ICC-ES Evaluation Report

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DIVISION: 03 00 00—CONCRETE Section: 03 15 19—Cast-in Concrete Anchors Section: 03 16 00—Concrete Anchors	REPORT HOLDER: UCAN FASTENING PRODUCTS, A DIVISION OF BRITISH FASTENING SYSTEMS LIMITED	EVALUATION SUBJECT: UCAN UPI HEADED CAST-IN SPECIALTY INSERTS IN CONCRETE	

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2021, 2018, 2015, and 2012 *International Building Code®* (IBC)
- 2021, 2018, 2015, and 2012 *International Residential Code®* (IRC)

Property evaluated:

- Structural

2.0 USES

The UCAN UPI Headed Cast-In Specialty Inserts are used as anchorage to resist static, wind, and seismic (Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normal-weight or lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 10,000 psi (17.2 MPa to 68.9 MPa).

There are two models of the UPI inserts: The UPI 38 is used with a threaded rod size of $^3/_8$-inch nominal diameter, and the UPI 12 is used with a threaded rod size of ½-inch diameter.

Reference to “inserts” in this report refers to the proprietary specialty anchorage products (UPI) used in concrete; reference to “steel insert elements” refers to threaded rods or bolts; reference to “anchors” or “insert anchor system” in this report refers to the installed inserts in concrete with threaded rods or bolts.

The insert anchor system is an alternative to cast-in anchors described in Section 1901.3 of the 2021, 2018 and 2015 IBC, and Sections 1908 and 1909 of the 2012 IBC. The insert anchor system may be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 UPI Cast-in Inserts:

UPI inserts are steel internally threaded headed cast-in specialty inserts which receive threaded steel insert elements such as threaded rods and bolts in $^3/_8$-inch and $^1/_2$-inch-inch thread diameters.

The UPI insert bodies are manufactured from carbon steel and have a minimum 5.0 µm (0.0002 inch) yellow chromate zinc coating. The UPI steel insert body is covered in a non-structural plastic housing sleeve and three nails that are secured in the housing sleeve. The UPI insert is installed into the wood-form for a concrete member using the attached nails prior to the casting of the concrete. The threaded rod or bolt can be fastened into the UPI insert from below after the wood-form is removed from the concrete.

3.2 Steel Insert Elements:

3.2.1 Threaded Steel Rods and Bolts: Threaded steel rods (all-thread) or bolts must be threaded on their inserted end into the UPI. Table 3 includes design information for threaded rod or bolts for the applicable diameters. Carbon steel threaded rods or bolts must be furnished with a minimum 5.0 µm (0.0002 inch) zinc plating.

3.2.2 Ductility: In accordance with ACI 318 (-19 and -14) 2.3 or ACI 318-11 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 common steel threaded rod insert elements are provided in Table 3 of this report. Where values are nonconforming or unstated, the steel element must be considered brittle.

3.3 Concrete:

Normal-weight and lightweight concrete must conform to Sections 1903 and 1905 of the IBC.

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design strength of anchors complying with the 2021 IBC as well as Section R301.1.3 of the 2021 IRC, must be determined in accordance with ACI 318-19 Chapter 17 and this report.

Design strength of anchors complying with the 2018 and 2015 IBC as well as Section R301.1.3 of the 2018 and 2015 IRC, must be determined in accordance with ACI 318-14 Chapter 17 and this report.

Design strength of anchors complying with the 2012 IBC as well as Section R301.1.3 of the 2012 IRC must be determined in accordance with ACI 318-11 Appendix D and this report.

Design parameters provided in this report are based on the 2021, 2018, 2015, and 2012 IBC (ACI 318 -19, -14, and -11, as applicable) unless noted otherwise in Sections 4.1.1 through 4.1.13. The strength design of anchors must comply with ACI 318-19 17.5.1.2, ACI 318-14 17.3.1, or ACI 318-11 D.4.1, except as required in ACI 318-19 17.10, ACI 318-14 17.2.3, or ACI 318-11 D.3.3, as applicable.

Strength reduction factors, ϕ, as given in ACI 318-19 17.5.3, ACI 318-14 17.3.3 and ACI 318-11 D.4.3 for cast-in headed anchors, must be used for load combinations calculated in accordance with Section 1605.1 of the 2021 IBC or Section 1605.2 of the 2018, 2015 and 2012 IBC, Section 5.3 of ACI 318 (-19 or -14) and Section 9.2 of ACI 318-11, as applicable. Strength reduction factors, ϕ, as given in ACI 318-11 D.4.4 must be used for load combinations calculated in accordance with ACI 318-11 Appendix C. An example calculation in accordance with the 2021, 2018, 2015, and 2012 IBC is provided in Figure 3 of this report. The value of f'_c used in the calculations must be limited to a maximum of 10,000 psi (68.9 MPa), in accordance with ACI 318-19 17.3.1, ACI 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

4.1.2 Requirements for Static Steel Strength in Tension: The nominal static steel strength in tension, N_{sa}, of a single anchor must be calculated in accordance with ACI 318-19 17.6.1, ACI 318-14 17.4.1 or ACI 318-11 Section D.5.1, as applicable, for the threaded steel insert element, $N_{sa,rod}$, as illustrated in Table 3 of this report. The lesser of $\phi N_{sa,rod}$ in Table 3 or $\phi N_{sa,insert}$ provided in Tables 1 and 2 must be used as the steel strength in tension.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension: The nominal concrete breakout strength of a single anchor or group of anchors in tension, N_{cb} or N_{cbg}, respectively, must be calculated in accordance with ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, for cast-in headed bolts. The basic concrete breakout strength in tension, N_b, must be calculated in accordance with

ACI 318-19 17.6.2.2, ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2, as applicable, using the values of h_{ef} given in Tables 1 and 2, and with k_c = 24. The nominal concrete breakout strength in tension in regions where analysis indicates no cracking in accordance with ACI 318-19 17.6.2.5, ACI 318-14 17.4.2.6 or ACI 318-11 D.5.2.6, as applicable, must be calculated with $\Psi_{c,N}$ = 1.25.

4.1.4 Static Pullout Strength in Tension: The static pullout strength in tension for the UPI anchors does not control design, and need not be calculated.

4.1.5 Requirements for Static Side-Face Blowout Strength in Tension: For the UPI anchors, the nominal side-face blowout strength of a headed insert, N_{sb}, must be calculated in accordance with ACI 318-19 17.6.4.1, ACI 318-14 17.4.4.1 or ACI 318-11 D.5.4.1, as applicable, for the cast-in headed insert, using the values of A_{brg} as given in Table 1 of this report, as applicable.

4.1.6 Requirements for Static Steel Strength in Shear: For the UPI anchors the nominal static steel strength of a single anchor in shear, V_{sa}, must be taken as the threaded steel insert element strength, $V_{sa,rod}$, given in Table 3 of this report. The lesser of $\phi V_{sa,rod}$ in Table 3 or $\phi V_{sa,insert}$ in Table 1 must be used as the steel strength in shear, and must be used in lieu of the values derived by calculation from ACI 318-19 Eq. 17.7.1.2a or 17.7.1.2b; ACI 318-14 Eq. 17.5.1.2a or 17.5.1.2b; or ACI 318-11, Eq. D-28 or D-29, as applicable.

The values given in Table 1 are for the insert only. Determination of the shear capacity of the threaded rod or other material inserted into the cast-in insert is the responsibility of the design professional. Shear values for common threaded rods are given in Table 3.

4.1.7 Requirements for Static Concrete Breakout Strength in Shear: For the UPI anchors, the nominal static concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg}, respectively, must be calculated in accordance with ACI 318-19 17.7.2, ACI 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable. The basic concrete breakout strength, V_b, must be calculated in accordance with ACI 318-19 17.7.2.2, ACI 318-14 17.5.2.2. or ACI 318-11 D.6.2.2, as applicable, based on the values provided in Table 1. The values of ℓ_e (=h_{ef}) and d_a used in ACI 318-19 Eq. 17.7.2.2.1a, ACI 318-14 Eq. 17.5.2.2a or ACI 318 -11 Eq. D-33, as applicable, are provided in Table 1 of this report.

4.1.8 Requirements for Static Concrete Pryout Strength in Shear: For the UPI anchors, the nominal concrete pryout strength of a single anchor or group of anchors, V_{cp} or V_{cpg}, respectively, must be calculated in accordance with ACI 318-19 17.7.3, ACI 318-14 17.5.3 or ACI 318-11 D.6.3, respectively.

4.1.9 Requirements for Seismic Design:

4.1.9.1 General: For load combinations including seismic, the design must be performed in accordance with ACI 318-19 17.10, ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Modifications to ACI 318-19 17.10 or ACI 318-14 17.2.3 shall be applied under Section 1905.1.8 of the 2021, 2018 and 2015 IBC. For the 2012 IBC, Section 1905.1.9 shall be omitted. The anchors may be installed in Seismic Design Categories A through F of the IBC. The UPI anchors comply with ACI 318 (-19 or -14) 2.3 or ACI 318-11 D.1, as applicable, as non-ductile steel elements.

For the UPI anchors, the nominal steel strength, nominal concrete breakout strength and nominal concrete side-face blowout strength for anchors in tension; and the nominal concrete breakout strength and pryout strength in shear, must be calculated in accordance with ACI 318-19 17.6 and 17.7, ACI 318-14 17.4 and 17.5, or ACI 318-11 D.5 and D.6, as applicable, using the values in Table 1, as applicable.

Seismic Tension: For the UPI anchors, the nominal steel strength in tension, $N_{sa,eq}$, of a single anchor must be calculated in accordance with ACI 318-19 17.6.1, ACI 318-14 17.4.1 or ACI 318-11 Section D.5.1, as applicable, for the threaded steel element, $N_{sa,rod,eq}$, as given in Table 3, not to exceed the corresponding values of $N_{sa,insert,eq}$ in Table 1 of this report; the nominal concrete breakout strength for anchors in tension must be calculated in accordance with ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, as described in Section 4.1.3 of this report; the nominal pullout strength need not be considered as noted in Section 4.1.4 of this report; the nominal concrete side-face blowout strength must be calculated in accordance with ACI 318-19 17.6.4.1 and 17.6.4.2, ACI 318-14 17.4.4.1 and 17.4.4.2, or ACI 318-11 D.5.4.1 and D.5.4.2, as applicable, and Section 4.1.5 of this report.

4.1.9.2 Seismic Shear: For the UPI anchors, the nominal concrete breakout strength and pryout strength in shear must be calculated in accordance with ACI 318-19 17.7.2 and 17.7.3, ACI 318-14 17.5.2 and 17.5.3, or ACI 318-11 D.6.2 and D.6.3, as applicable, as described in Sections 4.1.7 and 4.1.8 of this report. In accordance with ACI 318-19 17.7.1.2, ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable, the nominal steel strength for seismic loads, $V_{sa,eq}$, must be taken as the threaded steel element strength, $V_{sa,rod,eq}$, given in Table 3 of this report, not to exceed the corresponding values of $V_{sa,insert,eq}$, in Table 1.

4.1.10 Requirements for 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 318-19 17.8, ACI 318-14 17.6 or ACI 318-11 D.7, as applicable.

4.1.11 Requirements for Minimum Member Thickness, h_{min}, Minimum Anchor Spacing, s_{min}, and Minimum Edge Distance, c_{min}: Requirements on headed cast-in specialty anchor edge distance, spacing, member thickness, and concrete strength must be in accordance with the requirements in ACI 318-19 17.9, ACI 318-14 17.7 or ACI 318-11 D.8, as applicable for cast-in bolts.

4.1.12 Requirements for Critical Edge Distance: The calculation of the critical edge distance, c_{ac}, is not required, since the modification factor $\Psi_{cp,N}$ = 1.0 for cast-in anchors in accordance with ACI 318-19 17.6.2.6, ACI 318-14 17.4.2.5 or ACI 318-11 D.5.2.5, as applicable.

4.1.13 Lightweight Concrete: For the UPI anchors in lightweight concrete, the modification factor λ, for concrete breakout strength must be in accordance with ACI 318-19 17.2.4 (2021 IBC), ACI 318-14 17.2.6 (2018 and 2015 IBC), or ACI 318-11 D.3.6 (2012 IBC).

4.2 Allowable Stress Design (ASD):

4.2.1 General: Design values for use with allowable stress design (working stress design) load combinations calculated in accordance with Section 1605.1 of the 2021 IBC, Section 1605.3 of the 2018, 2015 and 2012 IBC, must be established as follows:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha}$$

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha}$$

where:

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

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

ϕN_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318-19 17.5 or ACI 318-14 17.3.1 and 2021, 2018 and 2015 IBC Section 1905.1.8, or ACI 318-11 D.4.1, as applicable (lbf or N).

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318-19 17.5, ACI 318-14 17.3.1 and 2021, 2018 and 2015 IBC Section 1905.1.8, ACI 318-11 D.4.1, as applicable (lbf or N).

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 non-ductile failure modes and required over-strength.

The requirements for member thickness, edge distance and spacing, described in this report, must apply. Examples of allowable stress design value determination for illustrative purposes are shown in Table 3.

4.2.2 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 318-19 17.8, ACI 318-14 17.6 or ACI 318-11 D.7, as applicable, as follows:

For shear loads $V_{applied} \leq 0.2V_{allowable,ASD}$, the full allowable load in tension must be permitted.

For tension loads $T_{applied} \leq 0.2T_{allowable,ASD}$, the full allowable load in shear must be permitted.

For all other cases:

$$\frac{T_{applied}}{T_{allowable,ASD}} + \frac{V_{applied}}{V_{allowable,ASD}} \leq 1.2 \quad \text{(Eq-1)}$$

4.3 Installation:

For the UPI anchors, installation parameters are provided in Table 1 and in Figures 1 and 2. UPI inserts must be assembled to the wood form using a hammer to drive the nails into the form prior to concrete placement. Following concrete placement and removal of formwork, remove protruding nails by shearing off with a hammer. From beneath the deck, following the concrete pour and wood form removal, the correct size threaded rod must be screwed into the UPI insert. The rod must be tightened until fully seated in the insert which will result in a minimum thread engagement equal to one rod diameter.

Installation of UPI anchors must be in accordance with this evaluation report and the manufacturer's published installation instruction (MPII) as provided in Figure 2 of this report. In the event of a conflict between this report and the MPII, this report governs.

4.4 Special Inspection:

Periodic special inspection is required in accordance with Section 1705.1.1 and Table 1705.3 of the 2021, 2018, 2015 or 2012 IBC, or Section 1704.15 and Table 1704.4 of the 2009 IBC, as applicable. The special inspector must make periodic inspections during installation of the headed cast-in specialty inserts to verify insert type, insert dimensions, concrete type, concrete compressive strength, insert spacing, edge distances, concrete member thickness, insert embedment, threaded rod fully seated into insert, and adherence to the manufacturer's printed 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 Sections 1705, 1706 and 1707 must be observed, where applicable.

5.0 CONDITIONS OF USE:

The UPI anchors described in this report are acceptable alternatives to what is specified in the codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Specialty inserts are limited to dry interior locations.

5.2 Specialty insert sizes, dimensions, minimum embedment depths, and other installation parameters are as set forth in this report.

5.3 Specialty inserts must be installed in accordance with the manufacturer's printed installation instructions (MPII) and this report. In case of conflict, this report governs.

5.4 Specialty inserts must be limited to use in cracked and uncracked normal-weight concrete, and lightweight concrete having a specified compressive strength, f'c, of 2,500 psi to 10,000 psi (17.2 MPa to 68.9 MPa).

5.5 The values of f'c, used for calculation purposes must not exceed 10,000 psi (68.9 MPa).

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

5.7 Allowable design values are established in accordance with Section 4.2.

5.8 Specialty insert spacing and edge distance as well as minimum member thickness must comply with ACI 318-19 17.9, ACI 318-14 17.7 or ACI 318-11 D.8 requirements, as applicable, for cast-in-place headed anchors, and Table 1 and Table 2, and Figure 1 and 2 of 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 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of the specialty inserts subjected to fatigue or shock loading is unavailable at this time, the use of these inserts under such conditions is beyond the scope of this report.

5.11 Specialty inserts may be installed in regions of concrete where analysis indicates cracking may occur ($f_t > f_r$), subject to the conditions of this report.

5.12 Specialty inserts may be used to resist short-term loading due to wind or seismic forces in locations designated as Seismic Design Categories A through F of the IBC, subject to the conditions of this report.

5.13 Where not otherwise prohibited in the code, inserts are permitted for use with fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:

- Headed cast-in specialty inserts that support 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.
- Headed cast-in specialty inserts are used to resist wind or seismic forces only.
- Headed cast-in specialty inserts are used to support nonstructural elements.

5.14 Special inspection must be provided in accordance with Section 4.4.

5.15 Specialty inserts are manufactured under an approved quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Headed Cast-in Specialty Inserts in Concrete (AC446), dated August 2018 (editorially revised April 2021).

6.2 Quality-control documentation.

7.0 IDENTIFICATION

7.1 The ICC-ES mark of conformity, electronic labeling, or the evaluation report number (ICC-ES ESR-5281) along with the name, registered trademark, or registered logo of the report holder must be included in the product label.

7.2 The UPI inserts are identified by packaging labeled with the manufacturer's name (UCAN Fastening Products) and contact information, insert name, insert size, and lot number. The inserts have various colored housings to identify the product size.

7.3 The report holder's contact information is the following:

UCAN FASTENING PRODUCTS, A DIVISION OF BRITISH FASTENING SYSTEMS LIMITED
155 CHAMPAGNE DRIVE, UNIT 10
TORONTO, ONTARIO M3J 2C6
CANADA
(416) 631-9400
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TABLE 1—UCAN UPI CAST-IN INSERT DESIGN AND INSTALLATION INFORMATION[1,2,3,4,5,6,7]

DESIGN INFORMATION	SYMBOL	UNITS	Nominal anchor diameter (in.)	
			3/8	1/2
Insert thread size	d	UNC	3/8-16	1/2-13
Insert steel characterization	-	-	Non-Ductile	
Effective embedment	h_{ef}	in. (mm)	1.75 (44.5)	1.75 (44.5)
Outside anchor diameter	d_a	in. (mm)	0.69 (17.5)	0.69 (17.5)
Bearing area	A_{brg}	in.^{2} (mm^2)	1.06 (685)	1.06 (685)
Minimum member thickness	h_{min}	in. (mm)	3.5 (89)	3.5 (89)
Minimum spacing	s_{min}	in. (mm)	6 (152)	
Minimum edge distance	c_{min}	in. (mm)	3 (76)	
Effectiveness factor concrete breakout[4]	k_c	-	24	
Modification factor for tension in uncracked concrete	$\psi_{c,N}$	-	1.25	
Nominal steel strength in tension as governed by the insert[2]	$N_{sa,insert}$	lb (kN)	9,900 (44.0)	13,775 (61.3)
Nominal seismic steel strength in tension as governed by the insert[2]	$N_{sa,insert,eq}$	lb (kN)	9,900 (44.0)	13,775 (61.3)
Strength reduction factor ϕ for tension, steel failure of insert	ϕ	-	0.65	
Strength reduction factor ϕ for tension, concrete failure modes, Condition B[5]	ϕ	-	0.70	
Concrete pullout, uncracked	$N_{p,uncr}$	-	N/A	
Concrete pullout, cracked	$N_{p,cr}$	-	N/A	
Nominal steel strength in shear as governed by the insert, normal-weight concrete[2]	$V_{sa,insert}$	lb (kN)	3,420 (15.2)	7,085 (31.5)
Nominal seismic steel strength in shear as governed by the insert, normal-weight concrete[2]	$V_{sa,insert,eq}$	lb (kN)	2,130 (9.5)	5,390 (24.0)
Coefficient for pryout strength	k_{cp}	-	1.0	
Strength reduction factor ϕ for shear, steel failure of insert	ϕ	-	0.60	
Strength reduction factor ϕ for shear, concrete failure modes, Condition B[5]	ϕ	-	0.70	

For SI: 1 inch = 25.4 mm. For pound-inch units: 1 mm = 0.03937 inch.

[1]Installation must comply with Section 4.3 and Figures 1 and 4 of this report.
[2]The design strength must be in accordance with ACI 318 (-19 or -14) Chapter 17 or ACI 318-11 Appendix D, as applicable, and Section 4.1 of this report. Values are for the insert only. The capacity of the threaded rod or other material threaded into the insert must be also be determined. See Table 3 for steel design information for common threaded rod elements.
[3]See ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable.
[4]See ACI 318-19 17.6.2.2, ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2, as applicable.
[5]For use with load combinations of ACI 318 (-19 and -14) Section 5.3 or ACI 318-11 Section 9.2, as applicable. Condition B applies where supplementary reinforcement in conformance with ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, is not provided. For cases where supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.
[6]Inserts must be installed in concrete with a minimum compressive strength f'_c of 2,500 psi.
[7]The design professional is responsible for checking threaded rod or bolt strength in tension, shear, and combined tension and shear, as applicable.

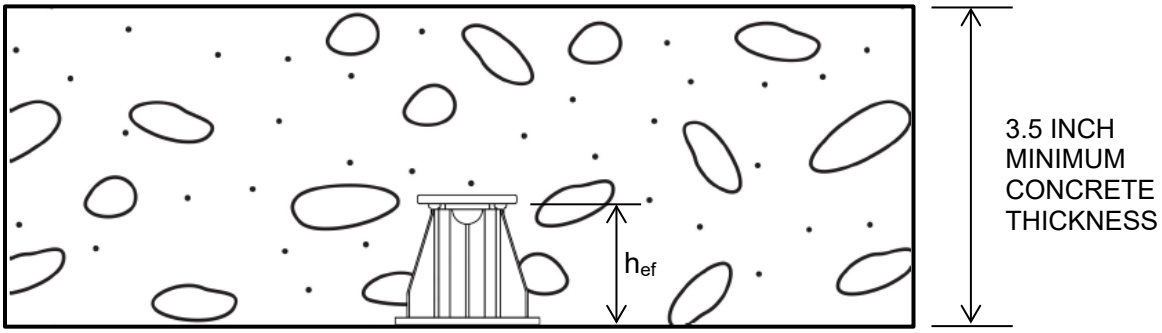


FIGURE 1— UCAN UPI INSERT IN CONCRETE

TABLE 2—STEEL DESIGN INFORMATION FOR COMMON THREADED ROD ELEMENTS USED WITH UCAN UPI CONCRETE INSERTS[1,2,3,4]

DESIGN INFORMATION	SYMBOL	UNITS	3/8-inch	1/2-inch
Threaded rod nominal outside diameter	d_{rod}	in. (mm)	0.375 (9.5)	0.500 (12.7)
Threaded rod effective cross-sectional area	A_{se}	in^2 (mm^2)	0.078 (50)	0.142 (92)
Nominal tension strength of ASTM A36 threaded rod in tension as governed by steel strength for static or seismic loading	$N_{sa,rod,A36}$ or $N_{sa,rod,eq,A36}$	lb (kN)	4,525 (20.0)	8,235 (36.6)
Nominal shear strength of ASTM A36 threaded rod in shear as governed by steel strength for static loading	$V_{sa,rod,A36}$	lb (kN)	2,695 (12.0)	4,490 (22.0)
Nominal shear strength of ASTM A36 threaded rod in shear as governed by steel strength for seismic loading	$V_{sa,rod,eq,A36}$	lb (kN)	1,900 (8.4)	3,460 (15.4)

For SI: 1 inch = 25.4 mm, 1 pound = 0.00445 kN, 1 in^2 = 645.2 mm^2. For pound-inch unit: 1 mm = 0.03937 inches.

[1]Values provided for steel element material types, or equivalent, based on minimum specified strength; $N_{sa,rod}$ and $V_{sa,rod}$ calculated in accordance with ACI 318-19 Eq. 17.6.1.2 and 17.7.1.2b, ACI 318-14 Eq. (17.4.1.2) and Eq. (17.5.1.2b) or ACI 318-11Eq. (D-2) and Eq. (D-29) respectively. $V_{sa,rod,eq}$ must be taken as $0.7V_{sa,rod}$. Materials of other strengths may be used and calculated in a similar manner.
[2]ϕN_{sa} shall be the lower of the $\phi N_{sa,rod}$ or $\phi N_{sa,insert}$ for static steel strength in tension; for seismic loading $\phi N_{sa,eq}$ shall be the lower of the $\phi N_{sa,rod,eq}$ or $\phi N_{sa,insert,eq}$.
[3]ϕV_{sa} shall be the lower of the $\phi V_{sa,rod}$ or $\phi V_{sa,insert}$ for static steel strength in tension; for seismic loading $\phi V_{sa,eq}$ shall be the lower of the $\phi V_{sa,rod,eq}$ or $\phi V_{sa,insert,eq}$.
[4]Strength reduction factors shall be taken from ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, for steel elements. Strength reduction factors for load combinations in accordance with ACI 318 (-19 and -14) Section 5.3 or ACI 318-11 Section 9.2, as applicable, governed by steel strength of ductile steel elements shall be taken as 0.75 for tension and 0.65 for shear. If the load combinations of ACI 318-11 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4.

TABLE 3—EXAMPLE ASD ALLOWABLE TENSION AND SHEAR DESIGN VALUES FOR ILLUSTRATIVE PURPOSES FOR UCAN UPI INSERTS INSTALLED IN NORMAL WEIGHT CONCRETE [1,2,3,4,5,6,7,8,9]

Nominal Insert Diameter (inches)	UPI	
	Tension (lbs)	Shear (lbs)
3/8	1,643	1,647
1/2	1,643	3,685

For SI: 1 inch = 25.4 mm, 1 pound = 0.00445 kN, 1 in^2 = 645.2 mm^2. For pound-inch unit: 1 mm = 0.03937 inches.

[1]Concrete strength f'_c = 2500 psi normal weight.
[2]Values are for single anchors with static tension or shear. Installation must be in accordance with applicable Figures 1 and 2.
[3]Values are for uncracked concrete.
[4]Load combinations as given in ACI 318 (-19 and -14) Section 5.3 or ACI 318-11 Section 9.2, as applicable (no seismic loading).
[5]30% dead load and 70% live load, controlling load combination 1.2D + 1.6 L.
[6]Calculation of ASD conversion α = 0.3*1.2 + 0.7*1.6 = 1.48
[7]Values assume no side-face blowout in tension.
[8]Values are for Condition B where supplementary reinforcement in accordance with ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, is not provided.
[9]The allowable loads shown are for the applicable insert only. Design professional is responsible for checking capacity of threaded rod, including tension, shear, and influence of bending on tension capacity when loaded in shear, or other material placed in insert.

1. Mark the locations on the formwork where the inserts will be installed per design specifications.

2. Position the inserts, one per location, over the marked locations, plastic surface and nails faced down.

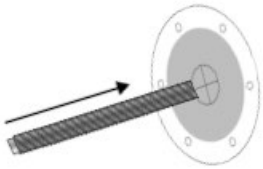
3. Using a hammer, drive the metal insert head down until the metal head contacts the plastic housing.

4. Pour concrete to completely enclose the inserts.

5. After formwork removal, bend the protruding nails outward, OR cut/snip them as necessary, e.g. for flush mounted fixtures.

6. After the concrete is cured, the insert is ready to be used.

7. Push the correct sice UNC threaded element (rod/bolt) through the center of the protective plastic seal and thread fully into the insert.



8. Attach fixtures per design specifications.

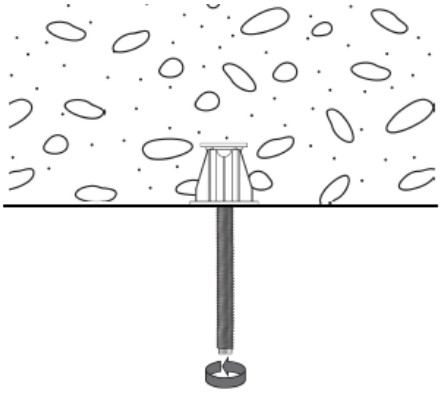


FIGURE 2—UCAN UPI CONCRETE INSERT MANUFACTURERS PRINTED INSTALLATION INSTRUCTIONS (MPII)

		Given: One ½ inch UCAN UPI12 anchor with an edge distance of 7 inches and spacing of 10 inches, loaded in tension. h_{ef}= 1.75 in No supplementary reinforcement Condition B per ACI 318-19 17.5.3, ACI 318-14 17.3.3 c) or ACI 318-11 D.4.3 c) Assume normal weight concrete, f'_c= 2,500 psi Assume uncracked concrete ASTM A36 attached steel rod insert element Using strength design provisions of ACI 318 (-19 or -14) Chapter 17, or ACI 318-11 Appendix D, calculate the nominal tensile strength and allowable stress design capacity for this configuration. For ASD, given 30% dead load and 70% live load, controlling load combination 1.2D + 1.6 L, calculation of ASD conversion α = 0.3*1.2 + 0.7*1.6 = 1.48

Calculations per ACI 318- and this report.	ACI 318-19 Chapter 17	ACI 318-14 Chapter 17	ACI 318-11 Appendix D
Step 1. Calculate steel tensile capacity. $N_{sa,insert}$ = → Given in Table 1 $N_{sa,insert}$= 13,775 lb. $\phi N_{sa,insert}$= (0.65) 13,775 lb. $\phi N_{sa,insert}$= **8,954 lb.** $N_{sa,rod,A36} = A_{se,N} f_{uta}$ → Given in Table 3 $N_{sa,rod,A36}$= 8,235 lb. $\phi N_{sa,rod,A36}$= (0.75) 8,235 lb. $\phi N_{sa,rod,A36}$ = **6,176 lb.**	17.6.1	17.4.1	D.5.1
Step 2. Calculate concrete breakout of anchor in tension. $N_{cb} = N_b (A_{Nc}/A_{Nco}) \psi_{ed,N} \psi_{c,N} \psi_{cp,N}$	17.6.2 a)	17.4.2.1 a)	D.5.2.1 a)
Step 2a. Check spacing and edge distance requirements. → Given in Table 1 c_{min} = 7 in > 3 in s_{min} = 10 in ≤ 6 in →okay spacing and edge distance	17.9	17.7	D.8
Step 2b. Determine λ; normal weight concrete; λ= 1.0	17.10	17.2.6	D.3.6
Step 2c. Calculate basic concrete breakout strength in tension. $N_b = 24\lambda\sqrt{f'_c}(h_{ef})^{1.5}$ $N_b = 24(1.0)\sqrt{2{,}500}(1.75)^{1.5}$ N_b = 2,778 lb	17.6.2.2	17.4.2.2	D.5.2.2
Step 2d. Determine ratio of projected concrete breakout areas. Single anchor, c_{min} = 7 in > 1.5 h_{ef} = 2.625 $A_{Nc} = A_{Nc0}$= 27.56 in^2 ; A_{Nc} / A_{Nc0} = 1.0	17.6.2.3	17.4.2.3	D.5.2.3
Step 2e. Determine $\psi_{ec,N}$. No eccentricity $\psi_{ec,N} = 1.0$	17.6.2.4	17.4.2.4	D.5.2.4
Step 2f. Determine $\psi_{ed,N}$. c_{min} = 7 in > 1.5 h_{ef} = 2.625 $\psi_{ed,N} = 1.0$	17.6.2.5	17.4.2.5	D.5.2.5
Step 2g. Determine $\psi_{c,N}$. uncracked concrete → $\psi_{c,N}$ = 1.25	17.6.2.6	17.4.2.6	D.5.2.6
Step 2j. Calculate ϕN_{cb}. $\phi N_{cb} = 0.70 * 2{,}778 * \frac{27.56}{27.56} * 1.0 * 1.25 * 1.0$ ϕN_{cb} = **2,431 lb**	17.5.3 c) 17.6.2.1 a)	17.3.3 c) 17.4.2.1 a)	D.4.3 c) D.5.2.1 a)
Step 3. Check pullout strength of concrete in tension. $N_{pN} = \psi_{c,p} N_p$; Table 1 – Pullout strength does not govern.	17.6.3.1	17.4.3.1	D.5.3.1
Step 4. Calculate concrete side face blowout. $h_{ef} < 2.5c_a$ → not applicable	17.6.4.2	17.4.4.1	D.5.4.1
Step 5. Determine the controlling tensile strength. *Steel insert strength* $\phi N_{sa,insert}$ = *8,954 lb* *Steel insert element strength* $\phi N_{sa,rod,A36}$ = *6.176 lb* *Concrete breakout strength* ϕN_{cb} = ***2,431 lb CONTROLS***	17.5.1.2	17.3.1	D.4.1
Step 6. Determine allowable stress design capacity using load conditions given above: $T_{allowable,ASD} = \phi N_n / \alpha$ = 2,431 / 1.48 = **1,643 lb**	ESR Section 4.2	ESR Section 4.2	ESR Section 4.2

FIGURE 3—DESIGN EXAMPLE FOR UCAN UPI ANCHORS