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ESR-3912

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DIVISION: 03 00 00—CONCRETE
SECTION: 03 16 00—CONCRETE ANCHORS

REPORT HOLDER:

DEWALT

701 EAST JOPPA ROAD
TOWSON, MARYLAND 21286

EVALUATION SUBJECT:

MINI-UNDERCUT+™ ANCHORS IN CRACKED AND UNCRACKED CONCRETE
(DEWALT)



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

REPORT HOLDER:

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EVALUATION SUBJECT:

MINI-UNDERCUT+™ ANCHORS IN CRACKED AND UNCRACKED CONCRETE (DEWALT)

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2015, 2012 and 2009 *International Building Code*® (IBC)
- 2015, 2012 and 2009 *International Residential Code*® (IRC)

Property evaluated:

Structural

2.0 USES

The DEWALT Mini-Undercut+ anchor is used to resist static, wind and seismic, tension and shear loads in the underside (formed surface) of cracked and 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); Use of anchors is limited to supporting non-structural components.

The anchors may also be installed in the underside of cracked and uncracked hollow-core concrete slabs having a minimum specified compressive strength, f'_c , of 6,000 psi (41.4 MPa); Use of anchors is limited to supporting non-structural components.

3.0 DESCRIPTION

3.1 Mini-Undercut+ Anchors:

Mini-Undercut+ anchors are internally threaded undercutting anchors which receive threaded steel inserts such as threaded rods and bolts in $\frac{3}{8}$ -inch (9.5 mm) diameter.

Available nominal size is $\frac{3}{8}$ -inch (9.5 mm). The anchors are manufactured from carbon steel and comprised of an undercutting sleeve and an internally threaded plow which

have a minimum 0.0002-inch (5 μ m) zinc plating in accordance with ASTM B633. The Mini-Undercut+ anchor is illustrated in Figure 1.

The anchors must be installed in predrilled holes using a stop drill bit and engaged with a setting tool using a recommended hammer drill, all provided by DEWALT and noted in Table B of this report. The anchor expands into the sides of the predrilled hole and interlocks with the base material during installation.

3.2 Steel Insert Elements:

Threaded steel insert elements must be threaded into the Mini-Undercut+ anchors to form a connection. The material properties of the steel bolts and threaded rods must comply with minimum ASTM A36 or equivalent.

3.3 Concrete and Hollow-core Concrete Slabs:

Normal-weight concrete must comply with Sections 1903 and 1905 of the IBC. The minimum concrete compressive strength at the time of anchor installation is noted in Section 5.3 of this report. Hollow-core precast concrete slabs must comply with the configuration and dimensions as indicated in Figure 4.

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design strength of anchors complying with the 2015 IBC, as well as Section R301.1.3 of the 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 strength of anchors complying with the 2009 IBC, as well as Section R301.1.3 of the 2009 IRC, must be determined in accordance with ACI 318-08 Appendix D and this report.

Design parameters provided in Tables 2 and 3 of this report are based on the 2015 IBC (ACI 318-14) and the 2012 IBC (ACI 318-11) unless noted otherwise in Section 4.1.1 through 4.1.11 of this report.

The strength design of anchors must comply with ACI 318-14 17.3.1 or ACI 318-11 D.4.1, as applicable, except as required in ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Strength reduction factors, ϕ , as given in Tables 2 and 3 of this report, must be used in lieu of ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, for load

combinations calculated in accordance with Section 1605.2 of the IBC, Section 5.3 of ACI 318-14, or Section 9.2 of ACI 318-11, as applicable. Strength reduction factors, ϕ , as given in Appendix C of ACI 318-11 shall not be used. The value of f'_c used in the calculation must be limited to a maximum of 8,000 psi (55.2 MPa), in accordance with 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, N_{sa} : The nominal static steel strength in tension, N_{sa} , of a single anchor must be calculated in accordance with ACI 318-14 17.4.1 or ACI 318-11 Section D.5.1, as applicable, for the threaded steel element, $N_{sa,rod}$, as illustrated in Table 5 of this report. The lesser of $\phi N_{sa,rod}$ in Table 5 or ϕN_{sa} provided in Table 2 for the Mini-Undercut+ anchor shall be used as the steel strength in tension.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension N_{cb} or N_{cbg} : The nominal concrete breakout strength of a single anchor or a group of anchors in tension, N_{cb} or N_{cbg} , respectively, must be calculated in accordance with ACI 318-14 17.4.2 or ACI 318-11 D.5.2, as applicable, with modifications as described in this section. The basic concrete breakout strength of a single anchor in tension in cracked concrete, N_b , must be calculated according to ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2, as applicable, using the values of h_{ef} and k_{cr} as given in Table 2 of this report. The nominal concrete breakout strength in tension in regions where analysis indicates no cracking in accordance with ACI 318-14 17.4.2.6 or ACI 318-11 D.5.2.6, as applicable, must be calculated with the value of k_{uncr} as given in Table 2 of this report and with $\psi_{c,N} = 1.0$.

4.1.4 Requirements for Static Pullout Strength in Tension, N_{pn} : The nominal pullout strength of a single anchor or a group of anchors, in accordance with ACI 318-14 17.4.3 or ACI 318-11 D.5.3, as applicable, in cracked and uncracked concrete, $N_{p,cr}$ and $N_{p,uncr}$, respectively, is given in Table 2. In lieu of ACI 318-14 17.4.3.6 or ACI 318-11 D.5.3.6, as applicable, $\psi_{c,P} = 1.0$ for all design cases. The nominal pullout strength in cracked concrete may be adjusted by calculation according to Eq-1:

$$N_{p,f'_c} = N_{p,cr} \sqrt{\frac{f'_c}{2,500}} \quad (\text{lb, psi}) \quad (\text{Eq-1})$$

$$N_{p,f'_c} = N_{p,cr} \sqrt{\frac{f'_c}{17.2}} \quad (\text{N, MPa})$$

where f'_c is the specified concrete compressive strength. For hollow-core concrete slabs, the value of 6,000 psi (41.4 MPa) must be substituted for the value of 2,500 psi (17.2 MPa) in the denominator.

Where value for $N_{p,uncr}$ is not provided in Table 2 of this report, the pullout strength in tension need not be considered or evaluated.

4.1.5 Requirements for Static Steel Shear Capacity, V_{sa} : The nominal static steel strength in shear, V_{sa} , of a single anchor must be taken as the threaded steel element strength, $V_{sa,rod}$, given in Table 5 of this report. The lesser of $\phi V_{sa,rod}$ in Table 5 or ϕV_{sa} in Table 3 for the Mini-Undercut+ anchor shall be used as the steel strength in shear, and must be used in lieu of the values derived by calculation from 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.

4.1.6 Requirements for Static Concrete Breakout Strength in Shear, V_{cb} or V_{cbg} : The nominal 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 318-14 17.5.2 or ACI 318-11 D.6.2,

as applicable, with modifications as described in this section. The basic concrete breakout strength of a single anchor in shear, V_b , must be calculated in accordance with ACI 318-14 17.5.2.2 or ACI 318-11 D.6.2.2, as applicable, using the value of ℓ_e and d_a given in Table 3 of this report.

For anchors installed in hollow-core concrete slabs, the nominal 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 318-14 17.5.2 or ACI 318-11 D.6.2, as applicable, using the actual member cover thickness of the hollow-core, $h_{min,core}$, in lieu of h_{min} , in the determination of A_{vc} . Minimum member cover thickness for anchors in the hollow-core concrete slabs is given in Table 1 and shown in Figure 4 of this report, as applicable.

4.1.7 Requirements for Static Concrete Pryout Strength in Shear, V_{cp} or V_{cpg} : 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 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable, using the value of k_{cp} provided in Table 3, and the value of N_{cb} or N_{cbg} as calculated in Section 4.1.3 of this report.

4.1.8 Requirements for Seismic Design:

4.1.8.1 General: For load combinations including seismic loads, the design must be performed in accordance with ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable. Modifications to ACI 318-14 17.2.3 shall be applied under 2015 IBC Section 1905.1.8. For the 2012 IBC, Section 1905.1.9 shall be omitted. Modifications to ACI 318-08 D.3.3 shall be applied under Section 1908.1.9 of the 2009 IBC.

The nominal steel strength and nominal concrete breakout strength for anchors in tension, and the nominal concrete breakout strength and pryout strength for anchors in shear, must be calculated according to ACI 318-14 17.4 and 17.5 or ACI 318-11 D.5 and D.6, respectively, as applicable, taking into account the corresponding values in Tables 2 and 3 of this report.

The anchors comply with ACI 318-14 2.3 or ACI 318-11 D.1, as applicable, as brittle steel elements and must be designed in accordance with ACI 318-14 17.2.3.4, 17.2.3.5, 17.2.3.6, or 17.2.3.7; ACI 318-11 D.3.3.4, D.3.3.5, D.3.3.6 or D.3.3.7; or ACI 318-08 D.3.3.4, D.3.3.5 or D.3.3.6, as applicable.

The $\frac{3}{8}$ -inch-diameter (9.5 mm) Mini-Undercut+ anchors may be installed in regions designated as IBC Seismic Design Categories A through F.

4.1.8.2 Seismic Tension: The nominal steel strength and nominal concrete breakout strength for anchors in tension must be calculated according to ACI 318-14 17.4.1 and 17.4.2, or ACI 318-11 D.5.1 and D.5.2, as applicable, as described in Sections 4.1.2 and 4.1.3 of this report. In accordance with ACI 318-14 17.4.3.2 or ACI 318-11 D.5.3.2, as applicable, the appropriate value for nominal pullout strength in tension for seismic loads, $N_{p,eq}$ described in Table 2 of this report, must be used in lieu of N_p . $N_{p,eq}$ may be adjusted by calculations for concrete compressive strength in accordance with Eq-1 of this report.

4.1.8.3 Seismic Shear: The nominal concrete breakout strength and pryout strength for anchors in shear must be calculated according to ACI 318-14 17.5.2 or 17.5.3, or ACI 318-11 D.6.2 and D.6.3, respectively, as described in Sections 4.1.6 and 4.1.7 of this report. In accordance with ACI 318-14 17.5.1.2 or ACI 318-11 D.6.1.2, as applicable,

the appropriate value for nominal steel strength in shear for seismic loads, $V_{sa,eq}$ described in Table 3 of this report, must be used in lieu of V_{sa} .

4.1.9 Requirements for the Interaction of Tensile and Shear Forces: The effects of combined tensile and shear forces must be determined in accordance with ACI 318-14 17.6 or ACI 318-11 D.7.

4.1.10 Requirements for Critical Edge Distance, c_{ac} : In applications where $c < c_{ac}$ and supplemental reinforcement to control splitting of the concrete is not present, the concrete breakout strength in tension for uncracked concrete, calculated according to ACI 318-14 17.4.2 or ACI 318 D.5.2, as applicable, must be further multiplied by the factor $\psi_{cp,N}$ as given by Eq 2:

$$\psi_{cp,N} = \frac{c}{c_{ac}} \quad (\text{Eq-2})$$

whereby the factor $\psi_{cp,N}$ need not be taken less than $\frac{1.5h_{ef}}{c_{ac}}$.

For all other cases, $\psi_{cp,N} = 1.0$. In lieu of using ACI 318-14 17.7.6 or ACI 318-11 D.8.6, as applicable, values of c_{ac} provided in Table 2 of this report must be used, as applicable

4.1.11 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: In lieu of ACI 318-14 17.7.1 and 17.7.3, or ACI 318-11 D.8.1 and D.8.3, respectively, as applicable, the values of s_{min} and c_{min} as given in Table 1 of this report must be used. In lieu of ACI 318-14 17.7.5 or ACI 318-11 D.8.5, as applicable, minimum member thicknesses, h_{min} , as given in Table 1 of this report must be used.

4.2 Allowable Stress Design (ASD):

4.2.1 General: Design values for use with allowable stress design load combinations calculated in accordance with Section 1605.3 of the IBC must be established using the following equations:

$$T_{allowable,ASD} = \phi N_n / \alpha \quad (\text{Eq-3})$$

$$V_{allowable,ASD} = \phi V_n / \alpha \quad (\text{Eq-4})$$

where:

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

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

$$\phi N_n = \text{Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318-14 Chapter 17 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Section 1908.1.9, and Section 4.1 of this report, as applicable (lbf or kN).}$$

$$\phi V_n = \text{Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318-14 Chapter 17 and 2015 IBC Section 1905.1.8, ACI 318-11 Appendix D, ACI 318-08 Appendix D and 2009 IBC Section 1908.1.9, and Section 4.1 of this report, as applicable (lbf or kN).}$$

$$\alpha = \text{Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, } \alpha \text{ must include all applicable factors to account for nonductile failure modes and required over-strength.}$$

Limits on edge distance, anchor spacing and member thickness as given in Table 1 of this report must apply.

4.2.2 Interaction of Tensile and Shear Forces: The interaction must be calculated and consistent with ACI 318-14 17.6 or ACI 318-11 D.7, as applicable, as follows:

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

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

$$\text{For all other cases: } \frac{T_{applied}}{T_{allowable,ASD}} + \frac{V_{applied}}{V_{allowable,ASD}} \leq 1.2 \quad (\text{Eq-5})$$

4.3 Installation:

Installation parameters are provided in Table 1 and Figures 1A, 2, 3 and 4 of this report. Anchor locations must comply with this report and plans and specifications approved by the code official. The Mini-Undercut+ anchor must be installed according to manufacturer's published installation instructions and this report. Anchors must be installed in holes drilled into concrete using carbide-tipped masonry drill bits complying with ANSI B212.15-1994. The stop drill bit size and drilled hole depth must be in accordance with Table 1. The anchors must be installed in drilled holes with a powered hammer drill and fitted with a Mini-Undercut+ setting tool supplied by DEWALT. The allowable ranges of installation parameters for the Mini-Undercut+ anchors are given in Table 1. The anchors must be driven until the shoulder of the Mini-Undercut+ anchor is flush with the surface of the concrete. The minimum thread engagement of a threaded rod or bolt insert element assembly into the Mini-Undercut+ anchor must be full anchor depth.

4.4 Special Inspection:

Periodic special inspection is required, in accordance with Section 1705.1.1 and Table 1705.3 of the 2015 IBC or 2012 IBC, as applicable; Section 1704.15 and Table 1704.4 of the 2009 IBC, as applicable. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, hole dimensions, drill bit size and type, anchor spacing, edge distances, concrete thickness, anchor embedment, and adherence to the installation instructions. The special inspector must be present as often as required in accordance with the "statement of special inspection."

5.0 CONDITIONS OF USE

The Mini-Undercut+ 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** The anchors must be installed in accordance with the manufacturer's published installation instructions and this report. In case of conflict, this report governs.
- 5.2** Anchor sizes, dimensions and minimum embedment depths are as set forth in this report.
- 5.3** The anchors must be limited to installation in the formed surface of cracked and 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), and cracked and uncracked hollow-core concrete slabs with the configuration and dimensions as indicated in Figure 4 having a minimum specified compressive strength, f'_c , of 6,000 psi (20.7 MPa).
- 5.4** The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.1 MPa).

- 5.5 Strength design values must be established in accordance with Section 4.1 of this report.
- 5.6 Allowable stress design values must be established in accordance with Section 4.2 of this report.
- 5.7 Anchor spacing and edge distance, as well as minimum member thickness, must comply with Table 1 and Figures 2 and 4 of this report.
- 5.8 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.
- 5.9 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 such conditions is beyond the scope of this report.
- 5.10 Anchors may be installed in regions of concrete where cracking has occurred or where analysis indicates cracking may occur ($f_t > f_r$), subject to the conditions of this report.
- 5.11 Anchors may be used to resist short-term loading due to wind or seismic forces (Seismic Design Categories A through F under the IBC), subject to the conditions of this report.
- 5.12 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:
 - The anchors are used to resist wind or seismic forces only.
 - Anchors are used to support nonstructural elements.

- 5.13 Special inspection must be provided in accordance with Section 4.4 of this report.
- 5.14 Use of anchors is limited to supporting non-structural components.
- 5.15 Use of anchors is limited to dry, interior locations.
- 5.16 Anchors are manufactured under an approved quality-control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

- 6.1 Reports of tension and shear tests of anchors in concrete in accordance with ACI 355.2-07 / ACI 355.2-04; including but not limited to reference, reliability and service-condition tests in cracked and uncracked concrete.
- 6.2 Reports of tension and shear tests of anchors in hollow-core concrete slabs in accordance with ASTM E488 and applicable sections of ACI 355.2.
- 6.3 Documentation on the strength and reliability of anchors in concrete with embedment depths of less than one-inch.
- 6.4 Quality-control documentation in accordance with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) dated June 2014.

7.0 IDENTIFICATION

The Mini-Undercut+ anchors have only one size and one type, which is identified in the field by their unique dimensional characteristics and packaging. Packages are identified with the anchor name, part number, type, size, and the evaluation report number (ESR-3912).

TABLE A—INSTALLATION AND DESIGN INDEX¹

Product Name	Installation Specifications	Tension Design Data		Shear Design Data	
		Concrete	Hollow-core Concrete Slabs	Concrete	Hollow-core Concrete Slabs
Mini-Undercut+	Table 1	Table 2	Table 2	Table 3	Table 3
Concrete Type	Concrete State	Anchor Nominal Size		Seismic Design Categories ²	
Normal-weight	Cracked	3/8"		A through F	
	Uncracked	3/8"		A through F	

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

¹Reference ACI 318-14 17.3.1.1 or ACI 318-11 D.4.1.1, as applicable. The controlling strength is decisive from all appropriate failure modes (i.e. steel, concrete breakout, pullout, pryout, as applicable) and design assumptions.

²See Section 4.1.8 for requirements for seismic design, where applicable.

TABLE B—MINI-UNDERCUT+ SYSTEM

Stop Drill Bit (SDS)	Mini-Undercut+ Anchor	Setting Tool (SDS)	DEWALT Recommended SDS Hammer-Tools
PPA2431720	PFM2111820	PFM2101720	DCH273, DCH133, D25133, D25262 ¹

¹Refer to Table 1 for required approximate tool impact power.

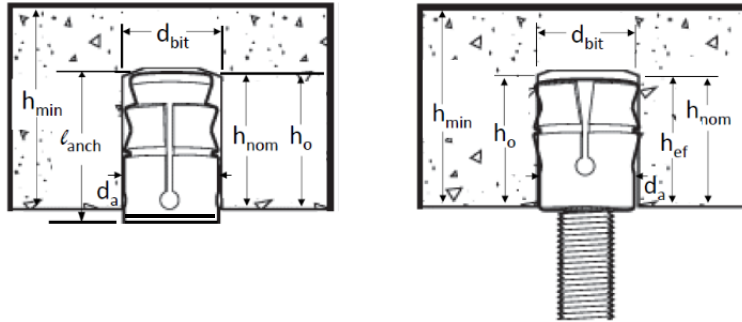


FIGURE 1A—MINI- UNDERCUT+ ANCHOR DETAIL Before (Left Picture) and After (Right Picture) Anchor Setting



FIGURE 1B—STOP DRILL BIT (Top Picture), MINI-UNDERCUT+ ANCHOR (Center Picture) AND SETTING TOOL (Bottom Picture)

TABLE 1—MINI-UNDERCUT+ ANCHOR INSTALLATION SPECIFICATIONS AND SUPPLEMENTAL INFORMATION^{1,2,3}

Anchor Property / Setting Information	Symbol	Units	Nominal Anchor Size / Threaded Rod Diameter (inch)	
			³ / ₈	
Nominal outside anchor diameter	d_a	in. (mm)	0.625 (15.9)	
Internal thread diameter (UNC)	d	in. (mm)	0.375 (9.5)	
Nominal stop drill bit diameter	d_{bit}	in.	⁵ / ₈ ANSI	
Minimum nominal embedment depth	h_{nom}	in. (mm)	³ / ₄ (19)	
Effective embedment	h_{ef}	in. (mm)	³ / ₄ (19)	
Hole depth	h_o	in. (mm)	0.75 (19)	
Overall anchor length (prior to setting)	l_{anch}	in. (mm)	¹⁵ / ₁₆ (24)	
Approximate tool impact power (hammer-drill)	-	J	2.1 to 2.8	
Minimum diameter of hole clearance in fixture for steel insert element (following anchor installation)	d_h	in.	⁷ / ₁₆	
Minimum member thickness in normal-weight concrete	h_{min}	in. (mm)	2 ¹ / ₂ (64)	
Minimum cover thickness in hollow core concrete slabs (see Figure 4)	$h_{min,core}$	in. (mm)	1 ¹ / ₂ (38)	
Critical edge distance	c_{ac}	in. (mm)	2 ¹ / ₄ (57)	
Minimum edge distance	c_{min}	in. (mm)	2 ¹ / ₂ (64)	
Minimum spacing distance	s_{min}	in. (mm)	2 ³ / ₄ (70)	
Max. installation torque	T_{max}	ft.-lb. (N-m)	5 (7)	
Effective tensile stress area (undercut anchor body)	A_{se}	in. ² (mm ²)	0.044 (28.4)	
Minimum specified ultimate strength	f_{uta}	psi (N/mm ²)	95,000 (655)	
Minimum specified yield strength	f_{ya}	psi (N/mm ²)	76,000 (524)	
Mean axial stiffness ⁴	Uncracked concrete	β_{uncr}	lbf/in.	50,400
	Cracked concrete	β_{cr}	lbf/in.	29,120

For SI: 1 inch = 25.4 mm, 1 ft-lb = 1.356 N-m.

¹The information presented in this table is to be used in conjunction with the design criteria of ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable.

²For installation detail for anchors in hollow-core concrete slabs, see Figure 4.

³The embedment depth, h_{nom} , is measured from the outside surface of the concrete member to the embedded end of the anchor, see Figure 1A.

⁴Mean values shown, actual stiffness varies considerably depending on concrete strength, loading and geometry of application.

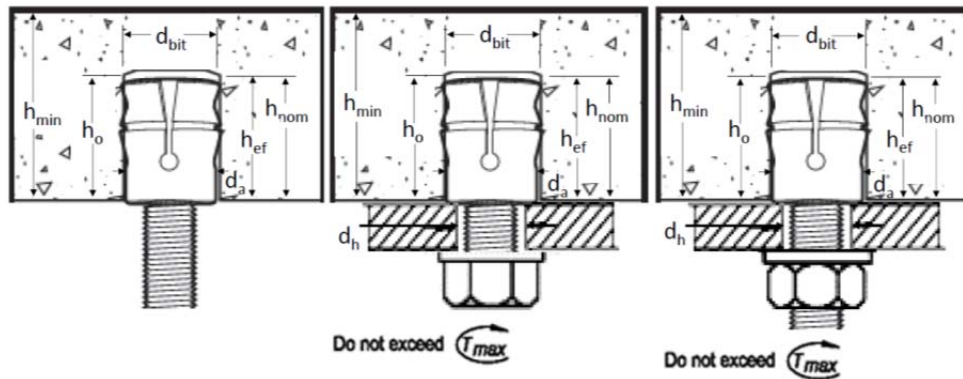


FIGURE 2—MINI-UNDERCUT+ ANCHOR INSTALLED WITH STEEL INSERT ELEMENT

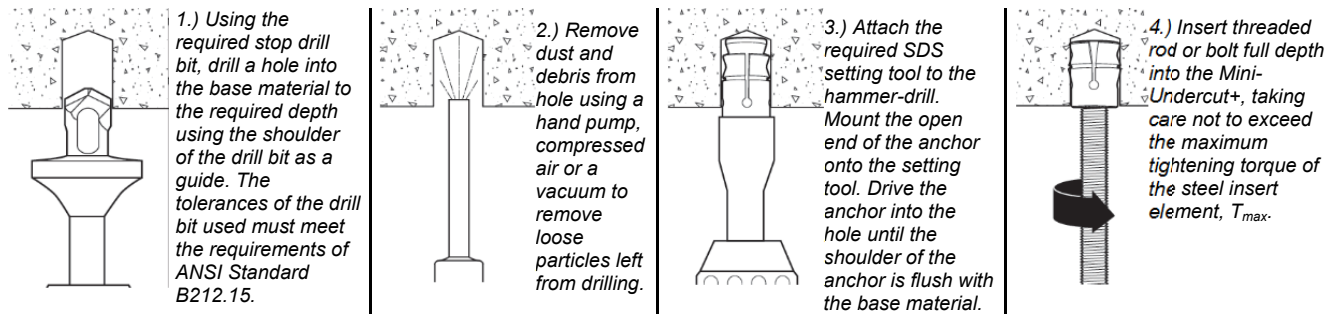


FIGURE 3—MINI-UNDERCUT+ SCREW ANCHOR INSTALLATION INSTRUCTIONS IN THE UNDERSIDE FORMED SURFACE OF CONCRETE

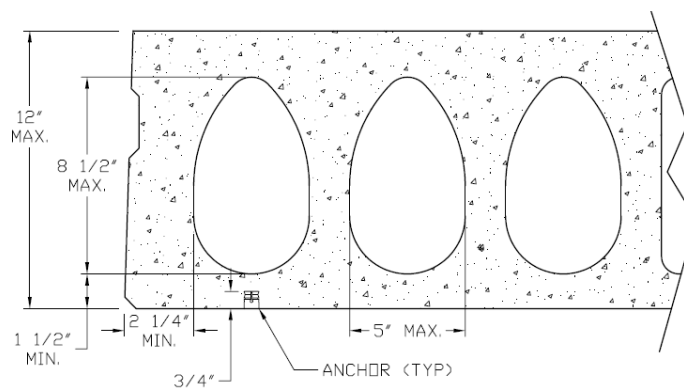


FIGURE 4—MINI-UNDERCUT+ INSTALLATION DETAIL FOR ANCHORS IN THE UNDERSIDE OF HOLLOW-CORE CONCRETE SLABS

TABLE 2—TENSION DESIGN INFORMATION FOR MINI-UNDERCUT+ ANCHORS IN THE UNDERSIDE OF NORMAL-WEIGHT CONCRETE AND THE UNDERSIDE OF HOLLOW CORE CONCRETE SLABS^{1,2,3,4,5,6,7}

Design Characteristic	Notation	Units	Nominal Anchor Size / Threaded Rod Diameter (in.)
			³ / ₈ inch
Anchor category	1, 2 or 3	-	1
Nominal embedment depth	h_{nom}	in. (mm)	³ / ₄ (19)
STEEL STRENGTH IN TENSION (ACI 318-14 17.4.1 or ACI 318-11 D.5.1)			
Steel strength in tension	N_{sa}	lb (kN)	4,180 (18.6)
Reduction factor, steel strength	ϕ	-	0.65
CONCRETE BREAKOUT STRENGTH IN TENSION (ACI 318-14 17.4.2 or ACI 318-11 D.5.2)			
Effective embedment	h_{ef}	in. (mm)	0.75 (19)
Effectiveness factor for uncracked concrete	k_{uncr}	-	24
Effectiveness factor for cracked concrete	k_{cr}	-	17
Modification factor for cracked and uncracked concrete	$\psi_{c,N}$	-	1.0 (see note 5)
Critical edge distance	c_{ac}	in. (mm)	2 ¹ / ₄ (57)
Reduction factor, concrete breakout strength	ϕ	-	0.40
PULLOUT STRENGTH IN TENSION (ACI 318-14 17.4.3 or ACI 318-11 D.5.3)			
Pullout strength, uncracked concrete	$N_{p,uncr}$	lb (kN)	See note 7
Pullout strength, cracked concrete	$N_{p,cr}$	lb (kN)	455 (2.0)
Reduction factor, pullout strength	ϕ	-	0.40
PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS (ACI 318-14 17.2.3.3 or ACI 318-11 D.3.3.3)			
Characteristic pullout strength, seismic	$N_{p,eq}$	lb (kN)	410 (1.82)
Reduction factor, pullout strength, seismic	ϕ	-	0.40

For SI: 1 inch = 25.4 mm, 1 ksi = 6.894 N/mm²; 1 lbf = 0.0044 kN.

¹The data in this table is intended to be used with the design provisions of ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable; for anchors resisting seismic load combinations the additional requirements of ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable, shall apply.

²Installation must comply with manufacturer's published installation instructions and details.

³All values of ϕ are applicable with the load combinations of IBC Section 1605.2, ACI 318-14 Section 5.3, or ACI 318-11 Section 9.2.

⁴The steel strength shown in this table is for the Mini-Undercut+ anchors only. Design professional is responsible for checking threaded rod strength in tension, shear, and combined tension and shear, as applicable. See Table 5 for steel design information for threaded rod elements.

⁵Select the appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}) and use $\psi_{c,N} = 1.0$.

⁶For calculation of N_{pn} see Section 4.1.4 of this report. The characteristic pullout strength for concrete compressive strengths greater than 2,500 psi for anchors may be increased by multiplying the value in the table by $(f'_c / 2,500)^{0.5}$ for psi or $(f'_c / 17.2)^{0.5}$. For hollow-core concrete slabs the characteristic pullout strength for concrete compressive strengths greater than 6,000 psi for anchors may be increased by multiplying the value in the table by $(f'_c / 6,000)^{0.5}$ for psi or $(f'_c / 41.4)^{0.5}$.

⁷Reported values for characteristic pullout strength in tension for seismic applications are based on test results per ACI 355.2, Section 9.5.

TABLE 3—SHEAR DESIGN INFORMATION FOR MINI-UNDERCUT+ ANCHORS IN THE UNDERSIDE OF NORMAL-WEIGHT CONCRETE AND THE UNDERSIDE OF HOLLOW CORE CONCRETE SLABS^{1,2,3,4,5,6}

Design Characteristic	Notation	Units	Nominal Anchor Size / Threaded Rod Diameter (in.)
			³ / ₈ inch
Anchor category	1, 2 or 3	-	1
Nominal embedment depth	h_{nom}	in. (mm)	³ / ₄ (19)
STEEL STRENGTH IN SHEAR (ACI 318-14 17.5.1 or ACI 318-11 D.6.1)			
Steel strength in shear	V_{sa}	lb (kN)	985 (4.4)
Reduction factor, steel strength	ϕ	-	0.60
STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS (ACI 318-14 17.2.3.3 or ACI 318-11 D.3.3.3)			
Steel strength in shear, seismic	$V_{sa,eq}$	lb (kN)	895 (4.0)
Reduction factor, steel strength in shear, seismic	ϕ	-	0.60
CONCRETE BREAKOUT STRENGTH IN SHEAR (ACI 318-14 17.5.2 or ACI 318-11 D.6.2)			
Load bearing length of anchor in shear	ℓ_e	in. (mm)	0.75 (19)
Nominal outside anchor diameter	d_a	in. (mm)	0.625 (15.9)
Reduction factor for concrete breakout strength	ϕ	-	0.45
PRYOUT STRENGTH IN SHEAR (ACI 318-14 17.5.3 or ACI 318-11 D.6.3)			
Coefficient for prout strength	k_{cp}	-	1.0
Effective embedment	h_{ef}	in. (mm)	0.75 (19)
Reduction factor, prout strength	ϕ	-	0.45

For **SI**: 1 inch = 25.4 mm, 1 lbf = 0.0044 kN.

¹The data in this table is intended to be used with the design provisions of ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable; for anchors resisting seismic load combinations the additional requirements of ACI 318-17 17.2.3 or ACI 318-11 D.3.3, as applicable shall apply

²Installation must comply with manufacturer’s published installation instructions and details.

³All values of ϕ are applicable with the load combinations of IBC Section 1605.2, ACI 318-14 Section 5.3, or ACI 318-11 Section 9.2.

⁴The strength shown in this table is for the Mini-Undercut+ anchors only. Design professional is responsible for checking threaded rod strength in tension, shear, and combined tension and shear, as applicable. See Table 5 for steel design information for threaded rod elements.

⁵Reported values for steel strength in shear are based on test results per ACI 355.2, Section 9.4 (in cracked concrete) and must be used for design in lieu of the calculated results using equation 17.5.1.2b of ACI 318-14 or equation D-29 in ACI 318-11 D.6.1.2.

⁶Reported values for steel strength in shear for the Mini-Undercut+ anchors are for seismic applications and based on test results in accordance with ACI 355.2, Section 9.6 and must be used for design.

TABLE 4—SPECIFICATIONS AND PHYSICAL PROPERTIES OF COMMON CARBON STEEL THREADED ROD ELEMENTS

THREADED ROD SPECIFICATION		UNITS	MIN. SPECIFIED ULTIMATE STRENGTH, f_{uta}	MIN. SPECIFIED YIELD STRENGTH 0.2 PERCENT OFFSET, f_{ya}	f_{uta} — f_{ya}	ELONGATION MINIMUM PERCENT	REDUCTION OF AREA MIN. PERCENT	RELATED NUT SPECIFICATION ³
Carbon Steel	ASTM A36/A36M ¹ and F1554 ² Grade 36	psi (MPa)	58,000 (400)	36,000 (248)	1.61	23	40 (50 for A36)	ASTM A194 / A563 Grade A

For **SI**: 1 inch = 25.4 mm, 1 psi = 0.006897 MPa. For **pound-inch** units: 1 mm = 0.03937 inch, 1 MPa = 145.0 psi.

¹Standard Specification for Carbon Structural Steel.

²Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

³Where nuts are applicable, nuts of other grades and style having specified proof load stress greater than the specified grade and style are also suitable.

TABLE 5—STEEL DESIGN INFORMATION FOR THREADED ROD ELEMENTS USED WITH MINI-UNDERCUT+ ANCHORS^{1,2,3,4}

DESIGN INFORMATION	SYMBOL	UNITS	³ / ₈ -inch
Threaded rod nominal outside diameter	d_{rod}	in. (mm)	0.375 (9.5)
Threaded rod effective cross-sectional area	A_{se}	in ² (mm ²)	0.078 (50)
Nominal tension strength of threaded rod as governed by steel strength	$N_{sa,rod}$	lb (kN)	4,525 (20.0)
Nominal tension strength of threaded rod as governed by steel strength, seismic			
Nominal shear strength of threaded rod as governed by steel strength	$V_{sa,rod}$	lb (kN)	2,695 (12.0)
Nominal shear strength of threaded rod as governed by steel strength, seismic			

For **SI**: 1 inch = 25.4 mm, 1 pound = 0.00445 kN, 1 in² = 645.2 mm². For **pound-inch** unit: 1 mm = 0.03937 inches.

¹Values provided for steel element material types, or equivalent, based on minimum specified strengths; $N_{sa,rod}$ and $V_{sa,rod}$ calculated in accordance with ACI 318-14 Eq. 17.5.1.2a and Eq. 17.5.1.2b or ACI 318-11 Eq. D-28 and Eq. D-29, respectively, as applicable. $V_{sa,rod,eq}$ must be taken as $0.7V_{sa,rod}$.

² ϕN_{sa} shall be the lower of the $\phi N_{sa,rod}$ or ϕN_{sa} 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 $\phi N_{sa,eq}$.

³ ϕV_{sa} shall be the lower of the $\phi V_{sa,rod}$ or ϕV_{sa} 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 $\phi V_{sa,eq}$.

⁴Strength reduction factors shall be taken from 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 318-14 5.3 or ACI 318-11 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. The value of ϕ applies when the load combinations of Section 1605.2 of the IBC, ACI 318-14 5.3 or ACI 318-11 9.2, as applicable, are used in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable.