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RESEARCH REPORT: RR 26042
(CSI #031600)

BASED UPON ICC-ES EVALUATION
REPORT NO. ESR-3657

REEVALUATION DUE
DATE: May 1, 2019
Issue Date: August 1, 2017
Code: 2017 LABC

GENERAL APPROVAL – Technical Modification – Powers Wood-Knocker and Wood-Knocker II+ Concrete Inserts and Bang-It Concrete Inserts for Steel Deck in 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-3657 reissued December 2016, revised May 2017 of the ICC-ES Evaluation Services, LLC. The report, in its entirety, is attached and made part of this general approval.

The parts of the ES Report, ESR-3657, which are excluded on the attached copy have been removed by the Los Angeles Building Department as not being included in this approval.

The approval is subject to the following conditions:

1. Plans, details and calculations shall be prepared by a Civil or Structural Engineer, licensed by the State of California.
2. The concrete tension and shear capacity of the concrete inserts shall be calculated in accordance with ACI 318-14 Chapter 17, with the design values specified in Table 2

and 3 of the attached ESR-3657. The threaded rod or concrete capacity may govern the overall connection capacity.

3. Wood-Knocker, Wood-Knocker II+ and Bang-It anchors shall only support non-structural components.

DISCUSSION

The technical modification is to recognize Wood Knocker II+ concrete inserts as part of this general approval.

This report is in compliance with the 2017 City of Los Angeles Building Code.

The approval is based on tests and analyses in accordance with ICC-ES Acceptance Criteria for Headed Cast-In Specialty Inserts in Concrete (AC 446), dated February 2015, editorially revised January 2015.

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.

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Attachments: ICC-ES Evaluation Report No. ESR-3657 (13 Pages).

ICC-ES Evaluation Report

ESR-3657

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DIVISION: 03 00 00—CONCRETE
Section: 03 15 19—Cast-In Concrete Anchors
Section: 03 16 00—Concrete Anchors

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EVALUATION SUBJECT:

WOOD-KNOCKER® AND WOOD-KNOCKER® II+ CONCRETE INSERTS AND BANG-IT®+ CONCRETE INSERTS FOR STEEL DECK IN CRACKED AND UNCRACKED CONCRETE (DEWALT / POWERS)

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)

* ~~For evaluation for compliance with the *National Building Code of Canada®* (NBCC), see listing report ELC-3657.~~

Properties evaluated:

Structural

2.0 USES

The Wood-Knocker and Wood-Knocker II+ concrete inserts are used to resist static, wind, and seismic tension and shear loads in cracked and uncracked normal-weight concrete, sand-lightweight, and all-lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 10,000 psi (17.2 MPa to 68.9 MPa).

The Bang-It+ steel deck concrete inserts are used to resist static, wind, and seismic tension and shear loads in the soffit of cracked and uncracked normal-weight concrete and sand-lightweight concrete on steel deck having a specified compressive strength, f'_c, of 2,500 psi to 10,000 psi (17.2 MPa to 68.9 MPa).

There are seven models for the Wood-Knocker inserts; five fractional and two metric: $^1/_4$-inch, $^3/_8$-inch, M10, M12, $^1/_2$-inch, $^5/_8$-inch, and $^3/_4$-inch, corresponding to the sizes of the threaded rods or bolts used for the inserts.

There are six models for the Wood-Knocker II+ inserts: $^1/_4$-inch, $^3/_8$-inch, $^3/_8$ & $^1/_2$-inch multi, $^1/_2$-inch, $^5/_8$-inch, and $^3/_4$-inch, corresponding to the sizes of the threaded rods or bolts used for the inserts.

There are eight models for the Bang-It+ inserts; five fractional and two metric: $^1/_4$-inch, $^3/_8$-inch, $^3/_8$ & $^1/_2$-inch multi, M10, M12, $^1/_2$-inch, $^5/_8$-inch, and $^3/_4$-inch, corresponding to the sizes of the threaded rods or bolts used for the inserts.

Reference to "inserts" in this report refers to the manufactured specialty anchorage products (Wood-Knocker, Wood-Knocker II+, and Bang-It+) used in concrete; reference to "steel elements" refers to threaded rods or bolts; reference to "anchors" in this report refers to the installed inserts in concrete with threaded rods or bolts. The $^3/_8$ & $^1/_2$-inch multi inserts use an internal step thread that can accept $^3/_8$ and $^1/_2$-inch diameter threaded rods or bolts. Applications designed to resist shear loads must use the larger diameter threaded rod or bolt.

The inserts are alternatives to cast-in anchors described in Section 1901.3 of the 2015 IBC, Sections 1908 and 1909 of the 2012 IBC and Sections 1911 and 1912 of the 2009 IBC. The anchors may be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 Wood-Knocker, Wood-Knocker II+ and Bang-It+ Inserts:

Product names for the report holder and the additional listee are presented in the following table:

Company Name	Product Name
DEWALT	Wood-Knocker® II+
	Bang-It®+
Powers Fasteners	Wood-Knocker®
	Bang-It®

The Wood-Knocker and Wood-Knocker II+ inserts are cast-in concrete form inserts. The inserts consists of a steel internally threaded headed insert (body), an outer plastic sleeve and nails used to attach the insert to the

* Deleted by the City of Los Angeles

inside surface of concrete formwork. The inserts are illustrated in Figure 1A, 1B and Figure 6. The internally threaded inserts are manufactured from low carbon steel. The Wood-Knocker inserts have minimum 5 μm (0.002-inch) zinc plating. The plastic sleeve is fabricated from polypropylene.

The Bang-It+ steel deck inserts are cast-in concrete inserts. The insert consists of a steel internally threaded headed insert (body), an outer spring, a plastic sleeve and a washer (base plate). The insert is illustrated in Figure 2 and Figure 6. The internally threaded insert and washer are manufactured from low carbon steel. The Bang-It+ inserts have a minimum 5 μm (0.002-inch) zinc plating. The spring is manufactured from steel music wire. The plastic sleeve is fabricated from polypropylene.

The anchor assembly is comprised of a Wood-Knocker, Wood-Knocker II+, or Bang-It+ insert with a threaded steel element (e.g. rod or bolt). The Wood-Knocker insert is installed on the inside surface of wood formwork and the nails driven into the form until the insert base sits flush on the form. The Wood-Knocker II+ insert is installed on the inside surface of wood formwork and the head driven down until it comes into contact with the plastic sleeve and the nails enter the form. The Bang-It+ insert is installed in a predrilled hole in the topside of the metal deck, and impacted with sufficient force to compress the spring and drive the flared plastic fins of the sleeve completely through the hole. Concrete can then be cast over the insert.

3.2 Steel Elements:

3.2.1 Threaded Steel Rods and Bolts: Threaded steel rods (all-thread) or bolts must be threaded on their embedded end in diameters as described in Table 5 of this report. Specifications for grades of common threaded rod or bolts, including the mechanical strength properties are described in Table 4 of this report. Carbon steel threaded rods or bolts must be furnished with a minimum 0.0002-inch-thick (0.005 mm) zinc plating.

3.2.2 Ductility: In accordance with ACI 318 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 elements are provided in Tables 4 and 5 of this report. Where values are nonconforming or unstated, the steel element must be considered brittle

3.3 Concrete:

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

3.4 Steel Deck Panels:

Steel deck panels must be in accordance with the configuration in Figures 4A, 4B and 4C and have a minimum base steel thickness of 22 gage [0.034 inch (0.864 mm)]. Steel must comply with ASTM A653/A653M SS Grade 33 minimum and have a minimum yield strength of 33,000 psi (228 MPa).

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 and 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, 3, and 5 of this report are based on the 2015 IBC (ACI 318-14) and the 2012 IBC (ACI 318-11), as applicable, unless noted otherwise in Sections 4.1.1 through 4.1.12. 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 D.3.3, as applicable.

Strength reduction factors, ϕ, as given in ACI 318-14 17.3.3 and ACI 318-11 D.4.3, as applicable, for cast-in headed anchors, must be used for load combinations calculated in accordance with Section 1605.2 of the IBC, Section 5.3 of ACI 318-14 and Section 9.2 of ACI 318-11. 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 2012 IBC is provided in Figure 9. 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 318-14 17.2.7 or ACI 318-11 D.3.7, as applicable.

The pullout strength in tension is not decisive for design and does not need to be evaluated.

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 318-14 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 $\phi N_{sa,insert}$ provided in Tables 2 and 3 shall be used as the steel strength in tension.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension: For the Wood-Knocker, Wood-Knocker II+, and Bang-It+ anchors, 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 318-14 17.4.2 or ACI 318-11 D.5.2 as applicable for cast-in headed bolts, with modifications as described in this section, and with Figures 3, 4A, 4B and 4C of this report, as applicable. The basic concrete breakout strength in tension, N_b, must be calculated in accordance with 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 2 and 3, and with k_c = 24. 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 $\Psi_{c,N}$ = 1.25. For the Bang-It+ inserts installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck assemblies, the contribution of the steel deck strength must be ignored and the calculation of A_{Nc} / A_{Nco} in accordance with ACI 318-14 17.4.2.1 or ACI 318-11 D.5.2.1, as applicable, and $c_{a,min}$ (minimum edge distance) must be based on Figures 4A, 4B and 4C.

4.1.4 Requirements for Static Side-Face Blowout Strength in Tension: For the Wood-Knocker and Wood-Knocker II+ anchors, the nominal side-face blowout strength of a headed insert, N_{sb}, must be calculated in accordance with ACI 318-14 17.4.4.1 or ACI 318-11 D.5.4.1, as applicable, for the cast-in headed insert, in cracked and uncracked concrete, as applicable.

For the Bang-It+ inserts installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies as shown in Figures 4A, 4B and 4C, calculation of the concrete side blowout strength is not required.

4.1.5 Requirements for Static Steel Strength in Shear: For Wood-Knocker and Wood-Knocker II+ anchors, 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 $\phi V_{sa,insert}$ in Table 2 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.

For Bang-It+ anchors, the nominal static steel strength in shear, $V_{sa,deck}$, of a single Bang-It+ insert, in the lower flute and upper flute of concrete filled steel deck assemblies, 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 $\phi V_{sa,insert,deck}$ in Table 3 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: For Wood-Knocker and Wood-Knocker II+ anchors, 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. The basic concrete breakout strength, 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, based on the values provided in Table 1. The value of ℓ_e used in ACI 318-14 Eq. 17.5.2.2a or ACI 318-11 Eq. D-33, as applicable, must be taken as no greater than the lesser of h_{ef} or $8d_a$.

For the Bang-It+ inserts installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figures 4A, 4B and 4C, the breakout strength in shear need not be calculated.

4.1.7 Requirements for Static Concrete Pryout Strength in Shear: For Wood-Knocker and Wood-Knocker II+ 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 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable.

For the Bang-It+ inserts installed in the soffit of sand-lightweight or normal-weight concrete filled steel deck assemblies, as shown in Figures 4A, 4B and 4C, calculation of the concrete pry-out strength in accordance with ACI 318-14 17.5.3 or ACI 318-11 D.6.3, as applicable, is not required.

4.1.8 Requirements for Seismic Design:

4.1.8.1 General: For load combinations including seismic, 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 Section 1905.1.8 of the 2015 IBC. 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 anchors may be installed in Seismic Design Categories A through F of the IBC.

For Wood-Knocker and Wood-Knocker II+ anchors, the 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 318-14 17.4 and 17.5 or ACI 318-11 D.5 and D.6, as applicable.

For Bang-It+ anchors, the nominal concrete breakout strength for anchors in tension; and the nominal concrete breakout strength in the upper flute of concrete filled steel deck assemblies for anchors in shear, must be calculated in accordance with ACI 318-14 17.4 and 17.5 or ACI 318-11 D.5 and D.6, as applicable.

4.1.8.2 Seismic Tension: For Wood-Knocker and Wood-Knocker II+ anchors, the nominal 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 D.5.1, as applicable, for the threaded steel element, $N_{sa,rod,eq}$, as given in Table 5, not to exceed the corresponding values of $N_{sa,insert,eq}$ in Table 2 of this report; the nominal concrete breakout strength for anchors in tension must be calculated in accordance with 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 concrete side-face blowout strength must be calculated in accordance with 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 4.1.4 of this report.

For Bang-It+ anchors, the nominal 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 D.5.1, as applicable, for the threaded steel element, $N_{sa,rod,eq}$, as given in Table 5, not to exceed the corresponding values of $N_{sa,insert,eq}$ in Table 3 of this report; the nominal concrete breakout strength for anchors in tension must be calculated in accordance with 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 concrete pullout strength calculations in accordance with ACI 318-14 17.4.3.1 and 17.4.3.4 or ACI 318-11 D.5.3.1 and D.5.3.4, as applicable, are not required.

4.1.8.3 Seismic Shear: For Wood-Knocker anchors, the nominal concrete breakout strength and pryout strength in shear must be calculated in accordance with 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 4.1.6 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 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 5 of this report, not to exceed the corresponding values of $V_{sa,insert,eq}$, in Table 2.

For Bang-It+ anchors, the nominal concrete breakout strength and pryout strength in shear, calculations in accordance with 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 4.1.6 and 4.1.7 of this report, are not required. In accordance with 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 5 of this report, not to exceed the corresponding values of $V_{sa,insert,deck,eq}$, in Table 3, for lower flute or upper flute of the concrete filled steel deck assembly, as applicable.

4.1.9 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 318-14 17.6 or ACI 318-11 D.7, as applicable.

Due to the projection of the internally-threaded end of the Bang-It+ insert when installed in concrete filled steel deck assemblies (approximately $^3/_4$-inch), for anchors or groups of anchors that are subject to the effects of combined tension and shear forces, the design engineer must verify the validity of the interaction equation in ACI 318-14 17.6 or ACI 318-11 D.7, as applicable.

4.1.10 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: 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 as applicable for cast-in bolts.

For Bang-It+ inserts installed in the soffit of sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, the anchors must be installed in accordance with Figures 4A, 4B and 4C and shall have a minimum axial spacing along the flute in accordance with Table 3.

4.1.11 Requirements for Critical Edge Distance: The critical edge distance, c_{ac}, must be calculated in accordance with ACI 318-14 17.7.2 or ACI 318-11 D.8.2, as applicable. The modification factor $\Psi_{cp,N}$ = 1.0 in accordance with ACI 318-14 17.4.2.5 or ACI 318-11 D.5.2.5, as applicable.

4.1.12 Sand-lightweight Concrete: For ACI 318-14, 318-11 and 318-08, when the Wood-Knocker and Wood-Knocker II+ anchors are used in sand-lightweight or all-lightweight concrete, the modification factor λ_a or λ, respectively, for concrete breakout strength must be taken as 0.85 for sand-lightweight or 0.75 for all-lightweight according to ACI 318-14 17.2.6 (2015 IBC), ACI 318-11 D.3.6 (2012 IBC) or ACI 318-08 D.3.4 (2009 IBC).

For Bang-It+ inserts in the soffit of sand-lightweight concrete-filled steel deck, λ_a or λ shall be taken as 0.85 and applied to the concrete breakout strength in tension only as applicable. Values are shown in Table 3 and installation details are shown in Figures 4A, 4B and 4C.

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 1605.3 of the 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 318-14 Chapter 17 and 2015 IBC Section 1905.1.8, ACI 318-11, -08 Appendix D, and 2009 IBC Section 1908.1.9, as applicable (lbf or N).

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318-14 Chapter 17 and 2015 IBC Section 1905.1.8, ACI 318-11, -08 Appendix D, and 2009 IBC Section 1908.1.9, 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 values for tension and shear for illustrative purposes are shown in Tables 6 through 9. The values presented in Tables 6 through 9 are only valid when all of the conditions given in the footnotes to the respective tables are applicable.

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 318-14 17.6 or ACI 318-11, -08 D.7, as applicable, as follows:

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

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

For all other cases:

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

Due to the projection of the internally-threaded end of the Bang-It+ insert when installed in concrete filled steel deck assemblies (approximately $^3/_4$-inch), for anchors or groups of anchors that are subject to the effects of combined tension and shear forces, the design engineer must verify the validity of the interaction equation in ACI 318-14 17.6 or ACI 318-11, -08 D.7 as applicable.

4.3 Installation:

For the Wood-Knocker and Wood-Knocker II+ inserts, installation parameters are provided in Table 2 and in Figures 3 and 7. Wood-Knocker inserts must be positioned on wood or similar formwork with all three nails in contact with the form. The head of the Wood-Knocker must be impacted with sufficient force to drive nails all the way into the formwork until the plastic base sits flush and tight against the form. For the Wood-Knocker II+, the head of the insert must be impacted with sufficient force until it comes into contact with the plastic sleeve and the nails enter the form completely. From beneath the deck, following the concrete pour and form removal, a threaded rod or bolt element must be screwed into the internal threads of the Wood-Knocker or until fully seated in the inserts, which will result in a thread Wood-Knocker II+ engagement equal to one diameter. The threaded steel rod or bolt element must have a minimum thread engagement equal to one steel element diameter.

For the Bang-It+ inserts, installation parameters are provided in Table 3 and in Figures 4A, 4B, 4C and 7. A hole must be made in the steel deck using a step-drill, hole saw, deck punch or equivalent in accordance with the following hole diameters: $^{13}/_{16}$-inch or $^7/_8$-inch (21 mm or 22 mm) diameter [for Bang-It+ $^1/_4$-inch, $^3/_8$-inch, $^3/_8$ & $^1/_2$-inch multi, M10, M12, or $^1/_2$-inch] and $1^3/_{16}$-inch or $1^1/_4$-inch (30 mm or 32 mm) [for Bang-It+ $^5/_8$-inch or $^3/_4$-inch]. The Bang-It+ plastic sleeve must be placed in the hole, and following this, the head of the insert must be impacted with sufficient force to compress the outer spring and drive the flared plastic fins of the sleeve completely through the hole in the steel deck. The Bang-It+ metal base plate may be screwed to the deck for additional stability (optional). Before or after Bang-It+ insertion in deck, a threaded rod or bolt element must be inserted through the plastic thread protector nozzle until contact is made with the inner steel barrel. The threaded rod or bolt element must then be screwed into the Bang-It+ internal threads. The rod or bolt must be tightened until fully seated in the insert, which will result in a thread engagement equal to a minimum of one rod diameter. The plastic sleeve must be cut and trimmed to the surface of the insert following the concrete pour if the insert is intended to resist shear loads. Bang-It+ inserts are permitted to be installed in either the upper or lower flute of the steel deck.

Installation of Wood-Knocker, Wood-Knocker II+ and Bang-It+ inserts must be in accordance with this evaluation report and the manufacturer's published installation instruction (MPII) as provided in Figure 8 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 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 Wood-Knocker, Wood-Knocker II+, and Bang-It+ concrete specialty 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 published instructions 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, sand-lightweight concrete and all-lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 10,000 psi (17.2 MPa to 68.9 MPa) for the Wood-Knocker inserts, and in cracked and uncracked normal-weight or sand-lightweight concrete filled steel deck assemblies having a specified compressive strength, f'_c, of 2,500 psi to 10,000 psi (17.2 MPa to 68.9 MPa) for the Bang-It+ inserts.

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 Section D.8 for cast-in-place headed anchors

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, Wood-Knocker, Wood-Knocker II+, and Bang-It+ 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 Use of zinc-coated carbon steel anchors is limited to dry, interior locations.

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

5.16 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 February 2015, editorially revised January 2016.

6.2 Quality control documentation.

7.0 IDENTIFICATION

The inserts are identified by packaging labeled with the insert size, lot number, company name, and corresponding insert name as set forth in Section 3.1 of this report, and evaluation report number (ESR-3657). The inserts have the letters Wood-Knocker or Bang-It+, as applicable, and the specific size embossed atop the head of the insert, visible prior to installation for verification.

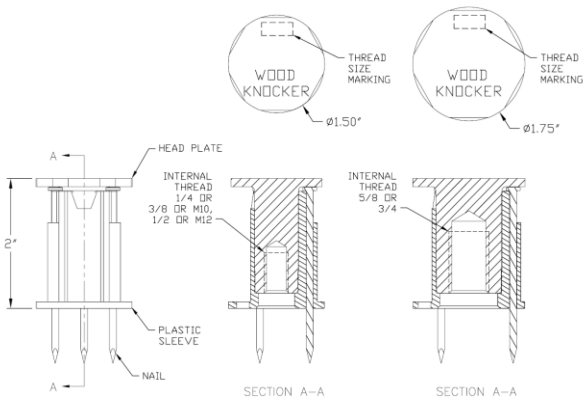


FIGURE 1A— WOOD-KNOCKER CAST-IN-PLACE INSERTS FOR FORM POUR CONCRETE

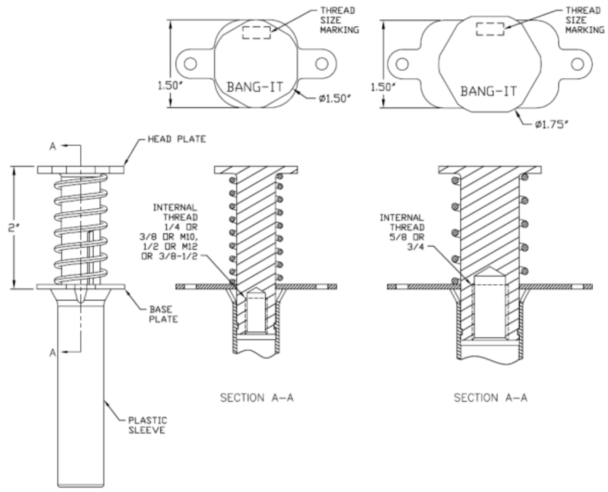


FIGURE 2—BANG-IT+ CAST-IN-PLACE INSERTS FOR CONCRETE FILLED STEEL DECK FLOOR AND ROOF ASSEMBLIES

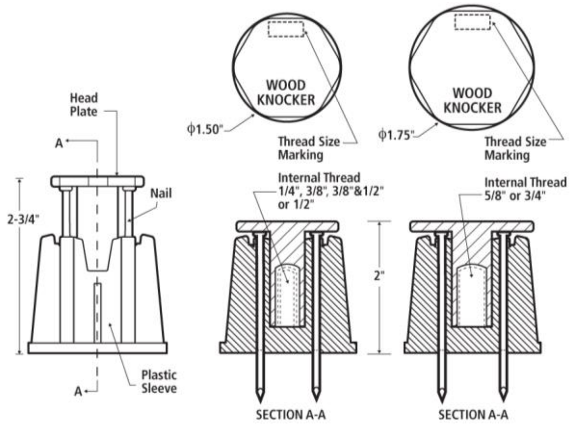


FIGURE 1B— WOOD-KNOCKER II+ CAST-IN-PLACE INSERTS FOR FORM POUR CONCRETE
Before Setting (head plate starting position) and After Setting (head plate and nails down)

TABLE 1—DESIGN USE AND REPORT TABLE INDEX

DESIGN STRENGTH[1]		WOOD-KNOCKER INSERTS	WOOD-KNOCKER II+ INSERTS	BANG-IT+ STEEL DECK INSERTS	THREADED STEEL ELEMENTS
Steel	N_{sa}, V_{sa}	Table 2	Table 2	Table 3	Table 5
Concrete	N_{cb}, N_{cbg}	Table 2	Table 2	Table 3	Not applicable
	V_{cb}, V_{cbg}, V_{cp}, V_{cpg}	Table 2	Table 2	Not applicable	Not applicable
Side-face Blowout	N_{sb}	Table 2	Table 2	Not applicable	Not applicable

CONCRETE TYPE	CONCRETE STATE	INSERT / STEEL ELEMENT NOMINAL SIZE	SEISMIC DESIGN CATEGORIES[2]
Normal-weight and lightweight	Cracked	$^1/_4$", $^3/_8$", M10, M12, $^1/_2$", $^5/_8$", $^3/_4$"	A through F
	Uncracked	$^1/_4$", $^3/_8$", M10, M12, $^1/_2$", $^5/_8$", $^3/_4$"	A through F

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

[1]Reference 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, pryout and side-face blowout, as applicable) and design assumptions. The pullout strength in tension is not decisive for design and does not need to be evaluated.

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

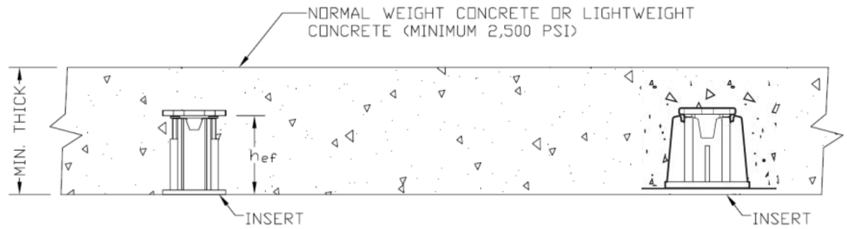


FIGURE 3—WOOD-KNOCKER OR WOOD-KNOCKER II+ INSERTS INSTALLED IN FORM POUR CONCRETE FLOOR AND ROOF ASSEMBLIES

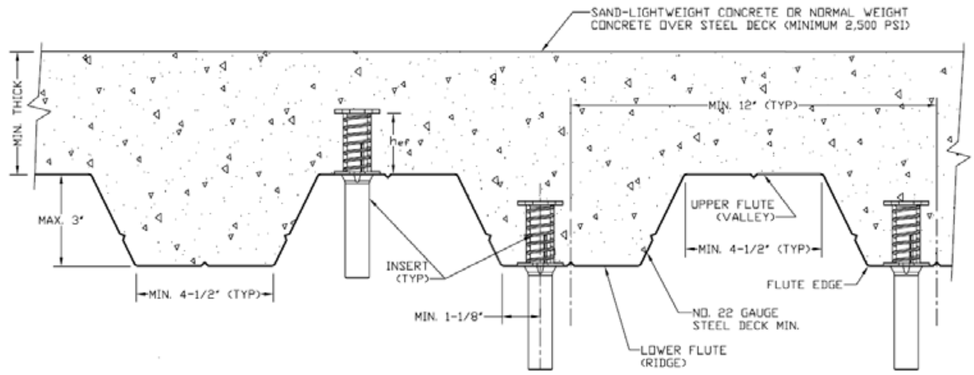


FIGURE 4A—BANG-IT+ INSERTS INSTALLED IN SOFFIT OF CONCRETE FILLED STEEL DECK FLOOR AND ROOF ASSEMBLIES[1,2,3 4]

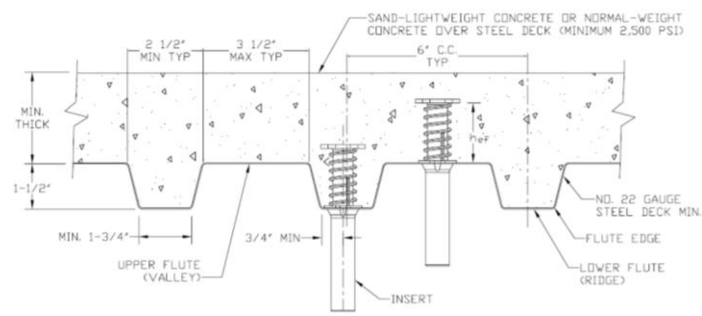


FIGURE 4B—BANG-IT+ INSERTS INSTALLED IN SOFFIT OF CONCRETE FILLED STEEL DECK FLOOR AND ROOF ASSEMBLIES[1,2,3,5,6,7]

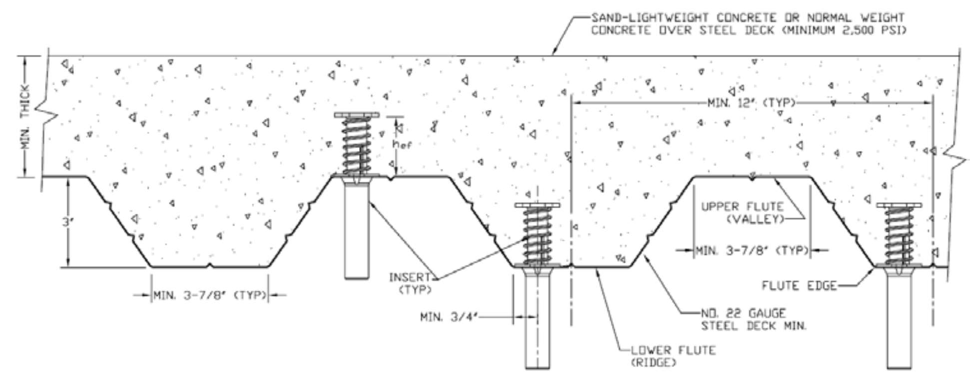


FIGURE 4C—BANG-IT+ INSERTS INSTALLED IN SOFFIT OF CONCRETE FILLED STEEL DECK FLOOR AND ROOF ASSEMBLIES[1,2,3,8]

[1]Inserts may be placed in the upper flute or lower flute of the steel deck assembly. Inserts in the lower flute require a minimum 1.5" of concrete topping thickness (min. thick in Figures) from the top of the upper flute. Upper flute installations require a minimum 3" concrete topping thickness from the top of the upper flute. Inserts in upper flute may be installed anywhere across upper flute.

[2]Axial spacing for Bang-It+ inserts along the lower flute length shall be minimum $3h_{ef}$.

[3]Upper flute Bang-It+ inserts are not subject to steel deck dimension limitations, or the minimum steel deck gauge limitations.

[4]Inserts in the lower flute of Figure 4A may be installed with a maximum $1^1/_8$-inch offset in either direction from the center of the flute. The offset distance may be increased for flute widths greater than those shown provided the minimum lower flute edge distance of $1^1/_8$-inch is also satisfied.

[5]Inserts in the lower flute of Figure 4B may be installed with a maximum $^1/_8$-inch offset in either direction from the center of the flute. The offset distance may be increased for flute widths greater than those shown provided the minimum lower flute edge distance of $^3/_4$-inch is also satisfied.

[6]Lower flute installations of Figure 4B with flutes widths greater than $1^3/_4$-inch are permitted.

[7]Lower flute installations of Figure 4B in flute depths greater than $1^1/_2$-inch are permitted provided the minimum edge distance of $^3/_4$-inch is met and the minimum lower flute width is increased proportionally (e.g. applicable to a lower flute depth of 2-inch with a minimum lower flute width of $2^1/_4$-inch).

[8]Inserts in the lower flute of Figure 4C may be installed with a maximum $1^3/_{16}$-inch offset in either direction from the center of the flute.

TABLE 2—WOOD-KNOCKER AND WOOD KNOCKER II+ INSERT DESIGN INFORMATION[1,2,3,4,5,6,7]

<table>
<tr><th>DESIGN INFORMATION</th><th>SYMBOL</th><th>UNITS</th><th>$^1/_4$-inch</th><th>$^3/_8$-inch</th><th>M10</th><th>M12</th><th>$^1/_2$-inch</th><th>$^5/_8$-inch</th><th>$^3/_4$-inch</th></tr>
<tr><td>Insert O.D.</td><td>d_a (d_o)</td><td>in.
(mm)</td><td colspan="5">0.7
(18)</td><td colspan="2">1.0
(25)</td></tr>
<tr><td>Insert head net bearing area</td><td>A_{brg}</td><td>in^2
(mm^2)</td><td colspan="5">1.20
(762)</td><td colspan="2">1.30
(839)</td></tr>
<tr><td>Effective embedment depth</td><td>h_{ef}</td><td>in.
(mm)</td><td colspan="5">1.75
(45)</td><td colspan="2">1.75
(45)</td></tr>
<tr><td>Minimum member thickness</td><td>h_{min}</td><td>in.
(mm)</td><td colspan="5">3.5
(89)</td><td colspan="2">3.5
(89)</td></tr>
<tr><td>Minimum spacing and edge distances</td><td>s_{min} , c_{min}</td><td>-</td><td colspan="7">See ACI 318 Section D.8.1 and D.8.2</td></tr>
<tr><td>Effectiveness factor for cracked concrete</td><td>k_c</td><td>-
(SI)</td><td colspan="7">24
(10)</td></tr>
<tr><td>Modification factor for tension strength in uncracked concrete</td><td>$\Psi_{C,N}$</td><td>-</td><td colspan="7">1.25</td></tr>
<tr><td>Nominal tension strength of single insert as governed by steel strength</td><td>$N_{sa,insert}$</td><td>lb
(kN)</td><td colspan="4">10,270
(45.7)</td><td>9,005
(40.1)</td><td colspan="2">12,685
(56.4)</td></tr>
<tr><td>Nominal tension strength of single insert as governed by steel strength, seismic</td><td>$N_{sa,insert,eq}$</td><td>lb
(kN)</td><td colspan="4">10,270
(45.7)</td><td>9,005
(40.1)</td><td colspan="2">12,685
(56.4)</td></tr>
<tr><td>Nominal steel shear strength of single insert</td><td>$V_{sa,insert}$</td><td>lb
(kN)</td><td colspan="4">7,180
(31.9)</td><td>7,180
(31.9)</td><td colspan="2">9,075
(40.4)</td></tr>
<tr><td>Nominal steel shear strength of single insert, seismic</td><td>$V_{sa,insert,eq}$</td><td>lb
(kN)</td><td colspan="4">7,180
(31.9)</td><td>7,180
(31.9)</td><td colspan="2">9,075
(40.4)</td></tr>
</table>

For **SI:** 1 inch = 25.4 mm, 1 pound = 0.00445 kN, 1 psi = 0.006895 MPa. For **pound-inch unit**: 1 mm = 0.03937 inches.

[1]Concrete must have a compressive strength f'_c of 2,500 psi minimum. Installation must comply with Sections 4.1.10 and 4.3, and Figure 3 of this report.
[2]Design of headed cast-in specialty inserts shall be in accordance with the provisions of ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable, for cast-in headed anchors. Concrete breakout strength must also be in accordance with Figure 3.
[3]Strength reduction factors for the inserts shall be taken from ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, for cast-in headed anchors. 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 the insert shall be taken as 0.65 for tension and 0.60 for shear; values correspond to brittle steel elements. 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. 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.
[4]Insert O.D. is the outside diameter of the headed insert body.
[5]Minimum spacing distance between anchors and minimum edge distance for cast-in headed Wood-Knocker and Wood Knocker II+ anchors shall be in accordance with ACI 318-14 17.7 or ACI 318-11 D.8, as applicable.
[6]Only the largest size of threaded rod or bolt for the $^3/_8$- & $^1/_2$-inch multi insert (i.e. $^1/_2$-inch diameter) must be used for applications resisting shear loads.
[7]The strengths shown in the table are for inserts only. Design professional is responsible for checking threaded rod or bolt strength in tension, shear, and combined tension and shear, as applicable. See Table 5 for steel design information for common threaded rod elements.

TABLE 3—BANG-IT+ INSERT DESIGN INFORMATION[1,2,3,4,5,6,7,8]

<table>
<tr><th colspan="3">DESIGN INFORMATION</th><th>SYMBOL</th><th>UNITS</th><th>$^1/_4$-inch</th><th>$^3/_8$-inch</th><th>M10</th><th>M12</th><th>$^1/_2$-inch</th><th>$^5/_8$-inch</th><th>$^3/_4$-inch</th></tr>
<tr><td colspan="3">Insert O.D.</td><td>d_a (d_o)</td><td>in.
(mm)</td><td colspan="5">0.7
(18)</td><td colspan="2">1.0
(25)</td></tr>
<tr><td colspan="3">Insert head net bearing area</td><td>A_{brg}</td><td>in^2
(mm^2)</td><td colspan="5">1.20
(762)</td><td colspan="2">1.30
(839)</td></tr>
<tr><td colspan="3">Effective embedment depth</td><td>h_{ef}</td><td>in.
(mm)</td><td colspan="5">1.75
(45)</td><td colspan="2">1.75
(45)</td></tr>
<tr><td colspan="3">Minimum member thickness</td><td>h_{min}</td><td>-</td><td colspan="7">See Figures 4A, 4B and 4C as applicable</td></tr>
<tr><td colspan="2" rowspan="2">Minimum spacing and edge distances</td><td>Upper flute</td><td>s_{min} , c_{min}</td><td>-</td><td colspan="7">See ACI 318 Section D.8.1 and D.8.2</td></tr>
<tr><td>Lower flute</td><td>s_{min} , c_{min}</td><td>-</td><td colspan="7">See Figures 4A, 4B and 4C as applicable</td></tr>
<tr><td colspan="3">Effectiveness factor for cracked concrete</td><td>k_c</td><td>-
(SI)</td><td colspan="7">24
(10)</td></tr>
<tr><td colspan="3">Modification factor for tension strength in uncracked concrete</td><td>$\Psi_{C,N}$</td><td>-</td><td colspan="7">1.25</td></tr>
<tr><td rowspan="2">According to Figures 4A, 4B & 4C</td><td colspan="2">Nominal tension strength of single insert as governed by steel strength</td><td>$N_{sa,insert}$</td><td>lb
(kN)</td><td colspan="3">10,440
(46.4)</td><td colspan="2">9,850
(43.8)</td><td colspan="2">11,985
(53.3)</td></tr>
<tr><td colspan="2">Nominal tension strength of single insert as governed by steel strength, seismic</td><td>$N_{sa,insert,eq}$</td><td>lb
(kN)</td><td colspan="3">10,440
(46.4)</td><td colspan="2">9,850
(43.8)</td><td colspan="2">11,985
(53.3)</td></tr>
<tr><td rowspan="2">According to Figure 4A</td><td colspan="2">Nominal steel shear strength of single insert in the soffit of concrete on steel deck</td><td>$V_{sa,insert,deck}$</td><td>lb
(kN)</td><td colspan="5">2,280
(10.2)</td><td colspan="2">3,075
(13.7)</td></tr>
<tr><td colspan="2">Nominal steel shear strength of single insert in the soffit of concrete on steel deck, seismic</td><td>$V_{sa,insert,deck,eq}$</td><td>lb
(kN)</td><td colspan="5">2,280
(10.2)</td><td colspan="2">2,695
(12.0)</td></tr>
<tr><td rowspan="2">According to Figures 4B & 4C</td><td colspan="2">Nominal steel shear strength of single insert in the soffit of concrete on steel deck</td><td>$V_{sa,insert,deck}$</td><td>lb
(kN)</td><td colspan="5">2,080
(10.2)</td><td colspan="2">2,975
(13.2)</td></tr>
<tr><td colspan="2">Nominal steel shear strength of single insert in the soffit of concrete on steel deck, seismic</td><td>$V_{sa,insert,deck,eq}$</td><td>lb
(kN)</td><td colspan="5">2,080
(10.2)</td><td colspan="2">2,695
(12.0)</td></tr>
</table>

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

[1]Concrete must have a compressive strength f'_c of 2,500 psi minimum. Installation must comply with Sections 4.1.10 and 4.3, and Figure 3 of this report.
[2]Design of headed cast-in specialty inserts shall be in accordance with the provisions of Figures 4A, 4B and 4C, as applicable, and ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable, for cast-in headed anchors. Concrete breakout strength must also be in accordance with Figures 4A, 4B and 4C, as applicable.
[3]Strength reduction factors for the inserts shall be taken from ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, for cast-in headed anchors. 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 the insert shall be taken as 0.65 for tension and 0.60 for shear; values correspond to brittle steel elements. 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. 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.
[4]Insert O.D. is the outside diameter of the headed insert body.
[5]Minimum spacing distance between anchors and minimum edge distances for cast-in headed Bang-It+ anchors shall be in accordance with Figures 4A, 4B or 4C, as applicable, and noted provisions.
[6]Only the largest size of threaded rod or bolt for the $^3/_8$- & $^1/_2$-inch multi insert (i.e. $^1/_2$-inch diameter) must be used for applications resisting shear loads.
[7]The strengths shown in the table are for inserts 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 common threaded rod elements.
[8]The tabulated insert strength values are applicable to installations in the lower flute or upper flute of the steel deck profiles; see Figures 4A, 4B and 4C.

TABLE 4—SPECIFICATIONS AND PHYSICAL PROPERTIES OF COMMON CARBON STEEL THREADED ROD ELEMENTS[1]

THREADED ROD SPECIFICATION		UNITS	MIN. SPECIFIED ULTIMATE STRENGTH, f_{uta}	MIN. SPECIFIED YIELD STRENGTH 0.2 PERCENT OFFSET, f_{ya}	$\frac{f_{uta}}{f_{ya}}$	ELONGATION MINIMUM PERCENT[6]	REDUCTION OF AREA MIN. PERCENT	RELATED NUT SPECIFICATION[8]
Carbon Steel	ASTM A36/A36M[2] and F1554[3] Grade 36	psi (MPa)	58,000 (400)	36,000 (248)	1.61	23	40 (50 for A36)	ASTM A194 / A563 Grade A
	ISO 898-1[5] Class 4.6	MPa (psi)	400 (58,000)	240 (34,800)	1.67	22	-[7]	ISO 4032 Grade 4
	ASTM F1554[3] Grade 105	psi (MPa)	125,000 (862)	105,000 (724)	1.19	15	45	ASTM A194 / A563 Grade DH
	ASTM A193/A193M[4] Grade B7	psi (MPa)	125,000 (860)	105,000 (720)	1.19	16	50	

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.

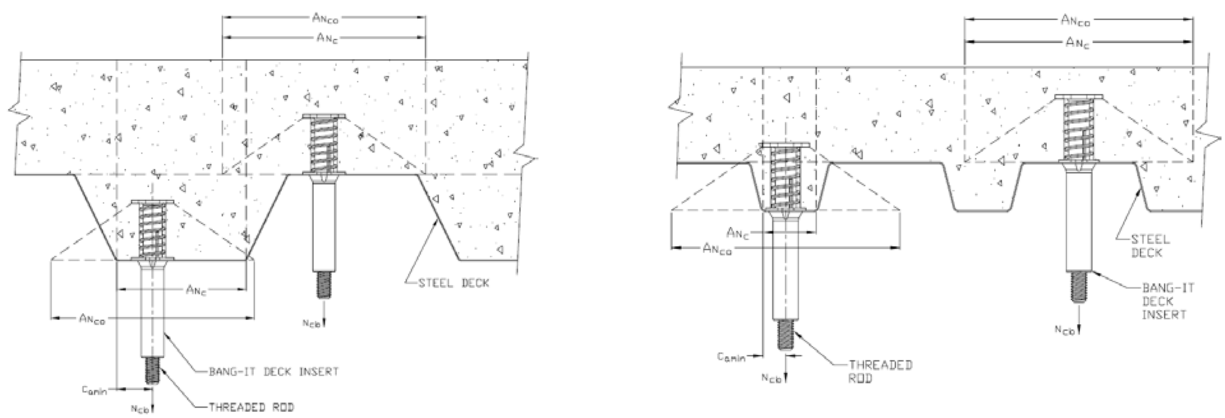
[1]Inserts may be used in conjunction with all grades of continuously threaded carbon steels (all-thread) that comply with code reference standards and that have thread characteristics comparable with ANSI B1.1 UNC Coarse Thread Series or ANSI B1.13M M Profile Metric Coarse Thread Series. Tabulated values correspond to anchor diameters included in this report. See Section 3.2.2 of this report for ductility of steel anchor elements.
[2]*Standard Specification for Carbon Structural Steel.*
[3]*Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.*
[4]*Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.*
[5]*Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs.*
[6]Based on 2-inch (50 mm) gauge length except ASTM A193, which are based on a gauge length of 4d.
[7]Minimum percent reduction of area not reported in the referenced standard.
[8]Where 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 COMMON THREADED ROD ELEMENTS USED WITH CONCRETE INSERTS[1,2,3,4]

DESIGN INFORMATION		SYMBOL	UNITS	$^1/_4$-inch	$^3/_8$-inch	M10	M12	$^1/_2$-inch	$^5/_8$-inch	$^3/_4$-inch
Threaded rod nominal outside diameter		d_{rod}	in. (mm)	0.250 (6.4)	0.375 (9.5)	0.394 (10)	0.472 (12)	0.500 (12.7)	0.625 (15.9)	0.750 (19.1)
Threaded rod effective cross-sectional area		A_{se}	in^2 (mm^2)	0.032 (21)	0.078 (50)	0.090 (58)	0.131 (85)	0.142 (92)	0.226 (146)	0.335 (216)
Nominal tension strength of threaded rod as governed by steel strength	ASTM A36	$N_{sa,rod,A36}$	lb (kN)	1,855 (8.2)	4,525 (20.0)	5,220 (23.2)	7,600 (33.8)	8,235 (36.6)	13,110 (58.3)	19,400 (86.3)
Nominal tension strength of threaded rod as governed by steel strength, seismic		$N_{sa,rod,eq,A36}$	lb (kN)	1,855 (8.2)	4,525 (20.0)	5,220 (23.2)	7,600 (33.8)	8,235 (36.6)	13,110 (58.3)	19,400 (86.3)
Nominal tension strength of threaded rod as governed by steel strength	ASTM A193, Grade B7	$N_{sa,rod,B7}$	lb (kN)	4,000 (17.7)	9,750 (43.1)	11,250 (50.1)	16,375 (72.9)	17,750 (78.9)	28,250 (125.7)	41,875 (186.0)
Nominal tension strength of threaded rod as governed by steel strength, seismic		$N_{sa,rod,eq,B7}$	lb (kN)	4,000 (17.7)	9,750 (43.1)	11,250 (50.1)	16,375 (72.9)	17,750 (78.9)	28,250 (125.7)	41,875 (186.0)
Nominal shear strength of threaded rod as governed by steel strength	ASTM A36	$V_{sa,rod,A36}$	lb (kN)	1,105 (4.9)	2,695 (12.0)	3,130 (13.9)	4,560 (20.3)	4,940 (22.0)	7,860 (35.0)	11,640 (51.8)
Nominal shear strength of threaded rod as governed by steel strength, seismic		$V_{sa,rod,eq,A36}$	lb (kN)	780 (3.5)	1,900 (8.4)	2,190 (9.7)	3,190 (14.2)	3,460 (15.4)	5,505 (24.5)	8,160 (36.3)
Nominal shear strength of threaded rod as governed by steel strength	ASTM A193, Grade B7	$V_{sa,rod,B7}$	lb (kN)	2,385 (10.6)	5,815 (25.9)	6,750 (30.0)	9,825 (43.7)	10,640 (7.3)	16,950 (75.4)	25,085 (111.6)
Nominal shear strength of threaded rod as governed by steel strength, seismic		$V_{sa,rod,eq,B7}$	lb (kN)	1,680 (7.5)	4,095 (18.2)	4,725 (21.0)	6,880 (30.6)	7,455 (34.2)	11,865 (52.8)	17,590 (78.2)

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 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 $\phi N_{sa,insert}$ 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 318-14 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. 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.



Idealization of Steel Deck Profile (e.g. see Figures 4A and 4C)

Idealization of Steel Deck Profile (e.g. see Figure 4B)

FIGURE 5—IDEALIZATION OF CONCRETE FILLED STEEL DECKS FOR DETERMINATION OF CONCRETE BREAKOUT STRENGTH IN ACCORDANCE WITH ACI 318

TABLE 6—EXAMPLE ASD ALLOWABLE TENSION DESIGN VALUES FOR ILLUSTRATIVE PURPOSES[1,2,3,4,5,6,7,8,9,10]

CONCRETE STRENGTH (f'_c)	THREADED ROD SPECIFICATION (ASTM)	WOOD-KNOCKER OR WOOD KNOCKER II+ IN CONCRETE						
		1/4-INCH (lbs)	3/8-INCH (lbs)	M10 (lbs)	M12 (lbs)	1/2-INCH (lbs)	5/8-INCH (lbs)	3/4-INCH (lbs)
2,500	A36	940	1,640	1,640	1,640	1,640	1,640	1,640
	A193, Grade B7	1,640	1,640	1,640	1,640	1,640	1,640	1,640
3,000	A36	940	1,800	1,800	1,800	1,800	1,800	1,800
	A193, Grade B7	1,800	1,800	1,800	1,800	1,800	1,800	1,800
4,000	A36	940	2,080	2,080	2,080	2,080	2,080	2,080
	A193, Grade B7	2,025	2,080	2,080	2,080	2,080	2,080	2,080
6,000	A36	940	2,295	2,545	2,545	2,545	2,545	2,545
	A193, Grade B7	2,025	2,545	2,545	2,545	2,545	2,545	2,545
8,000	A36	940	2,295	2,645	2,940	2,940	2,940	2,940
	A193, Grade B7	2,025	2,940	2,940	2,940	2,940	2,940	2,940
10,000	A36	940	2,295	2,645	3,285	3,285	3,285	3,285
	A193, Grade B7	2,025	3,285	3,285	3,285	3,285	3,285	3,285

For **SI:** 1 pound = 4.45 N. For pound-inch unit: 1 inch = 25.4 mm.

Illustrative Allowable Stress Design Values in Table 6 are applicable only when all of the following design assumptions are followed:
[1]Concrete compressive strength, f'_c, given for normal weight concrete.
[2]Single anchors with static tension load with installation in accordance to Figure 3 for Wood-Knocker or Wood-Knocker II+.
[3]Concrete determined to remain uncracked for the life of the anchorage.
[4]Load combinations from ACI 318-14 5.3 or ACI 318-11 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 the weighted average for α = 1.2*0.3 + 1.6*0.7 = 1.48.
[7]Assuming no edge distance influence ($c_{a1} \geq 1.5h_{ef}$) and no side-face blowout in tension for Wood-Knocker or Wood-Knocker II+.
[9]$h \geq h_{min}$ according to ACI 318-14 17.7 or ACI 318-11 D.8, as applicable.
[10]Values are for Condition B where supplementary reinforcement in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, is not provided.

TABLE 7—EXAMPLE ASD ALLOWABLE SHEAR DESIGN VALUE FOR ILLUSTRATIVE PURPOSES[1,2,3,4,5,6,7,8,9,10]

CONCRETE STRENGTH (f'_c)	THREADED ROD SPECIFICATION (ASTM)	WOOD-KNOCKER OR WOOD KNOCKER II+ IN CONCRETE						
		1/4-INCH (lbs)	3/8-INCH (lbs)	M10 (lbs)	M12 (lbs)	1/2-INCH (lbs)	5/8-INCH (lbs)	3/4-INCH (lbs)
2,500	A36	490	1,195	1,375	1,640	1,640	1,640	1,640
	A193, Grade B7	1,055	1,640	1,640	1,640	1,640	1,640	1,640
3,000	A36	490	1,195	1,375	1,800	1,800	1,800	1,800
	A193, Grade B7	1,055	1,800	1,800	1,800	1,800	1,800	1,800
4,000	A36	490	1,195	1,375	2,005	2,080	2,080	2,080
	A193, Grade B7	1,055	2,080	2,080	2,080	2,080	2,080	2,080
6,000	A36	490	1,195	1,375	2,005	2,170	2,545	2,545
	A193, Grade B7	1,055	2,545	2,545	2,545	2,545	2,545	2,545
8,000	A36	490	1,195	1,375	2,005	2,170	2,940	2,940
	A193, Grade B7	1,055	2,570	2,910	2,910	2,910	2,940	2,940
10,000	A36	490	1,195	1,375	2,005	2,170	3,285	3,285
	A193, Grade B7	1,055	2,570	2,910	2,910	2,910	3,285	3,285

For **SI:** 1 pound = 4.45 N. For pound-inch unit: 1 inch = 25.4 mm.

Illustrative Allowable Stress Design Values in Table 7 are applicable only when all of the following design assumptions are followed:
[1]Concrete compressive strength, f'_c, given for normal weight concrete.
[2]Single anchors with static shear load with installation in accordance with Figure 3 for Wood-Knocker or Wood-Knocker II+.
[3]Concrete determined to remain uncracked for the life of the anchorage.
[4]Load combinations from ACI 318-14 5.3 or ACI 318-11 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 the weighted average for α = 1.2*0.3 + 1.6*0.7 = 1.48.
[7]Assuming no edge distance ($c_{a1} \geq 1.5h_{ef}$) or corner distance influence ($c_{a2} \geq 1.5c_{a1}$) for Wood-Knocker or Wood-Knocker II+.
[8]Shear loads may be applied in any direction.
[9]$h \geq h_{min}$ according to ACI 318-14 17.7 or ACI 318-11D.8, as applicable.
[10]Values are for Condition B where supplementary reinforcement in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, is not provided.

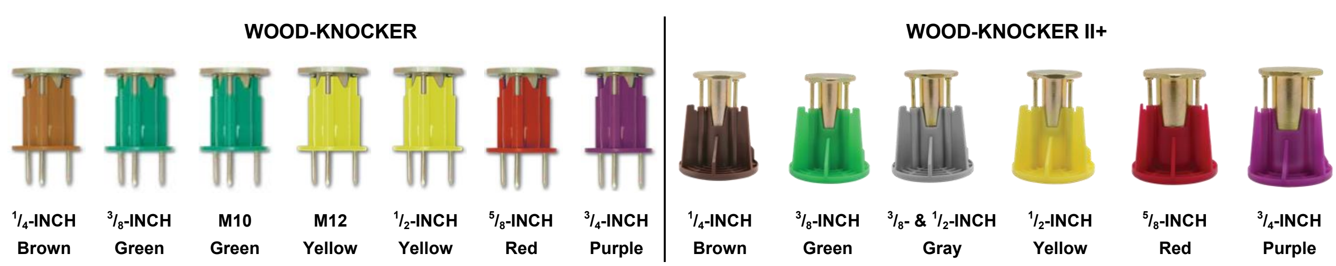


FIGURE 6—WOOD-KNOCKER AND WOOD-KNOCKER II+ CONCRETE INSERTS

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

CONCRETE STRENGTH (f'_c)	THREADED ROD SPECIFICATION (ASTM)	BANG-IT+ IN CONCRETE-FILLED STEEL DECK (FIGURE 4A)[10]													
		$^1/_4$-INCH (lbs)		$^3/_8$-INCH (lbs)		M10 (lbs)		M12 (lbs)		$^1/_2$-INCH (lbs)		$^5/_8$-INCH (lbs)		$^3/_4$-INCH (lbs)	
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
2,500	A36	940	830	1,395	830	1,395	830	1,395	830	1,395	830	1,395	830	1,395	830
	A193, Grade B7	1,395	830	1,395	830	1,395	830	1,395	830	1,395	830	1,395	830	1,395	830
3,000	A36	940	905	1,530	905	1,530	905	1,530	905	1,530	905	1,530	905	1,530	905
	A193, Grade B7	1,530	905	1,530	905	1,530	905	1,530	905	1,530	905	1,530	905	1,530	905
4,000	A36	940	940	1,765	1,045	1,765	1,045	1,765	1,045	1,765	1,045	1,765	1,045	1,765	1,045
	A193, Grade B7	1,765	1,045	1,765	1,045	1,765	1,045	1,765	1,045	1,765	1,045	1,765	1,045	1,765	1,045
6,000	A36	940	940	2,160	1,280	2,160	1,280	2,160	1,280	2,160	1,280	2,160	1,280	2,160	1,280
	A193, Grade B7	2,025	1,280	2,160	1,280	2,160	1,280	2,160	1,280	2,160	1,280	2,160	1,280	2,160	1,280
8,000	A36	940	940	2,295	1,475	2,495	1,475	2,495	1,475	2,495	1,475	2,495	1,475	2,495	1,475
	A193, Grade B7	2,025	1,475	2,495	1,475	2,495	1,475	2,495	1,475	2,495	1,475	2,495	1,475	2,495	1,475
10,000	A36	940	940	2,295	1,650	2,645	1,650	2,790	1,650	2,790	1,650	2,790	1,650	2,790	1,650
	A193, Grade B7	2,025	1,650	2,790	1,650	2,790	1,650	2,790	1,650	2,790	1,650	2,790	1,650	2,790	1,650
CONCRETE STRENGTH (f'_c)	THREADED ROD SPECIFICATION (ASTM)	BANG-IT+ IN CONCRETE-FILLED STEEL DECK (FIGURE 4B)[11]													
		$^1/_4$-INCH (lbs)		$^3/_8$-INCH (lbs)		M10 (lbs)		M12 (lbs)		$^1/_2$-INCH (lbs)		$^5/_8$-INCH (lbs)		$^3/_4$-INCH (lbs)	
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
2,500	A36	940	365	1,395	365	1,395	365	1,395	365	1,395	365	1,395	365	1,395	365
	A193, Grade B7	1,395	365	1,395	365	1,395	365	1,395	365	1,395	365	1,395	365	1,395	365
3,000	A36	940	400	1,530	400	1,530	400	1,530	400	1,530	400	1,530	400	1,530	400
	A193, Grade B7	1,530	400	1,530	400	1,530	400	1,530	400	1,530	400	1,530	400	1,530	400
4,000	A36	940	465	1,765	465	1,765	465	1,765	465	1,765	465	1,765	465	1,765	465
	A193, Grade B7	1,765	465	1,765	465	1,765	465	1,765	465	1,765	465	1,765	465	1,765	465
6,000	A36	940	570	2,160	570	2,160	570	2,160	570	2,160	570	2,160	570	2,160	570
	A193, Grade B7	2,025	570	2,160	570	2,160	570	2,160	570	2,160	570	2,160	570	2,160	570
8,000	A36	940	655	2,295	655	2,495	655	2,495	655	2,495	655	2,495	655	2,495	655
	A193, Grade B7	2,025	655	2,495	655	2,495	655	2,495	655	2,495	655	2,495	655	2,495	655
10,000	A36	940	730	2,295	730	2,645	730	2,790	730	2,790	730	2,790	730	2,790	730
	A193, Grade B7	2,025	730	2,790	730	2,790	730	2,790	730	2,790	730	2,790	730	2,790	730
CONCRETE STRENGTH (f'_c)	THREADED ROD SPECIFICATION (ASTM)	BANG-IT+ IN CONCRETE-FILLED STEEL DECK (FIGURE 4C)[12]													
		$^1/_4$-INCH (lbs)		$^3/_8$-INCH (lbs)		M10 (lbs)		M12 (lbs)		$^1/_2$-INCH (lbs)		$^5/_8$-INCH (lbs)		$^3/_4$-INCH (lbs)	
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
2,500	A36	940	705	1,395	705	1,395	705	1,395	705	1,395	705	1,395	705	1,395	705
	A193, Grade B7	1,395	705	1,395	705	1,395	705	1,395	705	1,395	705	1,395	705	1,395	705
3,000	A36	940	775	1,530	775	1,530	775	1,530	775	1,530	775	1,530	775	1,530	775
	A193, Grade B7	1,530	775	1,530	775	1,530	775	1,530	775	1,530	775	1,530	775	1,530	775
4,000	A36	940	890	1,765	890	1,765	890	1,765	890	1,765	890	1,765	890	1,765	890
	A193, Grade B7	1,765	890	1,765	890	1,765	890	1,765	890	1,765	890	1,765	890	1,765	890
6,000	A36	940	940	2,160	1,090	2,160	1,090	2,160	1,090	2,160	1,090	2,160	1,090	2,160	1,090
	A193, Grade B7	2,025	1,090	2,160	1,090	2,160	1,090	2,160	1,090	2,160	1,090	2,160	1,090	2,160	1,090
8,000	A36	940	940	2,295	1,260	2,495	1,260	2,495	1,260	2,495	1,260	2,495	1,260	2,495	1,260
	A193, Grade B7	2,025	1,260	2,495	1,260	2,495	1,260	2,495	1,260	2,495	1,260	2,495	1,260	2,495	1,260
10,000	A36	940	940	2,295	1,410	2,645	1,410	2,790	1,410	2,790	1,410	2,790	1,410	2,790	1,410
	A193, Grade B7	2,025	1,410	2,790	1,410	2,790	1,410	2,790	1,410	2,790	1,410	2,790	1,410	2,790	1,410

For **SI:** 1 pound = 4.45 N. For **pound-inch** unit: 1 inch = 25.4 mm.

Illustrative Allowable Stress Design Values in Table 8 are applicable only when all of the following design assumptions are followed:

[1]Concrete compressive strength, f'_c, given for sand-light weight concrete for Bang-It+ anchors.

[2]Single anchors; static tension load with installation in upper and lower flute locations in concrete-filled steel deck in accordance with Figures 4A, 4B or 4C, as applicable, and noted provisions.

[3]Concrete determined to remain uncracked for the life of the anchorage.

[4]Load combinations from ACI 318-14 5.3 or ACI 318-11 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 the weighted average for $\alpha = 1.2*0.3 + 1.6*0.7 = 1.48$.

[7]$h \geq h_{min}$ according to ACI 318-14 17.7 or ACI 318-11 Section D.8, as applicable.

[8]Values are for Condition B where supplementary reinforcement in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, is not provided.

[9]Assuming no edge distance influence with $\Psi_{ed,N}$ = 1.0 and no side-face blowout in tension for upper flute Bang-It+anchors.

[10]For lower flute Bang-It+ anchors, the near edge distance, $c_{a,min}$, is 1.125-inch (see Figure 4A).

[11]For lower flute Bang-It+ anchors, the near edge distance, $c_{a,min}$, is 0.75-inch (see Figure 4B).

[12]For lower flute Bang-It+ anchors, the near edge distance, $c_{a,min}$, is 0.75-inch (see Figure 4C).

$^1/_4$-INCH Brown | **$^3/_8$-INCH Green** | **M10 Green** | **$^3/_8$- & $^1/_2$-INCH Gray** | **M12 Yellow** | **$^1/_2$-INCH Yellow** | **$^5/_8$-INCH Red** | **$^3/_4$-INCH Purple**

FIGURE 7—BANG-IT+ INSERTS FOR CONCRETE-FILLED STEEL DECKS

TABLE 9—EXAMPLE ASD ALLOWABLE SHEAR DESIGN VALUE FOR ILLUSTRATIVE PURPOSES[1,2,3,4,5,6,7,8,9,10]

CONCRETE STRENGTH (f'_c)	THREADED ROD SPECIFICATION (ASTM)	BANG-IT+ IN CONCRETE-FILLED STEEL DECK (FIGURE 4A)													
		$^1/_4$-INCH (lbs)		$^3/_8$-INCH (lbs)		M10 (lbs)		M12 (lbs)		$^1/_2$-INCH (lbs)		$^5/_8$-INCH (lbs)		$^3/_4$-INCH (lbs)	
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
2,500 to 10,000	A36	490	490	925	925	925	925	925	925	925	925	1,245	1,245	1,245	1,245
	A193, Grade B7	925	925	925	925	925	925	925	925	925	925	1,245	1,245	1,245	1,245
CONCRETE STRENGTH (f'_c)	THREADED ROD SPECIFICATION (ASTM)	BANG-IT+ IN CONCRETE-FILLED STEEL DECK (FIGURE 4B)													
		$^1/_4$-INCH (lbs)		$^3/_8$-INCH (lbs)		M10 (lbs)		M12 (lbs)		$^1/_2$-INCH (lbs)		$^5/_8$-INCH (lbs)		$^3/_4$-INCH (lbs)	
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
2,500 to 10,000	A36	490	490	845	845	845	845	845	845	845	845	1,205	1,205	1,205	1,205
	A193, Grade B7	845	845	845	845	845	845	845	845	845	845	1,205	1,205	1,205	1,205
CONCRETE STRENGTH (f'_c)	THREADED ROD SPECIFICATION (ASTM)	BANG-IT+ IN CONCRETE-FILLED STEEL DECK (FIGURE 4C)													
		$^1/_4$-INCH (lbs)		$^3/_8$-INCH (lbs)		M10 (lbs)		M12 (lbs)		$^1/_2$-INCH (lbs)		$^5/_8$-INCH (lbs)		$^3/_4$-INCH (lbs)	
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
2,500 to 10,000	A36	490	490	845	845	845	845	845	845	845	845	1,205	1,205	1,205	1,205
	A193, Grade B7	845	845	845	845	845	845	845	845	845	845	1,205	1,205	1,205	1,205

For **SI:** 1 pound = 4.45 N. For **pound-inch** unit: 1 inch = 25.4 mm.

Illustrative Allowable Stress Design Values in Table 9 are applicable only when all of the following design assumptions are followed:

[1]Concrete compressive strength, f'_c, given for sand-light weight for Bang-It+ anchors.
[2]Single anchors; static shear load with installation in upper and lower flute locations in concrete-filled steel deck in accordance with Figures 4A, 4B or 4C, as applicable, and noted provisions.
[3]Concrete determined to remain uncracked for the life of the anchorage.
[4]Load combinations from ACI 318-14 5.3 or ACI 318-11 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 the weighted average for α = 1.2*0.3 + 1.6*0.7 = 1.48.
[7]Assuming no edge distance ($c_{a1} \geq 1.5h_{ef}$) or corner distance influence ($c_{a2} \geq 1.5c_{a1}$) upper flute Bang-It+ anchors.
[8]Shear loads may be applied in any direction.
[9]$h \geq h_{min}$ according to ACI 318-14 17.7 or ACI 318-11 D.8, as applicable.
[10]Values are for Condition B where supplementary reinforcement in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable is not provided.

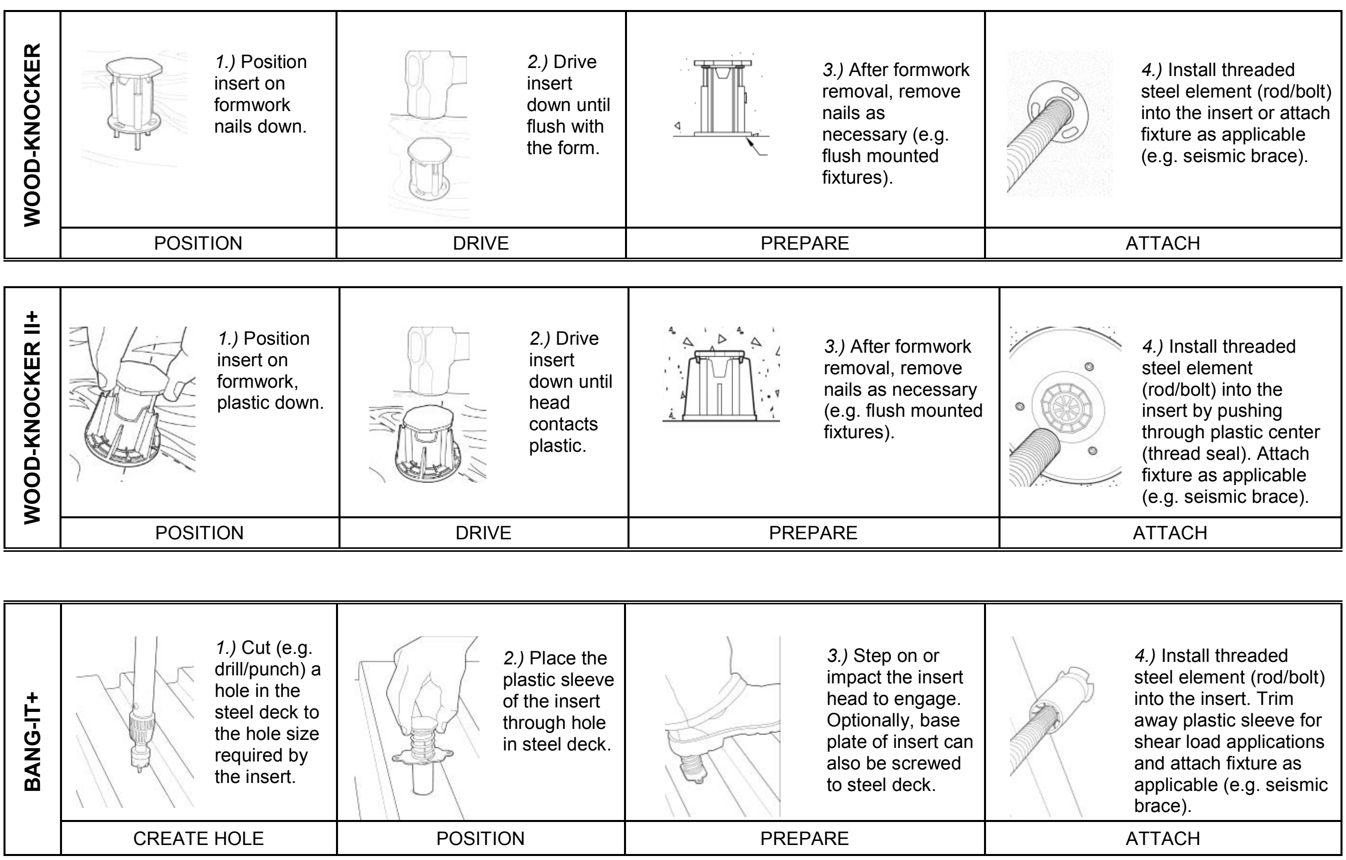
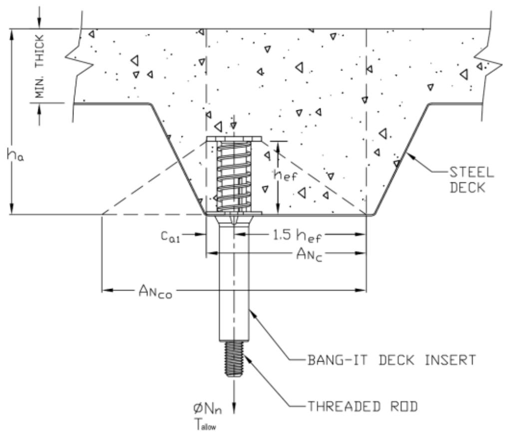
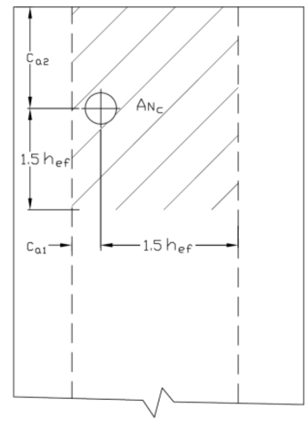


FIGURE 8—WOOD-KNOCKER AND WOOD KNOCKER II+ CONCRETE INSERTS, AND BANG-IT+ CONCRETE INSERTS FOR STEEL DECK, MANUFACTUER PUBLISHED INSTALLATION INSTRUCTIONS (MPII)

Given:
One $^3/_8$" Bang-it+ insert with ASTM A36 rod installed in the lower flute of steel deck
Steel deck in accordance with Figure 4C of this report ($3^7/_8$" min. flute width)
Anchor is $1^3/_{16}$" offset from center of flute ($^3/_4$" from close edge, $3^1/_8$ from far edge)
Sand-lightweight concrete with compressive strength: (f'_c) = 3,000 psi
No supplemental reinforcement: *(Condition B per ACI 318-11 D.4.3 c)*
Assume cracked concrete and no seismic

h_a = 5 in. (2" topping thickness)
h_{ef} = 1.75 in.
$c_{a1} = c_{a,min}$ = 0.75 in.
$c_{a2} \geq 1.5h_{ef}$ ($\therefore$ taken as $1.5h_{ef}$)





Calculate the factored resistance design strength in tension and equivalent allowable stress design load for the anchor in the given configuration.

Calculation in accordance with ACI 318-11 and this report:	**Code Ref.**	**Report Ref.**
Step 1. Verify minimum member thickness, spacing and edge distance: h_a = 5.0 in. (2" topping thickness, lower flute) ≥ h_{min} = 4.5 in. (1.5" topping thickness, lower flute) ∴ OK s_a = N/A (not applicable) c_{a1} = 0.75 in. ≥ $c_{a,min}$ = 0.75 in. ∴ OK	D.8	Table 3 Figure 4C
Step 2. Calculate steel strength of the anchor in tension: Calculate $\phi N_{sa,insert}$ and $\phi N_{sa,rod}$ and determine the controlling steel strength in tension	D.5.1.1 D.5.1.2	§4.1.2 Table 3 and Table 5
Step 2a. Calculate steel strength of the insert in tension: $\phi N_{sa,insert}$ = 0.65 • 10,440 lbs. = **6,785 lbs**.	D.5.1.1 D.5.1.2	§4.1.2 Table 3
Step 2b. Calculate steel strength of the threaded rod in tension: $\phi N_{sa,rod,A36}$ = 0.75 • 4,525 lbs. = **3,395 lbs**.	D.5.1.1 D.5.1.2	§4.1.2 Table 3
Step 2c. $\phi N_{sa,rod,A36} < \phi N_{sa,insert}$ ∴ threaded rod capacity controls steel strength in tension	D.5.1.1 D.5.1.2	§4.1.2
Step 3. Calculate concrete breakout strength of the anchor in tension: $N_{cb} = \frac{A_{Nc}}{A_{Nc0}}\psi_{ed,N}\psi_{c,N}\psi_{cp,N}N_b$	D.5.2.1 (b)	§4.1.3
Step 3a. Calculate A_{Nco} and A_{Nc} $A_{Nco} = 9h_{ef}^2 = 9 \bullet (1.75)^2$ = **27.6 in.²** $A_{nc} = (c_{a1} + (1.5h_{ef})) \bullet (c_{a2} + 1.5h_{ef})$ = (0.75 + 2.625)•((2.625 + 2.625)) = **17.7 in.²** ∴ A_{Nc} = **17.7 in.²**	D.5.2.1 (b)	§4.1.3 Figure 4C
Step 3b. Calculate $\psi_{ed,N}$ = 1.0 if $c_{a,min} \geq 1.5h_{ef}$; $\psi_{ed,N} = 0.7 + 0.3\frac{c_{a,min}}{1.5h_{ef}}$ if $c_{a,min} < 1.5h_{ef}$ $c_{a,min}$ = 0.75 in. < $1.5h_{ef}$ ∴ $\psi_{ed,N}$ = 0.7 + 0.3•(0.75/2.625) = **0.79**	D.5.2.5	§4.1.3 Table 3 Figure 4C
Step 3c. Calculate $\psi_{c,N}$ = **1.0** (for cracked concrete)	D.5.2.6	Table 3
Step 3d. Calculate $\psi_{cp,N}$ = **1.0** (for cast-in anchors)	D.5.2.7	-
Step 3f. Calculate $N_b = k_c\lambda_a\sqrt{f'_c}\,h_{ef}^{1.5} = 24\,(0.85)\sqrt{3{,}000} \bullet 1.75^{1.5}$ = **2,587 lbs.**	D.5.2.2 D.3.6	Table 3
Step 3g. Calculate concrete breakout strength of the anchor in tension: N_{cb} = (17.7/27.6) • 0.79 • 1.0 • 1.0 • 2,587 = 1,310 lbs. Calculate concrete breakout capacity = ϕN_{cb} = 0.70 • 1,310 = **917 lbs.**	D.5.2.1 (a)	§4.1.3
Step 4. Calculate nominal pullout strength of a single anchor in tension: N/A (not applicable)	D.5.3.1	§4.1.1
Step 5. Calculate nominal side-face blowout strength of the anchor: N/A (not applicable)	D.5.4.1	§4.1.4
Step 6. Determine the controlling resistance strength of the anchor in tension: $\phi N_n = \min\lvert\phi N_{sa}, \phi N_{cb}\rvert = \phi N_{cb}$ = **917 lbs.**	D.4.1	§4.1.1
Step 7. Calculate allowable stress design conversion factor for loading condition: Assume controlling load combination: 1.2D + 1.6L ; 30% Dead Load, 70% Live Load α = 1.2(0.3) + 1.6(0.7) = **1.48**	9.2	§4.2.1
Step 8. Calculate allowable stress design value: $T_{allowable,ASD} = \frac{\phi N_n}{\alpha} = \frac{917}{1.48}$ = **620 lbs.**	9.2	§4.2.1

FIGURE 9—EXAMPLE STRENGTH DESIGN CALCULATION FOR TENSION CAPACITY OF BANG-IT+ ANCHOR IN CONCRETE-FILLED STEEL DECK ASSEMBLIES