equations D-16a, D-16f and Table 3 of this report	N_{ao}	$= \tau_{k,uncr}\ \pi d h_{ef}$ = 1,620*3.14*0.5*4.5 = 11,445 lbs
			$=\phi\ A_{Na}/A_{Na0}\ \psi_{ed,Na}\ \psi_{c,Na}\ N_{ao}$ = 0.55*1.0*1.0*1.0*1.0*11,445 = 0.55*11,445
		ϕN_{ao}	**= 6,295 lbs bond strength**
Step 4	Determine controlling resistance strength in tension per ACI 318 D 4.1.1 and D 4.1.2		**= 6,173 lbs controlling resistance (steel)**
Step 5	Calculate allowable stress design conversion factor for loading condition per ACI 318 Section 9.2:	α	$=1.2D + 1.6L$ =1.2(0.3) + 1.6(0.7) **=1.48**
Step 6	Calculate allowable stress design value per Section 4.2 of this report	$T_{allowable,ASD}$	$= \phi N_n / \alpha$ = 6,173/ 1.48 **= 4,171 lbs allowable stress design**

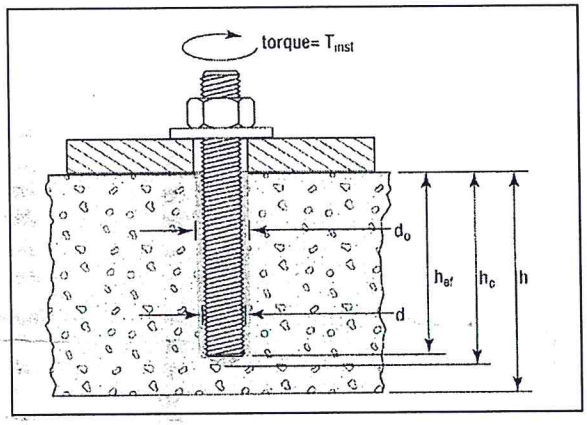
FIGURE 1b—EXAMPLE DESIGN CALCULATION

SPECIFICATIONS FOR INSTALLATION OF EPCON G5 ADHESIVE ANCHORS IN CONCRETE

CHARACTERISTIC	SYMBOL	UNITS	NOMINAL ROD DIAMETER (inch)						
			3/8	1/2	5/8	3/4	7/8	1	1 1/4
Nominal carbide bit diameter		in.	7/16	9/16	3/4	7/8	1	1 1/8	1 3/8
Anchor embedment depth - minimum	$h_{ef,\,min}$	in.	2 3/8	2 3/4	3 1/8	3 1/2	3 1/2	4	5
Anchor embedment depth - maximum	$h_{ef,\,max}$	in.	3 3/8	4 1/2	5 5/8	6 3/4	7 7/8	9	11 1/4
Minimum spacing	s_{min}	in.	15/16	1	2 1/2	6	3 1/2	4	5
Minimum edge distance	c_{min}	in.	15/16	1	2 1/2	6	3 1/2	4	5
Minimum concrete thickness	h_{min}	in.	h_{ef} + 1 1/4		h_{ef} + $2d_o$				
Maximum tightening torque for pretension clamping	T_{inst}	ft lb	9	16	47	90	145	170	370

For **SI:** 1 inch = 25.4mm, 1 lbf = 4.45N, 1ft-lbf = 1.356N-m, 1psi = 0.006895MPa.

ANCHOR INSTALLATION



BRUSH SPECIFICATIONS

Brush color	Part No.	Anchor diameter (in) **(d)**	Drill bit diameter (in) **(d_o)**	Minimum brush diameter (in) **(d_{brush})**
Grey	SB038	3/8	7/16	0.563
Brown	SB012	1/2	9/16	0.675
Green	SB058	5/8	3/4	0.900
Yellow	SB034	3/4	7/8	1.125
Red	SB078	7/8	1	1.350
Purple	SB010	1	1 1/8	1.463
Blue	SB125	1 1/4	1 3/8	1.575

WORKING TIMES AND CURE TIME FOR EPCON G5 ADHESIVE

Concrete Temp. (°F)[1,2]	Working Time (minutes)[3]	Cure Time (hours)[4]
70	15	24
90	9	24
110	9	24

For **SI:** t° (°F-32) X .555 = °C.

[1]Adhesive must be installed in base material temperatures of 70°F to 110°F or artificially maintained.
[2] Cartridge temperature should not differ significantly from the temperature of the base material.
[3]Working time is the maximum time from the end of mixing to when the insertion of the anchor into the adhesive shall be completed.
[4]Cure time is the minimum time from the end of working time to when the anchor maybe torqued or loaded. Anchors are to be undisturbed during the cure time.

FIGURE 2—INSTALLATION INFORMATION AND PARAMETERS (Continued)