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RESEARCH REPORT: RR 25810
(CSI # 05 05 19)

BASED UPON ICC ES EVALUATION REPORT NO. ESR-2272

REEVALUATION DUE DATE: August 1, 2018
Issued Date: August 1, 2016
Code: 2014 LABC

GENERAL APPROVAL – Reevaluation - Powers Snake+ Anchors for Cracked and Uncracked Concrete

DETAILS

The above assemblies and/or products are approved when in compliance with the use, description, design, installation, conditions of approval, and identification of Evaluation Report No. ESR-2272, reissued December 1, 2012, revised January 2014, 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-2272 which are excluded on the attached copy have been deleted by the Los Angeles Building and Safety Department as not being included in this approval.

The approval is subject to the following conditions:

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

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

3. 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.

4. Design values and minimum embedment requirements shall be per Tables in ICC ES Report No. ESR-2272.

5. The concrete shall have attained its minimum design strength prior to installation of the anchors.

6. Special inspection in accordance with Section 1705.1.1 and Table 1705.3 of the 2014 Los Angeles City Building Code shall be provided for anchor installations.

7. The use of anchors is limited to dry interior locations.

8. The anchors are not approved for masonry application.

9. Calculations demonstrating that the applied loads or factored loads are less than the allowable load values or design strength level values respectively, described in this report shall be submitted to the plan check Engineer at the time of permit application. The calculations shall be prepared by a Civil or Structural Engineer registered in the State of California.

   EXCEPTION: Anchors used for the installation of mechanical, plumbing and electrical equipment may be designed and detailed on a plan prepared by an engineer licensed by the state of California.

DISCUSSION

The report is in compliance with the 2014 City of Los Angeles Building Code.

The approval is based on tests in accordance with ICC ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC 193), dated February 2009, which incorporate requirements in ACI 355.2-04, for use in cracked and un-cracked concrete, and quality control documentation.

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.

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.

Powers Fasteners offers software to assist in the design of anchorages using Powers Fasteners products. The software "PDA Powers Design Assist" includes selectable Strength Design methodology utilizing ICC-ES AC193-compliant data to generate designs in conformance with the 2011 Los Angeles City Building Code. The PDA Software may be downloaded at www.Powers.com.

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Attachment: ICC ES Report No. ESR-2272 (11 Pages)

ICC-ES Evaluation Report

ESR-2272*

Reissued December 1, 2012

This report is subject to renewal December 1, 2014.

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

DIVISION: 05 05 19—METALS
Section: 05 05 19—Post-installed Concrete Anchors

REPORT HOLDER:

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EVALUATION SUBJECT:

POWERS SNAKE+™ ANCHORS IN CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2012, 2009, 2006 ~~and 2003~~ *International Building Code®* (IBC)
- 2012, 2009, ~~2006 and 2003~~ *International Residential Code®* (IRC)

Properties evaluated:

- Structural
- Nonstructural

2.0 USES

The Powers Snake+ anchor is used to resist static, wind and seismic tension and shear loads in cracked and uncracked normal-weight concrete and sand-lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).

* ~~The $^{3}/_{8}$-inch-diameter (9.5 mm) anchors may be installed in the topside of cracked and uncracked normal-weight or sand-lightweight concrete-filled steel deck having a minimum specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).~~

The $^{3}/_{8}$-inch- and $^{1}/_{2}$-inch-diameter (9.5 mm and 12.7 mm) anchors may be installed in the soffit of cracked and uncracked normal-weight or sand-lightweight concrete-filled steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

* The Powers Snake+ $^{3}/_{8}$-inch and $^{1}/_{2}$-inch (9.5 mm and 12.7 mm) anchors may be used in single anchor applications or in group anchorages if designed according to ACI 318 Appendix D and Sections 4.1 and 4.2 of this report, as applicable. ~~The Powers Snake+ $^{1}/_{4}$-inch, $^{3}/_{8}$-inch and $^{1}/_{2}$-inch (6.4 mm, 9.5 mm, and 12.7 mm) anchors may also be used for redundant applications where multiple anchors support linear elements, if designed according to Section 4.3 of this report.~~

* The Snake+ anchors are an alternative to anchors described in Sections 1908 and 1909 of the 2012 IBC, Sections 1911 and 1912 of the 2009 and 2006 IBC ~~and Sections 1912 and 1913 of the 2003 IBC~~. 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 Snake+ Anchors:

* Snake+ anchors are one-piece, internally threaded screw anchors which receive threaded steel inserts such as threaded rods and bolts in ~~$^{1}/_{4}$-inch,~~ $^{3}/_{8}$-inch and $^{1}/_{2}$-inch diameters.

* Product names for the report holder and the additional listee are presented in Table A of this report. Available nominal sizes are ~~$^{1}/_{4}$ inch,~~ $^{3}/_{8}$ inch and $^{1}/_{2}$ inch. The anchors are manufactured from carbon steel, which are case hardened and have a minimum 0.0002-inch (5 μm) zinc plating in accordance with ASTM B633. The Snake+ anchor is illustrated in Figure 1.

The anchors are installed in predrilled holes with a powered impact wrench. The threads on the anchor body tap into the sides of the predrilled hole and interlock with the base material during installation.

3.2 Steel Insert Elements:

Threaded steel insert elements must be threaded into the Snake+ Anchors to form a connection. The material properties of the steel insert elements must comply with the minimum specifications as given in Table 2 of this report, or an equivalent.

3.3 Concrete:

Normal-weight and sand-lightweight concrete must comply with Sections 1903 and 1905 of the IBC.

***Revised January 2014**

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3.4 Steel Deck Panels:

Steel deck panels must comply with the configuration in Figure ~~4 and~~ 5 and have a minimum base-metal thickness of 0.035 inch (0.89 mm) [No. 20 gage]. Steel must comply with ASTM A653/A653M SS Grade 36, and have a minimum yield strength of 36 ksi (248 MPa). *

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design strength of anchors complying with the 2012 ~~and 2003~~ IBC, as well as Section R301.1.3 of the 2012 ~~and 2003~~ 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 strength of anchors complying with the 2006 IBC and ~~Section R301.1.3 of 2006 IRC~~ must be in accordance with ACI 318-05 Appendix D and this report. *

A design example according to the 2012 IBC is given in Figure 6 of this report. Design parameters are based on the 2012 IBC (ACI 318-11) unless noted otherwise in Sections 4.1.1 through 4.1.12 of this report.

The strength design of anchors must comply with ACI 318 D.4.1, except as required in ACI 318 D.3.3. Strength reduction factors, ϕ, as given in ACI 318-11 D.4.3 and noted in Tables 2 and 3, must be used for load combinations calculated in accordance with Section 1605.2 of the IBC and Section 9.2 of ACI 318. Strength reduction factors, ϕ, described in ACI 318-11 D.4.4 must be used for load combinations calculated in accordance with Appendix C of ACI 318. Strength reduction factors, ϕ, corresponding to brittle steel elements must be used.

4.1.2 Requirements for Static Steel Strength in Tension, N_{sa}: The nominal static steel strength of a single anchor in tension, N_{sa}, calculated in accordance with ACI 318 D.5.1.2 is given in Table 2 of this report.

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 D.5.2, with modifications as described in this section. The basic concrete breakout strength of a single anchor in tension, N_b, must be calculated in accordance with ACI 318 D.5.2.2, using the values of 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 D.5.2.6 must be calculated with the value of k_{uncr} as given in Table 2 and with $\psi_{c,N} = 1.0$.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, as shown in Figure 5, calculation of the concrete breakout strength in accordance with ACI 318 D.5.2 is not required.

4.1.4 Requirements for Static Pullout Strength in Tension, N_{pn}: The nominal pullout strength of a single anchor in cracked and uncracked concrete, $N_{p,cr}$ and $N_{p,uncr}$, respectively, in accordance with ACI 318 D.5.3, is provided in Table 2.

The nominal pullout strength in tension of the anchors installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, as shown in Figure 5, is provided in Table 2. In accordance with ACI 318 D.5.3.2, the nominal pullout strength in cracked concrete must be calculated according to Eq-1:

$$N_{p,f'_c} = N_{p,deck,cr}\sqrt{\frac{f'_c}{3,000}} \quad \text{(lb, psi)} \qquad \text{(Eq-1)}$$

$$N_{p,f'_c} = N_{p,deck,cr}\sqrt{\frac{f'_c}{20.7}} \quad \text{(N, MPa)}$$

where f'_c is the specified concrete compressive strength.

In regions where analysis indicates no cracking in accordance with ACI 318 D.5.3.6, the nominal pullout strength in tension can be adjusted by calculation according to Eq-2:

$$N_{p,f'_c} = N_{p,deck,uncr}\sqrt{\frac{f'_c}{3,000}} \quad \text{(lb, psi)} \qquad \text{(Eq-2)}$$

$$N_{p,f'_c} = N_{p,deck,uncr}\sqrt{\frac{f'_c}{20.7}} \quad \text{(N, MPa)}$$

where f'_c is the specified concrete compressive strength.

4.1.5 Requirements for Static Steel Shear Capacity, V_{sa}: The nominal steel strength in shear, V_{sa}, of a single anchor in accordance with ACI 318 D.6.1.2 is given in Table 3 of this report and must be used in lieu of the values derived by calculation from ACI 318-11, Eq. D-29.

The shear strength, $V_{sa,deck}$, of anchors installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, as shown in Figure 5, is given in Table 3.

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 D.6.2, 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 D.6.2.2 using the value of ℓ_e and d_a (d_o) given in Table 3 of this report.

* ~~For anchors installed in the topside of concrete-filled steel deck assemblies, as shown in Figure 4, 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 D.6.2, using the actual member thickness, $h_{min,deck}$, in the determination of A_{Vc}. Minimum member topping thickness for anchors in the topside of concrete-filled steel deck assemblies is given Table 1 of this report.~~

For anchors installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck floor and roof assemblies, as shown in Figure 5, calculation of the concrete breakout strength in accordance with ACI 318 D.6.2 is not required.

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 D.6.3, modified by using the value of k_{cp} described in Table 3 of this report and the value of N_{cb} or N_{cbg} as calculated in Section 4.1.3 of this report.

For anchors installed in the soffit of sand-lightweight or normal-weight concrete-filled steel deck floor and roof assemblies, as shown in Figure 5, calculation of the concrete pryout strength in accordance with ACI 318 D.6.3 is not required.

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

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ACI 318 D.3.3. For the 2012 IBC, Section 1905.1.9 shall be omitted. Modifications to ACI 318 D.3.3 shall be applied under Section 1908.1.9 of the 2009 IBC or Section 1908.1.16 of the 2006 IBC, ~~as applicable, or the following:~~

*

CODE	ACI 318 D.3.3 SEISMIC REGION	CODE EQUIVALENT DESIGNATION
2003 IBC and 2003 IRC	Moderate or high seismic risk	Seismic Design Categories C, D, E and F

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 D.5 and D.6, respectively, taking into account the corresponding values given in Tables 2 and 3 of this report.

The anchors comply with ACI 318 D.1 as brittle steel elements and must be designed in accordance with ACI 318-11 D.3.3.4, D.3.3.5, D.3.3.6 or D.3.3.7; ACI 318-08 D.3.3.5 or D.3.3.6; or ACI 318-05 D.3.3.5, as applicable. Strength reduction factors, ϕ, are given in Table 2 and Table 3.

The $^{3}/_{8}$-inch and $^{1}/_{2}$-inch 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 D.5.1 and D.5.2, as described in Sections 4.1.3 and 4.1.4 of this report. In accordance with ACI 318 D.5.3.2, the appropriate value for pullout strength in tension for seismic loads, $N_{p,eq}$ or $N_{p,deck,eq}$, described in Table 2 of this report, must be used in lieu of N_p. $N_{p,eq}$ or $N_{p,deck,eq}$ may be adjusted by calculations for concrete compressive strength in accordance with Eq-1 of this report.

Where values for $N_{p,eq}$ are not provided in Table 2, the pullout strength in tension for seismic loads need not be evaluated.

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 D.6.2 and D.6.3, as described in Sections 4.1.6 and 4.1.7 of this report. In accordance with ACI 318 D.6.1.2, the appropriate value for nominal steel strength in shear for seismic loads, $V_{sa,eq}$ or $V_{sa,deck,eq}$, 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: Anchors or groups of anchors that are subject to the effects of combined axial (tensile) and shear forces must be designed in accordance with ACI 318 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 D.5.2, must be further multiplied by the factor $\psi_{cp,N}$ given by Eq-3:

$$\Psi_{cp,N} = \frac{c}{c_{ac}} \quad \text{(Eq-3)}$$

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 D.8.6, values of c_{ac} provided in Table 2 of this report must be used.

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

* ~~For anchors installed in the topside of concrete-filled steel deck assemblies, the anchors must be installed in accordance with Table 1 and Figure 4.~~

For anchors installed through the soffit of steel deck assemblies, the anchors must be installed in accordance with Figure 5 and must have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width.

4.1.12 Sand-lightweight Concrete: For ACI 318-11 and ACI 318-08, when anchors are used in sand-lightweight concrete, the modification factor λ_a or λ, respectively, for concrete breakout strength must be taken as 0.6 in lieu of ACI 318-11 D.3.6 (2012 IBC) or ACI 318-08 D.3.4 (2009 IBC).

For ACI 318-05, the values N_b, and V_b must be multiplied by 0.60, in lieu of ACI 318 D.3.4.

For anchors installed through the soffit of sand-lightweight concrete-filled steel deck floor and roof assemblies, this reduction is not required.

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:

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

$$V_{allowable,ASD} = \phi V_n / \alpha \quad \text{(Eq-5)}$$

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 Appendix D, Section 4.1 of this report and 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable (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, Section 4.1 of this report and 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as appropriate (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.

The requirements for member thickness, edge distance and anchor spacing, described in this report, must apply. An example of allowable stress design tension values for illustrative purposes is shown in Table 4.

4.2.2 Interaction of Tensile and Shear Forces: The interaction must be calculated and consistent with ACI 318 D.7, as follows:

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

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

For all other cases: $\frac{T_{applied}}{T_{allowable,ASD}} + \frac{V_{applied}}{V_{allowable,ASD}} \le 1.2$ (Eq-6)

*

4.3 Redundant Fastening Design (Nonstructural):

4.3.1 General: For an anchoring system designed with redundancy, the load maintained by an anchor that experiences failure or excessive deflection can be transmitted to neighboring anchors without significant consequences to the fixture or remaining resistance of the anchoring system. In addition to the requirements for anchors, the fixture being attached must be able to resist the forces acting on it assuming one of the fixing points is not carrying load. It is assumed that by adhering to and specifying the limits shown for n_1, n_2 and n_3, illustrated and defined in Figures 7a and 7b of this report, redundancy is satisfied, where n_1 is the total number of anchorage points supporting the linear element, n_2 is the number of anchors per anchorage point and n_3 is the factored design load, N_{ua} or V_{ua}, or a combination of both on an anchorage point per IBC Section 1605.2 or ACI 318 Section 9.2.

For redundant fastening, the Powers Snake+ anchors are used to resist tension and shear in accordance with Section 2.0 and with the following limitations:

- Applications must be limited to the support of nonstructural elements.
- Single point anchor applications are prohibited.
- Anchor design must be limited to structures assigned to Seismic Design Category A or B only.
- The specified concrete compressive strength f'_c used for calculation purposes must equal 2,500 psi (17.2 MPa).

4.3.2 Strength Design: For the redundant applications of anchors in concrete loaded in tension and shear, the following equations must be satisfied:

$$\phi_{ra} F_{ra} \ge N_{ua} \quad \text{(Eq-7)}$$

$$\phi_{ra} F_{ra} \ge V_{ua} \quad \text{(Eq-8)}$$

where:

F_{ra} = Characteristic strength (resistance) for the anchors as shown in Table 5 of this report (lbf or kN).

N_{ua} = Factored tensile force applied at each anchorage point (lbf or kN).

V_{ua} = Factored shear force applied at each anchorage point (lbf or kN).

Corresponding strength reduction factors for redundant applications, ϕ_{ra}, are given in Table 5. The characteristic strength (resistance), F_{ra}, is independent of load direction and applicable for cracked and uncracked concrete.

For combined tension and shear loading of redundant applications the following equation must be satisfied:

$$\phi_{ra} F_{ra} \ge \sqrt{N_{ua}^2 + V_{ua}^2} \quad \text{(Eq-9)}$$

For the redundant applications of anchors installed in sand-lightweight concrete, the design strength $\phi_{ra} F_{ra}$ in Eq-7, Eq-8 and Eq-9 must be further multiplied by 0.6. For anchors installed in the soffit of sand-lightweight concrete-filled steel deck and floor and roof assemblies, this reduction is not required.

For the redundant applications of anchors installed in the soffit of sand-lightweight concrete-filled steel deck and floor and roof assemblies, F_{ra} must be replaced with $F_{ra,deck}$ in Eq-7, Eq-8 and Eq-9 and taken from Table 5.

*

4.3.3 Allowable Stress Design (ASD): Design values for redundant applications of anchors for use with allowable stress design must be calculated in accordance with Section 4.3.2 of this report and Eq-10:

$$R_{allowable,ASD} = \frac{\phi_{ra} F_{ra}}{\alpha} \quad \text{(Eq-10)}$$

where $R_{allowable,ASD}$ is the allowable load (lbf or kN) for redundant applications and where α is the conversion factor calculated as a weighted average of the load factors for the controlling load combination. The conversion factor, α, is equal to 1.4 assuming dead load only.

4.3.4 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: The values of c_{min}, s_{min} and h_{min} must comply with Table 5 of this report.

For anchors installed through the soffit of steel deck assemblies, the anchors must have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width.

4.4 Installation:

Installation parameters are provided in Tables 1 and 5, and Figures 2, 3, 4, 5, 7a and 7b. The Snake+ 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 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 impact screwdriver and fitted with a Snake+ setting tool supplied by Powers Fasteners. The allowable ranges of installation parameters for the Snake+ anchors using powered impact screwdriver are given in Table 1. The anchors must be driven until the shoulder of the Snake+ setting tool comes into contact with the surface of the concrete. The minimum thread engagement of a threaded rod or bolt insert element assembly into the Snake+ anchor must be full anchor depth.

* ~~For installation in the topside of concrete-filled steel deck assemblies, installation must comply with Figure 4.~~

For installation in the soffit of concrete-filled steel deck assemblies, the hole in the steel deck may not be more than 1/8 inch (3.2 mm) larger than the diameter of the hole in the concrete. Member thickness and edge distance restrictions for installations in the soffit of concrete-filled steel deck assemblies must comply with Figure 5.

4.5 Special Inspection:

Special inspection is required in accordance with Section 1705.1.1 and Table 1705.3 of the 2012 IBC, Section 1704.15 and Table 1704.4 of the 2009 IBC, or Section * 1704.13 of the 2006 ~~and 2003~~ 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, anchor spacing, edge distances, concrete thickness, anchor embedment 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."

5.0 CONDITIONS OF USE

The Powers Snake+ anchors described in this report comply with, or are suitable alternatives to what is

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specified in, those codes indicated 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 Anchors must be installed in cracked and uncracked normal-weight concrete and sand-lightweight 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 normal-weight or sand-lightweight concrete over steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

* ~~**5.4** The $^3/_8$-inch (9.5 mm) anchors may be installed in the topside of cracked and uncracked normal-weight or sand-lightweight concrete-filled steel deck having a minimum specified compressive strength f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa).~~

* **5.5** The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.1 MPa); ~~for redundant fastening (nonstructural) the values of f'_c used for calculation purposes must equal 2,500 psi (17.2 MPa).~~

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

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

* ~~**5.8** Redundant fastening design values must be established in accordance with Section 4.3 of this report.~~

* **5.9** Anchor spacing and edge distance, as well as minimum member thickness, must comply with Table 1 and 5 and Figure ~~4 and~~ 5 of this report.

5.10 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.

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

5.12 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.

5.13 For structural applications the $^3/_8$-inch- and $^1/_2$-inch-diameter 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. * ~~For redundant fastening (nonstructural), the $^1/_4$-inch-, $^3/_8$-inch- and $^1/_2$-inch-diameter anchors are limited to structures assigned to Seismic Design Category A or B only under the IBC.~~

5.14 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 or seismic 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.

5.15 Snake+ anchors must not be removed from concrete and reused.

* ~~**5.16** For redundant applications, the ability of the fixed element to transfer loads to adjacent anchors shall be justified to the satisfaction of the code official by the design professional~~.

5.17 Anchors have been evaluated for reliability against brittle failure and found to be not significantly sensitive to stress-induced hydrogen embrittlement.

5.18 Special inspection must be provided in accordance with Section 4.5 of this report.

5.19 Use of anchors is limited to dry, interior locations.

5.20 Anchors are manufactured under an approved quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated June 2012, which incorporates requirements in ACI 355.2-07 / ACI 355.2-04, for use in cracked and uncracked concrete; including optional suitability tests 12 and 13 (AC193, Table 4.2) for seismic tension and shear; and quality control documentation.

7.0 IDENTIFICATION

The Snake+ anchors are identified in the field by their dimensional characteristics and packaging. Packages are identified with the anchor name, part number, type, size, the company name as set forth in Table A of this report, and the evaluation report number (ESR-2272).

TABLE A—PRODUCT NAMES BY COMPANY

COMPANY NAME	PRODUCT NAME
Powers Fasteners, Inc.	Snake+
L. H. Dottie Co.	Dottie Snake+

* Deleted by the City of Los Angeles

TABLE B—MEAN AXIAL STIFFNESS VALUES, β, FOR SNAKE+ ANCHORS IN NORMAL-WEIGHT CONCRETE[1]

Concrete State	Units	Nominal Anchor Size / Threaded Coupler Diameter	
		3/8 inch	1/2 inch
Uncracked concrete	10^3 lbf/in.	2800	545
Cracked concrete	10^3 lbf/in.	900	160

[1]Mean values shown; actual stiffness varies considerably depending on concrete strength, loading and geometry of application.

FIGURE 1—SNAKE+ SCREW ANCHOR AND SETTING TOOL

TABLE 1—SNAKE+ ANCHOR INSTALLATION SPECIFICATIONS FOR SINGLE POINT APPLICATIONS[1]

*

Anchor Property / Setting Information	Symbol	Units	Nominal Anchor Size / Threaded Coupler Diameter (inch)		
			1/4[4]	3/8	1/2
Nominal outside anchor diameter	d_a (d_o)[3]	in. (mm)	0.375 (9.5)	0.500 (12.7)	0.750 (19.1)
Internal thread diameter (UNC)	d	in. (mm)	0.250 (6.4)	0.375 (9.5)	0.500 (12.7)
Minimum diameter of hole clearance in fixture for steel insert element (following anchor installation)	d_h	in.	5/16	7/16	9/16
Nominal drill bit diameter	d_{bit}	in.	3/8 ANSI	1/2 ANSI	3/4 ANSI
Minimum nominal embedment depth[2]	h_{nom}	in. (mm)	1 5/8 (41)	1 5/8 (41)	2 3/16 (55)
Effective embedment	h_{ef}	in. (mm)	Not applicable[4]	1.10 (28)	1.54 (39)
Minimum hole depth	h_{hole}	in. (mm)	2 (51)	2 (51)	2 1/2 (64)
Overall anchor length	ℓ_{anch}	in. (mm)	1 1/4 (32)	1 1/4 (32)	1 11/16 (43)
Maximum impact screwdriver power (torque)	T_{screw}	ft.-lb. (N-m)	120 (163)	345 (468)	345 (468)
Maximum tightening torque of steel insert element (threaded rod or bolt)	T_{max}	ft.-lb. (N-m)	4 (6)	8 (19)	36 (49)
Anchors Installed in Concrete Construction[2]					
Minimum member thickness[2]	h_{min}	in. (mm)	Not applicable[4]	4 (102)	4 (102)
Critical edge distance[2]	c_{ac}	in. (mm)	Not applicable[4]	3 (76)	4 (102)
Minimum edge distance[2]	c_{min}	in. (mm)	Not applicable[4]	3 (76)	4 (102)
Minimum spacing distance[2]	s_{min}	in. (mm)	Not applicable[4]	3 (76)	4 (102)
Anchors installed in the Topside of Concrete-filled Steel Deck Assemblies[5]					
Minimum member topping thickness	$h_{min,deck}$	in. (mm)	Not applicable[4]	3 1/4 (83)	Not applicable
Critical edge distance	$c_{ac,deck,top}$	in. (mm)	Not applicable[4]	3 (76)	Not applicable
Minimum edge distance	$c_{min,deck,top}$	in. (mm)	Not applicable[4]	3 (76)	Not applicable
Minimum spacing distance	$s_{min,deck,top}$	in. (mm)	Not applicable[4]	3 (76)	Not applicable

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

[1]The information presented in this table is to be used in conjunction with the design criteria of ACI 318 Appendix D.
[2]For installations through the soffit of steel deck into concrete, see Figure 5. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from center of the flute. In addition, anchors shall have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width.
[3]The notation in parenthesis is for the 2006 IBC.
* ~~[4]The 1/4-inch-diameter anchor is limited to redundant fastening design only as defined by Section 4.3 of this report. See Table 5 for additional information.~~
~~[5]For 3/8-inch-diameter anchors installed in the topside of concrete-filled steel deck assemblies, see Figure 4 of this report.~~

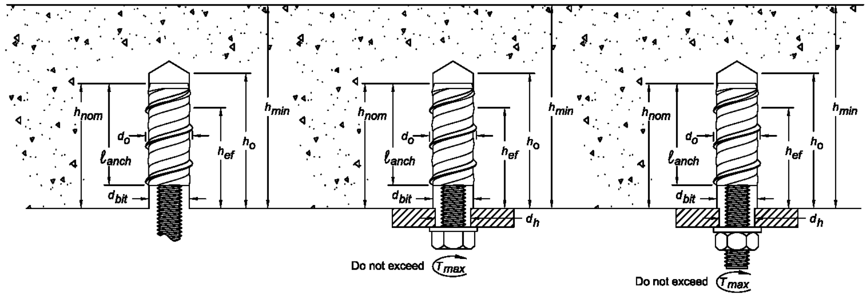
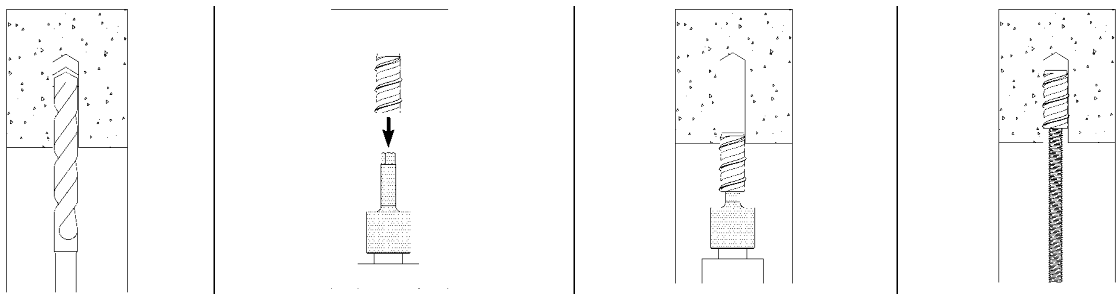


FIGURE 2—SNAKE+ SCREW ANCHOR INSTALLED WITH STEEL INSERT ELEMENT



1. *Using the proper drill bit size, drill a hole into the base material to the required depth. The tolerances of the carbide drill bit used should meet the requirements of ANSI Standard B212.15.*

2. *Select a powered impact wrench that does not exceed the maximum torque, T_{screw}, for the selected anchor diameter. Attach the Snake+ setting tool supplied by Powers Fasteners to the impact wrench. Mount the anchor onto the setting tool.*

3. *Drive the anchor into the hole to the required embedment until the shoulder of the Snake+ setting tool comes into contact with the surface of the base material. Do not spin the setting tool off the anchor to disengage.*

4. *Insert threaded rod or a bolt into the Snake+, taking care not to exceed the maximum specified tightening torque of the steel insert element, T_{max}. Minimum thread engagement must be full anchor depth.*

FIGURE 3—SNAKE+ SCREW ANCHOR INSTALLATION INSTRUCTIONS

*

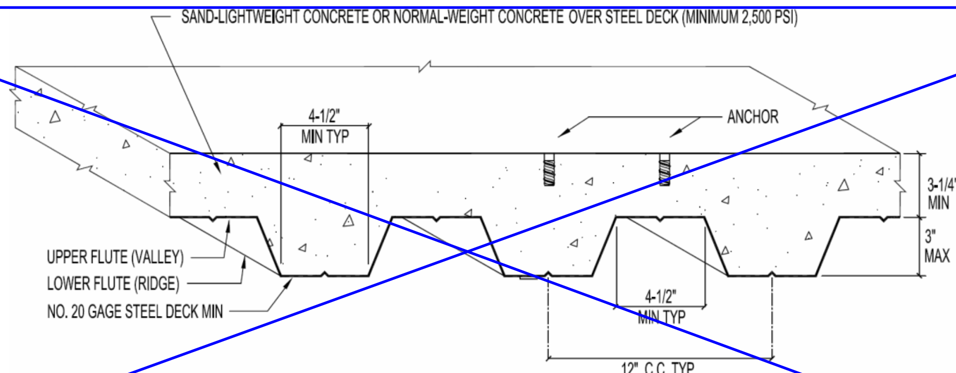


FIGURE 4—SNAKE+ INSTALLATION DETAIL FOR ANCHORS IN THE TOPSIDE OF CONCRETE-FILLED STEEL DECK FLOOR AND ROOF ASSEMBLIES[1]

[1] $^3/_8$-inch diameter anchors may be placed in the topside of steel deck profiles provided the minimum topping thickness, minimum spacing distance and minimum edge distance are satisfied as given in Table 1 of this report.

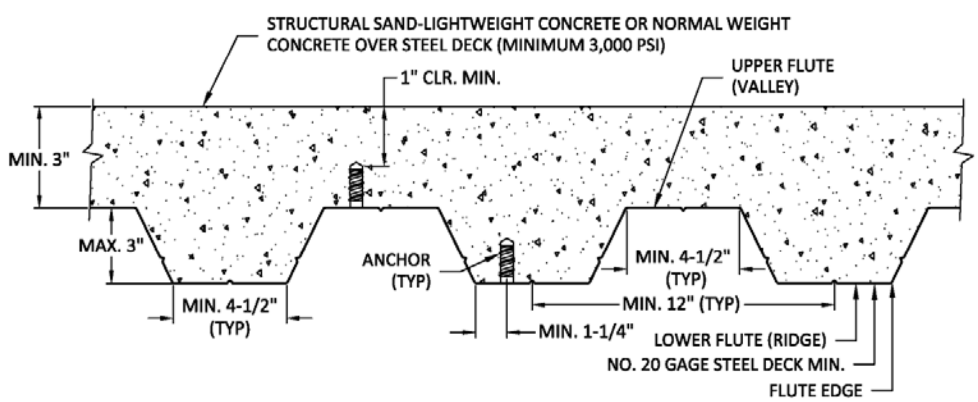


FIGURE 5—SNAKE+ INSTALLATION DETAIL FOR ANCHORS IN THE SOFFIT OF CONCRETE OVER STEEL DECK FLOOR AND ROOF ASSEMBLIES[1]

[1] Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum hole clearance is satisfied. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

* Deleted by the City of Los Angeles

TABLE 2—TENSION DESIGN INFORMATION FOR POWERS SNAKE+ ANCHORS IN CONCRETE (For use with load combinations taken from ACI 318, Section 9.2)[1,2]

Design Characteristic	Notation	Units	Nominal Anchor Size / Threaded Coupler Diameter (in.)		
			$^3/_8$ inch		$^1/_2$ inch
Anchor category	1, 2 or 3	-	1		1
Nominal embedment depth	h_{nom}	in. (mm)	$1^5/_8$ (41)		$2^3/_{16}$ (55)
STEEL STRENGTH IN TENSION[4]					
Minimum specified yield strength of steel insert element (threaded rod or bolt)	f_y	ksi (N/mm^2)	ASTM A36: 36.0 (248)	ASTM A193, Gr. B7: 105.0 (624)	ASTM A36: 36.0 (248)
Minimum specified ultimate strength of steel insert element (threaded rod or bolt)	f_{uta}[10]	ksi (N/mm^2)	ASTM A36: 58.0 (400)	ASTM A193, Gr. B7: 125.0 (862)	ASTM A36: 58.0 (400)
Effective tensile stress area of steel insert element (threaded rod or bolt)	$A_{se,N}$ (A_{se})[11]	in^2 (mm^2)	0.0318 (20.5)		0.1419 (91.6)
Steel strength in tension	N_{sa}[10]	lb (kN)	ASTM A36: 4,495 (20.0)	ASTM A193, Gr. B7: 9,685 (43.1)	ASTM A36: 8,230 (37.0)
Reduction factor for steel strength[3]	ϕ	-	0.65		
CONCRETE BREAKOUT STRENGTH IN TENSION[8]					
Effective embedment	h_{ef}	in. (mm)	1.10 (28)		1.54 (39)
Effectiveness factor for uncracked concrete	k_{uncr}	-	24		30
Effectiveness factor for cracked concrete	k_{cr}	-	17		24
Modification factor for cracked and uncracked concrete[5]	$\Psi_{c,N}$[10]	-	1.0 See note 5		1.0 See note 5
Critical edge distance	c_{ac}	in. (mm)	3 (76)		4 (102)
Reduction factor for concrete breakout strength[3]	ϕ	-	0.65 (Condition B)		
PULLOUT STRENGTH IN TENSION (NON-SEISMIC APPLICATIONS)[8]					
Characteristic pullout strength, uncracked concrete (2,500 psi)	$N_{p,uncr}$	lb (kN)	See note 7		See note 7
Characteristic pullout strength, cracked concrete (2,500 psi)	$N_{p,cr}$	lb (kN)	See note 7		1,665 (7.4)
Reduction factor for pullout strength[3]	ϕ	-	0.65 (Condition B)		
PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS[8]					
Characteristic pullout strength, seismic (2,500 psi)	$N_{p,eq}$[10]	lb (kN)	See note 7		1,665 (7.4)
Reduction factor for pullout strength, seismic[3]	ϕ	-	0.65 (Condition B)		
PULLOUT STRENGTH IN TENSION FOR SOFFIT OF SAND-LIGHTWEIGHT AND NORMAL WEIGHT CONCRETE OVER STEEL DECK					
Characteristic pullout strength, uncracked concrete over steel deck[6,9]	$N_{p,deck,uncr}$	lb (kN)	1,515 (6.7)		1,625 (7.2)
Characteristic pullout strength, cracked concrete over steel deck[6,9]	$N_{p,deck,cr}$	lb (kN)	1,075 (4.8)		1,300 (7.2)
Characteristic pullout strength, concrete over steel deck, seismic[6,9]	$N_{p,deck,eq}$	lb (kN)	1,075 (4.8)		1,300 (7.2)
Reduction factor for pullout strength, concrete over steel deck[3]	ϕ	-	0.65 (Condition B)		

For **SI**: 1 inch = 25.4 mm, 1 ksi = 6.894 N/mm^2; 1 lbf = 0.0044 kN.

[1]The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations the additional requirements of ACI 318 D.3.3 must apply.
[2]Installation must comply with published instructions and details.
[3]All values of ϕ were determined from the load combinations of IBC Section 1605.2 or ACI 318 Section 9.2. If the load combinations ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4. For reinforcement that meets ACI 318 Appendix D requirements for Condition A, see ACI 318-11 D.4.3 for the appropriate ϕ factor.
[4]It is assumed that the threaded rod or bolt used with the Snake+ anchor is a ductile steel element with minimum specified properties as listed in the table or an equivalent steel element. The Snake+ anchor is considered a brittle steel element in tension as defined by ACI 318 D.1. Tabulated values for steel strength in tension must be used for design.
[5]For all design cases use $\Psi_{c,N}$ = 1.0. The appropriate effectiveness factor for cracked concrete (k_{cr}) and uncracked concrete (k_{uncr}) must be used.
[6]For all design cases use $\psi_{c,P}$ = 1.0. For calculation of N_{pn}, see Section 4.1.4 of this report.
[7]Pullout strength does not control design of indicated anchors. Do not calculate pullout strength for indicated anchor size and embedment.
[8]Anchors are permitted to be used in sand-lightweight concrete in accordance with Section 4.1.12 of this report.
[9]Values for $N_{p,deck}$ are for sand-lightweight concrete ($f'_{c,min}$ = 3,000 psi) and additional lightweight concrete reduction factors need not be applied. In addition, evaluation for the concrete breakout capacity in accordance with ACI 318 D.5.2 is not required for anchors installed in the deck soffit (flute).
* ~~[10]For 2003 IBC, f_{uta} replaces f_{ut}; N_{sa} replaces N_s; $\Psi_{c,N}$ replaces Ψ_3; and $N_{p,eq}$ replaces $N_{p,seis}$.~~
[11]The notation in parenthesis is for the 2006 IBC.

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TABLE 3—SHEAR DESIGN INFORMATION FOR POWERS SNAKE+ ANCHORS IN CONCRETE
(For use with load combinations taken from ACI 318, Section 9.2)[1,2]

Design Characteristic	Notation	Units	Nominal Anchor Size / Threaded Coupler Diameter (in.)		
			$^3/_8$ inch		$^1/_2$ inch
Anchor category	1, 2 or 3	-	1		1
Nominal embedment depth	h_{nom}	in. (mm)	$1^5/_8$ (41)		$2^3/_{16}$ (55)
STEEL STRENGTH IN SHEAR[4]					
Steel strength in shear[5]	V_{sa}[10]	lb (kN)	ASTM A36: 770 (3.4)	ASTM A193, Gr. B7: 1,655 (7.4)	ASTM A36: 1,995 (8.9)
Reduction factor for steel strength[3]	ϕ	-	0.60		
CONCRETE BREAKOUT IN SHEAR[6]					
Load bearing length of anchor (h_{ef} or $8d_o$, whichever is less)	ℓ_e[10]	in. (mm)	1.10 (28)		1.54 (39)
Nominal outside anchor diameter	d_a (d_o)[11]	in. (mm)	0.500 (12.7)		0.750 (19.1)
Reduction factor for concrete breakout strength[3]	ϕ	-	0.70 (Condition B)		
PRYOUT STRENGTH IN SHEAR[6]					
Coefficient for pryout strength (1.0 for h_{ef} < 2.5 in, 2.0 for h_{ef} ≥ 2.5 in)	k_{cp}	-	1.0		1.0
Effective embedment	h_{ef}	in. (mm)	1.10 (28)		1.54 (39)
Reduction factor for pryout strength[3]	ϕ	-	0.70 (Condition B)		
STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS					
Steel strength in shear, seismic[7]	$V_{sa,eq}$[10]	lb (kN)	ASTM A36: 770 (3.4)	ASTM A193, Gr. B7: 1,655 (7.4)	ASTM A36: 1,995 (8.9)
Reduction factor for steel strength in shear, seismic[3]	ϕ	-	0.60		
STEEL STRENGTH IN SHEAR FOR SOFFIT OF SAND-LIGHTWEIGHT AND NORMAL WEIGHT CONCRETE OVER STEEL DECK[9]					
Steel strength in shear, concrete over steel deck[8]	$V_{sa,deck}$	lb (kN)	ASTM A36: 770 (3.4)	ASTM A193, Gr. B7: 1,655 (7.4)	ASTM A36: 1,995 (8.9)
Steel strength in shear, concrete over steel deck, seismic[8]	$V_{sa,deck,eq}$	lb (kN)	ASTM A36: 770 (3.4)	ASTM A193, Gr. B7: 1,655 (7.4)	ASTM A36: 1,995 (8.9)
Reduction factor for steel strength in shear, concrete over steel deck[3]	ϕ	-	0.60		

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

[1]The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations the additional requirements of ACI 318 D.3.3 shall apply.
[2]Installation must comply with published instructions and details.
[3]All values of ϕ were determined from the load combinations of IBC Section 1605.2 or ACI 318 Section 9.2. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318-11 D.4.4. For reinforcement that meets ACI 318 Appendix D requirements for Condition A, see ACI 318-11 D.4.3 for the appropriate ϕ factor.
[4]It is assumed that the threaded rod or bolt used with the Snake+ anchor will be a ductile steel element as defined by ACI 318 D.1.
[5]Tabulated values for steel strength in shear must be used for design. These tabulated values are lower than calculated results using equation D-29 in ACI 318-11 (D-20 in ACI 318-08 and -05) and ACI 318 D.6.1.2.
[6]Anchors are permitted to be used in sand-lightweight concrete in accordance with Section 4.1.12 of this report.
[7]Tabulated values for steel strength in shear are for seismic applications and based on test results in accordance with ACI 355.2 Section 9.6.
[8]Tabulated values for $V_{sa,deck}$ are for sand-lightweight concrete ($f'_{c,min}$ = 3,000 psi) and additional lightweight concrete reduction factors need not be applied. In addition, evaluation for the concrete breakout capacity in accordance with ACI 318 D.6.2 and the pryout capacity in accordance with ACI 318 D.6.3 are not required for anchors installed in the deck soffit (flute).
[9]Shear loads for anchors installed through steel deck into concrete may be applied in any direction.
* ~~[10]For 2003 IBC, f_{uta} replaces f_{ut}; V_{sa} replaces V_s; ℓ_e replaces ℓ; and $V_{sa,eq}$ replaces $V_{s,seis}$.~~
[11]The notation in parenthesis is for the 2006 IBC.

* Deleted by the City of Los Angeles

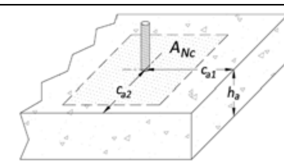
TABLE 4—EXAMPLE ALLOWABLE STRESS DESIGN VALUES FOR ILLUSTRATIVE PURPOSES[1,2,3,4,5,6,7,8,9]

Nominal Anchor Size (inches)	Steel Insert Element (ASTM)[10]	Nominal Embedment Depth (inches)	Effective Embedment (inches)	Allowable Tension Load (pounds)
3/8	A36	1 5/8	1.10	610
	A193, Gr. B7	1 5/8	1.10	610
1/2	A 36	2 3/16	1.54	1,260

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

[1]Single anchor with static tension load only.
[2]Concrete determined to remain uncracked for the life of the anchorage.
[3]Load combinations are taken from ACI 318 Section 9.2 (no seismic loading).
[4]Assumes 30% dead load and 70% live load, controlling load combination 1.2*D* + 1.6*L*.
[5]Calculation of weighted average for conversion factor α = 1.2(0.3) + 1.6(0.7) = 1.48.
[6] f'_c = 2,500 psi (normal weight concrete).
[7] $c_{a1} = c_{a2} \geq c_{ac}$.
[8] $h \geq h_{min}$.
[9]Values are for Condition B where supplementary reinforcement in accordance with ACI 318-11 D.4.3 is not provided.
[10]It is assumed that the threaded rod or bolt used with the Snake+ anchor has minimum specified properties as listed in Table 2 or an equivalent steel element.

Given: Calculate the factored resistance strength, $\boldsymbol{\phi N_n}$, and the allowable stress design value, $T_{allowable,ASD}$, for a 3/8-inch-diameter Snake+ anchor using an ASTM A36 threaded rod assuming the given conditions in Table 4.



Calculation in accordance with ACI 318-11 Appendix D and this report:	Code Ref.	Report Ref.
Step 1. Calculate steel strength of a single anchor in tension: $\boldsymbol{\phi N_{sa}} = (0.65)(4{,}495) = 2{,}922\ lbs.$	D.5.1.2	Table 2 §4.1.2
Step 2. Calculate concrete breakout strength of a single anchor in tension: $\phi N_{cb} = \phi \frac{A_{Nc}}{A_{Nc0}} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$	D.5.2.1	Table 2 §4.1.3
$N_b = k_c\ \lambda_a \sqrt{f'_c}(h_{ef})^{1.5}$ $N_b = (24)\ (1.0)\sqrt{2{,}500}(1.1)^{1.5} = 1{,}384\ lbs.$ $\boldsymbol{\phi N_{cb}} = (0.65)\frac{(10.9)}{(10.9)}(1.0)(1.0)(1.0)(1{,}384) = 900\ lbs.$	D.5.2.2	Table 2
Step 3. Calculate pullout strength: $\phi N_{pn} = \phi N_{p,uncr} \psi_{c,P} \left(\frac{f'_{c,act}}{2{,}500}\right)^{0.5}$ $\boldsymbol{\phi N_{pn}}$ = n/a (pullout strength does not control, see Table 2, footnote 7)	D.5.3.2	Table 2 §4.1.4
Step 4. Determine controlling resistance strength in tension: $\boldsymbol{\phi N_n} = \min\left\|\phi N_{sa}, \phi N_{cb}, \phi N_{pn}\right\| = \phi N_{cb} = 900\ lbs.$	D.4.1.1	
Step 5. Calculate allowable stress design conversion factor for loading condition: Controlling load combination: 1.2*D* + 1.6*L* $\boldsymbol{\alpha}$ = 1.2(30%) + 1.6(70%) = 1.48	9.2	§4.2
Step 6. Calculate allowable stress design value: $\boldsymbol{T_{allowable,ASD} = \frac{\phi N_n}{\alpha} = \frac{900}{1.48} = 608\ lbs.}$		

FIGURE 6—EXAMPLE STRENGTH DESIGN CALCULATION INCLUDING ASD CONVERSION FOR ILLUSTRATIVE PURPOSES

*

TABLE 5—REDUNDANT FASTENING DESIGN INFORMATION FOR SNAKE+ ANCHORS[1,2]

Design Characteristic	Notation	Units	Nominal Anchor Size / Threaded Coupler Diameter (inch)					
			$^{1}/_{4}$		$^{3}/_{8}$		$^{1}/_{2}$	
Anchor category	1, 2 or 3	-	1		1		1	
Minimum Edge Distance[6]	$c_{min} = c_{ac}$	in. (mm)	4 (102)		4 (102)		4 (102)	
Minimum Spacing[6]	s_{min}	in. (mm)	8 (203)		8 (203)		8 (203)	
Minimum Member Thickness	h_{min}	in. (mm)	3 (76.2)		3 (76.2)		3 (76.2)	
Nominal Embedment Depth	h_{nom}	in. (mm)	$1^{5}/_{8}$ (41)		$1^{5}/_{8}$ (41)		$2^{3}/_{16}$ (55)	
CHARACTERISTIC STRENGTH (RESISTANCE) INSTALLED IN CONCRETE[4,5]								
			Number of anchorage points		**Number of anchorage points**		**Number of anchorage points**	
			$n_1 \geq 4$	$n_1 \geq 3$	$n_1 \geq 4$	$n_1 \geq 3$	$n_1 \geq 4$	$n_1 \geq 3$
Resistance, cracked or uncracked concrete (2,500 psi)	F_{ra}	lb (kN)	550 (2.5)	360 (1.6)	675 (3.0)	450 (2.0)	675 (3.0)	450 (2.0)
Strength reduction factor[3]	ϕ_{ra}	-	0.65					
CHARACTERISTIC STRENGTH (RESISTANCE) FOR SAND-LIGHTWEIGHT AND NORMAL WEIGHT CONCRETE OVER STEEL DECK[4,6]								
			Number of anchorage points		**Number of anchorage points**		**Number of anchorage points**	
			$n_1 \geq 4$	$n_1 \geq 3$	$n_1 \geq 4$	$n_1 \geq 3$	$n_1 \geq 4$	$n_1 \geq 3$
Resistance, cracked or uncracked concrete over steel deck (2,500 psi)	$F_{ra,deck}$	lb (kN)	550 (2.5)	360 (1.6)	675 (3.0)	450 (2.0)	675 (3.0)	450 (2.0)
Strength reduction factor, concrete over steel deck[3]	ϕ_{ra}	-	0.65					

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

[1]The data in this table is intended to be used with the design provisions of Section 4.3 of this report; loads may be applied in tension, shear or any combination thereof.
[2]Installation must comply with published instructions and this report.
[3]All values of ϕ were determined from the load combinations of IBC Section 1605.2 or ACI 318 Section 9.2.
[4]It is assumed that the threaded rod or bolt used with the Snake+ anchor has properties as listed in Table 2 of this report.
[5]Anchors are permitted to be used in sand-lightweight concrete in accordance with Section 4.3.2 of this report.
[6]For installations through the soffit of steel deck into concrete see the installation detail. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from center of the flute. In addition, anchors shall have an axial spacing along the flute equal to the greater of 3*hef* or 1.5 times the flute width.

A redundant system is achieved by specifying and limiting the following variables:

n_1 = the total number of anchorage points supporting the linear element
n_2 = the number of anchors per anchorage point
n_3 = factored load at each anchorage point using the load combinations from IBC Section 1605.2.1 or ACI 318 Section 9.2

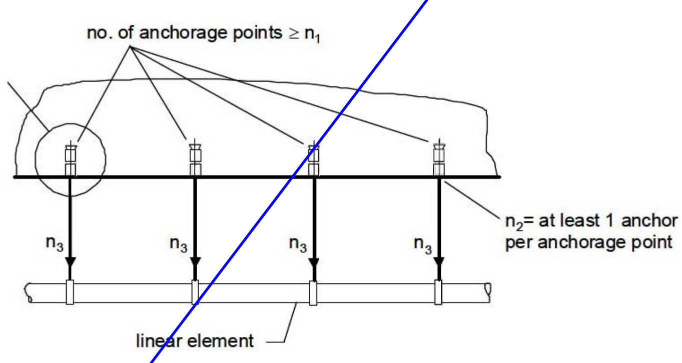


FIGURE 7a—REDUNDANT FASTENING APPLICATION REQUIREMENTS FOR STRENGTH DESIGN OF TYPICAL FIXTURES

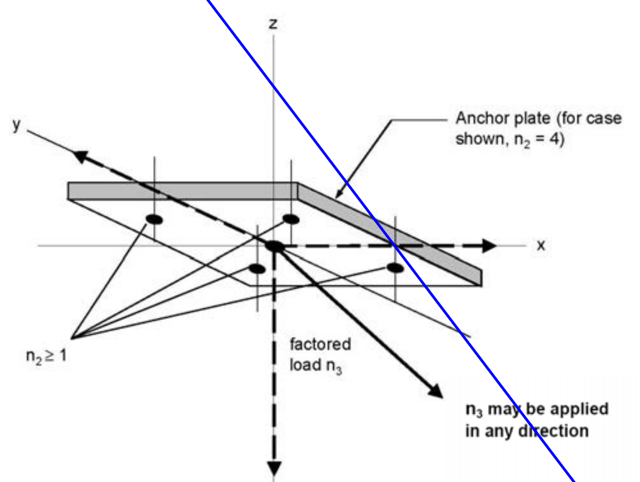


FIGURE 7b— DETAIL A; ANCHORAGE POINT

* Deleted by the City of Los Angeles