ICC-ES Evaluation Report

ESR-2202

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This report is subject to re-examination in one year.

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DIVISION: 03—CONCRETE
Section: 03151—Concrete Anchoring

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EVALUATION SUBJECT:

TAPCON® WITH ADVANCED THREADFORM TECHNOLOGY ANCHORS

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2006 *International Building Code*® (IBC)
- 2006 *International Residential Code*® (IRC)
- 1997 *Uniform Building Code*™ (UBC)

Property evaluated:

Structural

2.0 USES

The Tapcon® with Advanced Threadform Technology Anchors are screw anchors used to resist static and wind, tension and shear loads 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). The anchoring system is an alternative to cast-in-place anchors described in Sections 1911 and 1912 of the IBC and Sections 1923.1 and 1923.2 of the UBC. The anchors 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 Tapcon® with Advanced Threadform Technology Anchors:

The Tapcon® with Advanced Threadform Technology Anchors are manufactured from UNS G 10220 (formerly AISI 1022) heat-treaded carbon steel with supplementary heat treatment. They have an alternating high-low thread form on the shank and are available in $^3/_{16}$- and $^1/_4$-inch-diameter (4.8 and 6.4 mm) sizes with various lengths. Tapcon® anchors are available with a slotted hex washer head or phillips flat head, and have a blue Climaseal® coating. Illustrations of anchors are provided in Figure 1.

3.2 Concrete:

Normal-weight concrete must comply with Sections 1903 and 1905 of the IBC or UBC, as applicable.

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design tension and shear strengths ($øN_n$ *and* $øV_n$) must be determined in accordance with ACI 318-05 (ACI 318) Appendix D as modified by the IBC and this report. The anchor design must satisfy the requirements of ACI 318 Sections D.4.1.1 and D.4.1.2. The value of f'_c used in the calculations must be limited to a maximum of 8,000 psi (55.2 MPa), in accordance with ACI 318 Section D.3.5. Strength reduction factors ($ø$) as given in ACI 318 Section D.4.4 must be used for load combinations calculated in accordance with Section 1605.2 of the IBC, Section 9.2 of ACI 318, or Section 1612.2 of the UBC. Strength reduction factors as given in ACI 318 Section D.4.5 must be used for load combinations set forth in ACI 318 Appendix C or UBC Section 1909.2. Design parameters are provided in Table 1.

4.1.2 Requirements for Static Steel Strength in Tension: The nominal static steel strength of a single anchor in tension must be calculated in accordance with ACI 318 Section D.5.1.2. The resulting N_s values for a single anchor are provided in Table 1 of this report. Strength reduction factors $ø$ corresponding to brittle steel elements as defined in ACI 318 Section D.1.1, and provided in Table 1, must be used.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension: The nominal static concrete breakout strength for a single anchor or group of anchors in tension (N_{cb} or N_{cbg}) must be calculated in accordance with ACI 318 Section D.5.2, with modifications as described in this section. The nominal concrete breakout strength in tension in regions of concrete where analysis indicates no cracking in service loads, must be calculated in accordance with ACI

318 Section D.5.2.6. The basic concrete breakout strength of a single anchor in tension, N_b, must be calculated in accordance with ACI 318 Section D.5.2.2 using the values of h_{ef} and k_{uncr} as given in Table 1.

4.1.4 Requirements for Critical Edge Distance: The values for the critical edge distance, c_{ac}, for use with ACI 318 Section D.5.2.7 must be taken from Table 1. In applications where c is less than c_{ac} and supplemental reinforcement to control splitting of the concrete is not present, the concrete breakout strength in tension for uncracked concrete, calculated in accordance with ACI 318 Section 5.2, must be further multiplied by the factor $\psi_{cp,N}$ in accordance with ACI 318 Section D.5.2.7. The values of c_{ac} must be taken from Table 1. For all other cases, $\psi_{cp,N} = 1.0$.

4.1.5 Requirements for Pullout Strength in Tension: The nominal static pullout strength ($N_{p,uncr}$) of a single anchor installed in uncracked concrete is given in Table 1 of this report.

4.1.6 Requirements for Static Steel Strength of Anchor in Shear, V_s: In lieu of the values of V_s as given in ACI 318 Section D.6.1.2(c), the nominal static steel shear values for a single anchor given in Table 1 of this report must be used.

4.1.7 Requirements for Static Concrete Breakout Strength of Anchor in Shear, V_{cb} or V_{cbg}: The nominal static concrete breakout strength shear capacity of a single anchor or group of anchors (V_{cb} or V_{cbg}) must be calculated in accordance with ACI 318 Section D.6.2 based on the values provided in Table 1. The basic concrete breakout strength of a single anchor in cracked concrete, V_b, must be calculated in accordance with ACI 318 Section D.6.2.2 using the values given in Table 1. The value of l_e used in ACI 318 Section D, Eq. (D-24), must be taken as no greater than h_{ef}.

4.1.8 Requirements for Static Concrete Pryout Strength of Anchor in Shear, V_{cp} or V_{cpg}: The nominal static concrete pryout strength shear capacity of a single anchor or group of anchors (V_{cp} or V_{cpg}) must be calculated in accordance with ACI 318 Section D.6.3 based on the values provided in Table 1, and the values of N_{cb} or N_{cbg} as calculated in Section 4.1.3 of this report.

4.1.9 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: In lieu of ACI 318 Section D.8.3, values of c_a and s_a as given in Table 1 of this report must be used. In lieu of ACI 318 Section D.8.5, minimum concrete thickness h_{min} as given in Table 1 of this report must be used. In lieu of ACI 318 Section D.8.6, the critical edge distance at corners c_{ac} as given in Table 1 of this report must be used.

4.2 Allowable Stress Design:

4.2.1 General: Design values for use with allowable stress design (working stress design) must be established as follows:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha} \text{ and } V_{allowable,ASD} = \frac{\phi V_n}{\alpha}$$

where:

$T_{allowable, ASD}$ = Allowable tension load (lbf or kN).

$V_{allowable, ASD}$ = Allowable tension load (lbf or kN).

ϕN_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 Appendix D and IBC Section 1908.1.16 (lbf or kN).

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 Appendix D and IBC Section 1908.1.16 (lbf or kN).

α = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, α must include all applicable factors to account for nonductile failure modes and required over-strength. Limits on edge distance, anchor spacing and member thickness as given in Section 4.1.9 of this report must apply. An illustrative example of allowable stress design values is shown in Table 2.

4.2.2 Interaction: In lieu of ACI 318 Sections D.7.1, D.7.2, and D.7.3, interaction must be calculated as follows:

For shear loads: $V \le 0.2 \cdot V_{allowable,ASD}$, the full allowable load in tension $T_{allowable,ASD}$ may be taken.

For tension loads: $T \le 0.2 \cdot T_{allowable,ASD}$, the full allowable load in shear $V_{allowable,ASD}$ may be taken.

For all other cases:

$$\frac{T}{T_{allowable,ASD}} + \frac{V}{V_{allowable,ASD}} \le 1.2$$

4.3 Installation:

The anchors must be installed in accordance with the manufacturer's installation instructions and this report. Anchor location must comply with this report. Embedment, spacing, edge distance, and minimum concrete thickness are shown in Table 1. Holes must be predrilled in concrete with a carbide-tipped drill bit complying with ANSI B212.15-1994, supplied by ITW Buildex. The hole must be drilled to the specified embedment depth plus a minimum of $^1/_4$ inch (6.4 mm). Before anchor installation, dust and other deleterious matter must be removed by use of compressed air, or drilling must continue to an additional depth to accommodate drill fines. The anchors must then be installed through the attachment into the hole, in accordance with ITW Buildex's instructions, to the specified embedment depth using a hammer drill in a rotary-only mode with an ITW Buildex Condrive Tool and drive socket.

4.4 Special Inspection:

Special inspection is required in accordance with Section 1704.13 of the IBC and Section 1701.5.2 of the UBC. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, anchor spacing, edge distances, concrete thickness, anchor embedment, and adherence to the manufacturer's published installation instructions. The special inspector must be present as often as required in accordance with the "statement of special inspection." Under the IBC, additional requirements as set forth in Section 1705 or 1706 must be observed.

5.0 CONDITIONS OF USE

The Tapcon® with Advanced Threadform Technology Anchors described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Anchor sizes, dimensions, and installation are as set forth in this report.

5.2 The anchors must be installed in accordance with the manufacturer's published installation instructions and this report in uncracked normal-weight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2MPa to 58.6 MPa). In case of conflict between the manufacturer's installation instructions and this report, this report governs.

5.3 The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.1 MPa).

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

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

5.6 Anchor spacing, edge distance, and minimum concrete thickness must comply with Sections 4.1.4 and 4.1.9 and Table 1 of this report.

5.7 Prior to installation, calculations and details demonstrating compliance with this report must be submitted to the code official for approval. 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.

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

5.9 Anchors used to resist seismic loads must be limited to locations designated as Seismic Design Categories A and B.

5.10 Anchors may be used to resist short-term loading due to wind forces, subject to the conditions of this report.

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

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

5.12 Use of anchors must be limited to dry, interior locations.

5.13 Special inspection must be provided in accordance with Section 4.4 of the report.

5.14 Anchors are manufactured under an approved quality control program in Roselle, Illinois, with inspections by CEL Consulting (AA-639).

6.0 EVIDENCE SUBMITTED

Data complying with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated February 2009.

7.0 IDENTIFICATION

The Tapcon® Anchors are identified by packaging labeled with the manufacturer's name (ITW Buildex) and contact information, anchor name, anchor size, evaluation report number (ICC-ES ESR-2202), and the logo of the inspection agency (CEL Consulting). The letters BX and a length identification code letter are stamped on the head of each anchor. See the length identification system in Table 3 of this report.

TABLE 1—ITW BUILDEX TAPCON ANCHOR, DESIGN INFORMATION

CHARACTERISTIC	SYMBOL	UNITS	NOMINAL ANCHOR DIAMETER (inch)	
			$^3/_{16}$	$^1/_4$
Anchor outside diameter	d_o	inches	$^3/_{16}$	$^1/_4$
Effective embedment depth[1]	h_{ef}	inches	1.5	1.5
Nominal embedment depth[1]	h_{nom}	inches	2.0	2.1
Minimum hole depth in concrete[1]	h_{hole}	inches	2.25	2.35
Minimum edge distance	c_a	inches	2	2.5
Minimum anchor spacing	s_a	inches	3	4
Minimum concrete thickness	h_{min}	inches	3.5	3.5
Critical edge distance	c_{ac}	inches	4	4
Category	-	-	1	1
Specified yield strength of anchor steel	f_y	psi	100,000	100,000
Specified tensile strength of anchor steel	f_{ut}	psi	125,000	125,000
Tensile stress area	A_{se}	in^2	0.01474	0.02405
Shear stress area	A_{se}	in^2	0.01474	0.02405
Steel strength in tension	N_s	lbs.	2025	3800
Steel Shear strength	V_s	lbs.	715	1300
Effectiveness factor for concrete breakout	k_{uncr}	-	24	24
Pullout or pull-through resistance	$N_{p,uncr}$	lbs.	590	795
Axial stiffness in service load range	β	in^2	317,000	467,000
Strength reduction factor ϕ for tension, steel failure modes[2,4]			0.65	0.65
Strength reduction factor ϕ for shear, steel failure modes[2,4]			0.60	0.60
Strength reduction factor ϕ for tension, concrete failure modes, Condition B[3,4]			0.65	0.65
Strength reduction factor ϕ for shear, concrete failure modes, Condition B[3,4]			0.70	0.70

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 MPa. For pound-inch units: 1 mm = 0.03937 inch.

[1]See Figure 2 for an illustration of this dimension.
[2]The Tapcon® anchor is a brittle steel element as defined by ACI 318 Section D.1.
[3]Condition B applies in determination of these values where supplementary reinforcement in conformance with ACI 318-05 Section D.4.4 is not provided, or where product pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A as set forth in ACI 318 D.4.4 may be used.
[4]The ϕ factors are for ACI 318 Section D.4.4 when load combinations in IBC Section 1605.1, ACI 318 Section 9.2, and UBC Section 1612.2.1 are used. If the load combinations in ACI 318 Appendix C or UBC Section 1909.2 are used, the value of ϕ must be determined in accordance with ACI 318 Section D.4.5.

TABLE 2—EXAMPLE ALLOWABLE STRESS DESIGN VALUES FOR ILLUSTRATIVE PURPOSES FOR TAPCON WITH ADVANCED THREADFORM TECHNOLOGY ANCHOR[1,2,3,4,5,6,7,8]

NOMINAL ANCHOR DIAMETER (inch)	EFFECTIVE EMBEDMENT DEPTH (inches)	ALLOWABLE LOADS (pounds)				
		Tension				Shear
		2,500 psi	3,000 psi	4,000 psi	5,000 psi	2,500 psi
$^3/_{16}$	1.5	260	285	330	370	290
$^1/_4$	1.5	350	385	445	495	525

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

[1]Single anchor with static tension load only.
[2]Concrete determined to remain uncracked for the life of the anchorage.
[3]Load combination 9-2 from ACI 318 Section 9.2 (no seismic loading).
[4]Thirty percent dead load and 70 percent live load, controlling load combination 1.2D + 1.6L.
[5]Calculation of weighted average for α = 0.3* 1.2 + 0.7* 1.6 = 1.48.
[6]Normal weight concrete
[7]$c_{a1} = c_{a2} > c_{ac}$.
[8]$h \geq h_{min}$.
[9]Condition B in accordance with ACI 318 Section D.4.4 applies.

TABLE 3—LENGTH IDENTIFICATION SYSTEM

LENGTH MARKING ON ANCHOR HEAD			A	B	C	D	E	F	G	H	I	J
Length of anchor (inches)	From	1	$1^1/_2$	2	$2^1/_2$	3	$3^1/_2$	4	$4^1/_2$	5	$5^1/_2$	6
	Up to, but not including	$1^1/_2$	2	$2^1/_2$	3	$3^1/_2$	4	$4^1/_2$	5	$5^1/_2$	6	$6^1/_2$

For **SI:** 1 inch = 25.4 mm.

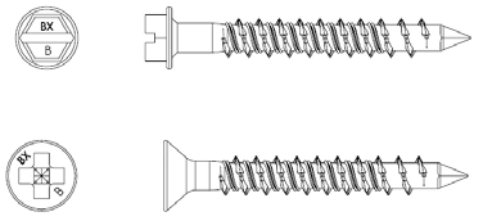

FIGURE 1—ITW BUILDEX TAPCON WITH ADVANCED THREADFORM TECHNOLOGY ANCHORS

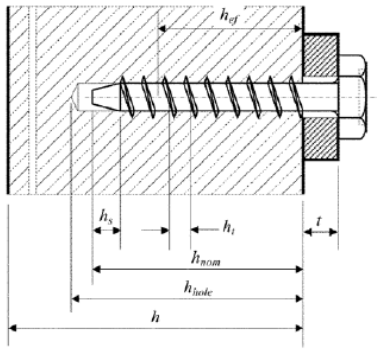

FIGURE 2—EFFECTIVE EMBEDMENT DEPTH OF SCREW ANCHORS