

# ICC-ES Evaluation Report

**ESR-3707**

Reissued November 2015

Revised January 19, 2016

This report is subject to renewal November 2017.

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

**REPORT HOLDER:**

**SIMPSON STRONG-TIE COMPANY INC.**  
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**EVALUATION SUBJECT:**

**SIMPSON STRONG-TIE® BLUE BANGER HANGER®**  
**CAST-IN-PLACE, INTERNALLY THREADED INSERTS IN**  
**CRACKED AND UNCRACKED CONCRETE**

**1.0 EVALUATION SCOPE**
**Compliance with the following codes:**

- 2015, 2012, 2009 and 2006 *International Building Code*® (IBC)
- \* ■ 2015, 2012, 2009 and ~~2006~~ *International Residential Code*® (IRC)

**Property evaluated:**

Structural

**2.0 USES**

The Simpson Strong-Tie® Blue Banger Hanger® Wood Form Inserts are 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 3,000 psi to 10,000 psi (20.7 MPa to 68.9 MPa).

The Simpson Strong-Tie® Blue Banger Hanger® Metal Deck 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 metal deck having a specified compressive strength,  $f'_c$ , of 3,000 psi to 10,000 psi (20.7 MPa to 68.9 MPa).

There are three models for the Wood Form Inserts: BBWF2550, BBWF3762, and BBWF6275. The BBWF2550 is used with a threaded rod size of  $\frac{1}{4}$  inch,  $\frac{3}{8}$  inch, or  $\frac{1}{2}$  inch; the BBWF3762 is used with a threaded rod size of  $\frac{3}{8}$  inch,  $\frac{1}{2}$  inch, or  $\frac{5}{8}$  inch; and the BBWF6275 is used with a threaded rod size of  $\frac{5}{8}$  inch or  $\frac{3}{4}$  inch.

There are three models for the Metal Deck Inserts: BBMD2550, BBMD3762, and BBMD6275. The BBMD2550

is used with a threaded rod size of  $\frac{1}{4}$  inch,  $\frac{3}{8}$  inch, or  $\frac{1}{2}$  inch; the BBMD3762 is used with a threaded rod size of  $\frac{3}{8}$  inch,  $\frac{1}{2}$  inch, or  $\frac{5}{8}$  inch; and the BBMD6275 is used with a threaded rod size of  $\frac{5}{8}$  inch or  $\frac{3}{4}$  inch.

For any application that includes shear loads, the largest size of threaded rod specified for each insert must be used.

Reference to “inserts” in this report refers to the manufactured specialty anchorage products (Wood Form Inserts and Metal Deck Inserts) used in concrete; reference to “anchors” in this report refers to the installed inserts in concrete with threaded rods. This report only covers the properties of the inserts.

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 and 2006 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 Form Inserts and Metal Deck Inserts:**

The Wood Form Inserts are cast-in concrete inserts. The insert consists of a steel internally threaded headed insert (anchor body), an outer plastic sleeve, and nails used to attach the insert to the inside surface of concrete formwork. The insert assembly is illustrated in [Figure 1](#). The internally threaded insert is manufactured from carbon steel GB/T 6478 Grade U40088 (ML08A1), GB/T 700 Grade Q195, or JIS G3507-1 Grade SWRCH8A. The inserts have a minimum 5.1  $\mu\text{m}$  (0.0002-inch) zinc plating. The plastic sleeve is fabricated from high-impact Type J340 PP (polypropylene) or equivalent. The plastic sleeve thickness is a maximum of 0.053 inch (1.35 mm).

The Metal Deck Inserts are cast-in concrete inserts. The insert consists of a steel internally threaded headed insert (anchor body), an outer spring, a plastic sleeve, and a washer (base plate). The insert assembly is illustrated in [Figure 2](#). The internally threaded insert and washer are manufactured from carbon steel GB/T 6478 Grade U40088 (ML08A1), GB/T 700 Grade Q195, or JIS G3507-1 Grade SWRCH8A. The inserts have a minimum 5.1  $\mu\text{m}$  (0.0002 inch) zinc plating. The spring is manufactured from #72A or JISG3521-91 spring steel. The plastic sleeve is fabricated from high-impact Type J340 PP (polypropylene) or equivalent.

The anchor assembly is comprised of a Wood Form or Metal Deck Insert with a threaded rod. The Wood Form

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 Metal Deck 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 completely through the hole. Concrete can then be cast over the insert.

### 3.2 Concrete:

Normal-weight and sand-lightweight concrete must conform to Sections [1903](#) and [1905](#) of the IBC.

### 3.3 Steel Deck Panels:

Steel deck panels must be in accordance with the configuration in [Figure 4](#) and have a minimum base steel thickness of 20 gage [0.035 inch (0.899 mm)]. Steel must comply with [ASTM A653/A653M](#) SS Grade 33 and have a minimum yield strength of 33,000 psi (228 MPa).

## 4.0 DESIGN AND INSTALLATION

### 4.1 Strength Design:

For any application that includes shear loads, the largest size of threaded rod specified for each insert must be used, that is:  $1/2$ -inch threaded rod only for BBWF2550 and BBMD2550;  $5/8$ -inch threaded rod only for BBWF3762 and BBMD3762; and  $3/4$ -inch threaded rod only for BBWF6275 and BBMD6275. Smaller diameter threaded rods are permitted to resist tension loads only.

**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 strength of anchors complying with the 2006 IBC and Section [R301.1.3](#) of the 2006 IRC must be in accordance with ACI 318-05 Appendix D and this report.~~

Design parameters provided in [Tables 1](#) and [2](#) of this report are based on the 2015 IBC (ACI 318-14) and on 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, except as required in ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable.

Strength reduction factors,  $\phi$ , 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,  $\phi$ , as given in ACI 318-11 D.4.4 must be used for load combinations calculated in accordance with [ACI 318](#) Appendix C. An example calculation in accordance with the 2012 IBC is provided in [Figure 7](#). 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 D.5.1, as applicable, for the threaded rod, not to exceed the values of  $N_{sa,insert}$  in [Tables 1](#) and [2](#) of this report. Strength reduction factors,  $\phi$ , corresponding to non-ductile steel shall be used when  $\phi N_{sa,insert}$  controls the design strength. When the threaded rod strength controls, the strength reduction factor,  $\phi$ , corresponding to the threaded rod shall be used.

**4.1.3 Requirements for Static Concrete Breakout Strength in Tension:** For the Wood Form Inserts and Metal Deck Inserts, 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 bolts, with modifications as described in this section, and with [Figure 1](#) and [2](#) of this report. 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 1](#) and [2](#), and  $k_c = 24$ . 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 Metal Deck Inserts installed in the soffit of sand-lightweight or normal-weight concrete on steel deck, the contribution of the metal deck strength must be ignored and the calculations of  $A_{Nc} / A_{Nco}$  and  $c_{a,min}$  (minimum edge distance) must be based on [Figure 5](#).

**4.1.4 Requirements for Static Side-Face Blowout Strength in Tension:** For the Wood Form Inserts, 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 Metal Deck Inserts installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies as shown in [Figure 4](#), calculation of the concrete side blowout strength is not required.

**4.1.5 Requirements for Static Steel Strength in Shear:** For any applications having a shear component, the largest size of threaded rod specified for each insert must be used.

For Wood Form Inserts, the nominal steel strength in shear,  $V_{sa}$ , of a single Wood Form Insert is given in Table 1 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 Metal Deck Inserts, the nominal steel strength in shear,  $V_{sa,deck,lower}$  and  $V_{sa,deck,upper}$ , of a single Metal Deck Insert, at lower flute and upper flute, respectively, are given in [Table 2](#) of this report 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 Form Inserts, 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 Metal Deck Inserts installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in [Figure 4](#), calculation of the concrete breakout strength in shear is not required.

**4.1.7 Requirements for Static Concrete Pryout Strength in Shear:** For Wood Form Inserts, 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 Metal Deck Inserts installed in the soffit of sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, as shown in [Figure 4](#), calculation of the concrete pry-out 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, 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 and -05 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. The nominal concrete breakout strength (for Wood Form Inserts and Metal Deck Inserts) and nominal concrete side-face blowout strength (for Wood Form Inserts only) for anchors in tension, and the nominal concrete breakout strength and pryout strength (for Wood Form Inserts and upper flute Metal Deck Inserts) 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. The anchors may be installed in Seismic Design Categories A through F of the IBC. The anchors comply with ACI 318-14 2.3 or ACI 318-11 D.1, as applicable, as brittle steel elements and must be designed in accordance with ACI 318-14 17.2.3.4, 17.2.3.5, 17.2.3.6, or 17.2.3.7; ACI 318-11 D.3.3.4, D.3.3.5, D.3.3.6 or D.3.3.7; ACI 318-08 D.3.3.4, D.3.3.5 or D.3.3.6; or ACI 318-05 D.3.3.4 or D.3.3.5, as applicable.

**4.1.8.2 Seismic Tension:** For Wood Form Inserts, 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 rod, not to exceed the nominal steel strength,  $N_{sa,insert,eq}$ , provided in [Table 1](#); 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 Metal Deck Inserts, 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 rod, not to exceed the nominal steel strength,  $N_{sa,insert,eq}$ , provided in [Table 2](#); 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 Sections 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 Form Inserts, 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 appropriate value for nominal steel strength for seismic loads,  $V_{sa,eq}$ , described in [Table 1](#) must be used in lieu of  $V_{sa}$ , as applicable.

For Metal Deck Inserts, 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 appropriate value for nominal steel strength for seismic loads,  $V_{sa,deck,lower,eq}$  or  $V_{sa,deck,upper,eq}$ , described in [Table 2](#), for lower flute or upper flute, respectively, must be used in lieu of  $V_{sa}$  as applicable.

**4.1.9 Requirements for Interaction of Tensile and Shear Forces:** For anchors or groups of anchors that are subject to the effects of combined tension and shear forces, the influence of bending on tension values when loaded in shear must be considered. 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 Metal Deck 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 [Figure 4](#) and shall have a minimum axial spacing along the flute equal to  $3h_{ef}$ .

**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  $Y_{cp,N} = 1.0$  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, ACI 318-11 and 318-08, when the Wood Form Inserts are used in sand-lightweight concrete, the modification factor  $\lambda_a$  or  $\lambda$ , respectively, for concrete breakout strength must be taken as 0.85 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 ACI 318-05, the values of  $N_b$  and  $V_b$  determined in accordance with this report must be modified in accordance with the provisions of ACI 318-05 D.3.4.

For Metal Deck Inserts installed in the soffit of sand-lightweight concrete-filled steel deck and floor and roof assemblies, this reduction is not required. Values are presented in [Table 2](#) and installation details are shown in [Figure 4](#).

#### 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).

$\phi N_n$  = 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, -5 Appendix D, and 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable (lbf or N).

$\phi V_n$  = 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, -5 Appendix D, and 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable (lbf or N).

$\alpha$  = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition,  $\alpha$  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 3](#) and [4](#).

**4.2.2 Interaction of Tensile and Shear Forces:** For anchors or groups of anchors that are subject to the effects of combined tension and shear forces, the influence of bending on tension values when loaded in shear must be considered. The design engineer must verify the validity of the interaction equation in ACI 318-14 17.6 or ACI 318-11, -08, -05 D.7, as applicable as follows:

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

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

For all other cases:

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

#### 4.3 Installation:

For the Wood Form Inserts, installation parameters are provided in [Table 1](#) and in [Figure 3](#) and [Figure 6A](#). The Wood Form Inserts must be positioned on wood formwork with all three nails in contact with the form. The head of the Wood Form Inserts must be impacted with sufficient force to drive the nails all the way into the wood until the plastic base sits flush and tight against the form. From beneath the deck, following the concrete pour and wood form removal, exposed nails must be broken away and an all-thread rod must be screwed into the internal threads of the Wood Form Insert. The rod must be tightened until fully seated in the insert, which will result in a minimum thread engagement equal to one rod diameter.

For the Metal Deck Inserts, installation parameters are provided in [Table 2](#) and in [Figure 4](#) and [Figure 6B](#). A hole

must be made in the metal deck using a step-drill, hole saw, or deck punch in accordance with the following hole diameters: BBMD2550 ( $7/8$ -inch diameter), BBMD3762 ( $1^{3/16}$ -inch diameter), and BBMD6275 ( $1^{1/4}$ -inch diameter). The Metal Deck Inserts must be placed in the hole, then the head of the insert must be impacted with sufficient force to compress the outer spring and drive the flared plastic fins completely through the hole in the metal deck. The metal base plate may be screwed to the deck for additional stability (optional). Before or after Metal Deck Insert insertion in deck, a threaded rod must be inserted through the plastic thread protector nozzle until contact is made with the inner steel barrel. The threaded rod must then be screwed into the internal threads of the Metal Deck Inserts. The rod 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 Metal Deck Inserts are permitted to be installed in either the upper or lower flute of the metal deck. For installation in the lower flute, the maximum offset from the flute centerline to the centerline of the Metal Deck Inserts must be no greater than  $1^{1/4}$  inches. The Metal Deck Inserts are suitable for installation anywhere across the upper flute.

Installation of Wood Form and Metal Deck Inserts must be in accordance with this evaluation report and the manufacturer's published installation instructions (MPII) depicted in [Figure 6A](#) and [6B](#). In the event of a conflict between this report and the MPPII, 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, or Section [1704.13](#) of the 2006 IBC, as applicable. For each type of headed cast-in specialty insert system, the manufacturer must submit inspection procedures to verify proper usage.

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 Form and Metal Deck concrete specialty inserts described in this report are acceptable alternatives to what is indicated 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 and sand-lightweight concrete having a specified compressive strength,  $f'_c$ , of 3,000 psi to 10,000 psi (20.7 MPa to 68.9 MPa) for the Wood-Form Inserts, and cracked

and uncracked normal-weight or sand-lightweight concrete over metal deck having a minimum specified compressive strength,  $f'_c$ , of 3,000 psi (20.7 MPa) for the Metal Deck 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 Form and Metal Deck 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 manufacturer's name (Simpson Strong-Tie Company, Inc.) and contact information, insert name, insert size, and evaluation report number (ESR-3707). The inserts have the Simpson Strong-Tie® "No Equal" logo (≠) embossed atop the head of the insert, which is visible for verification.

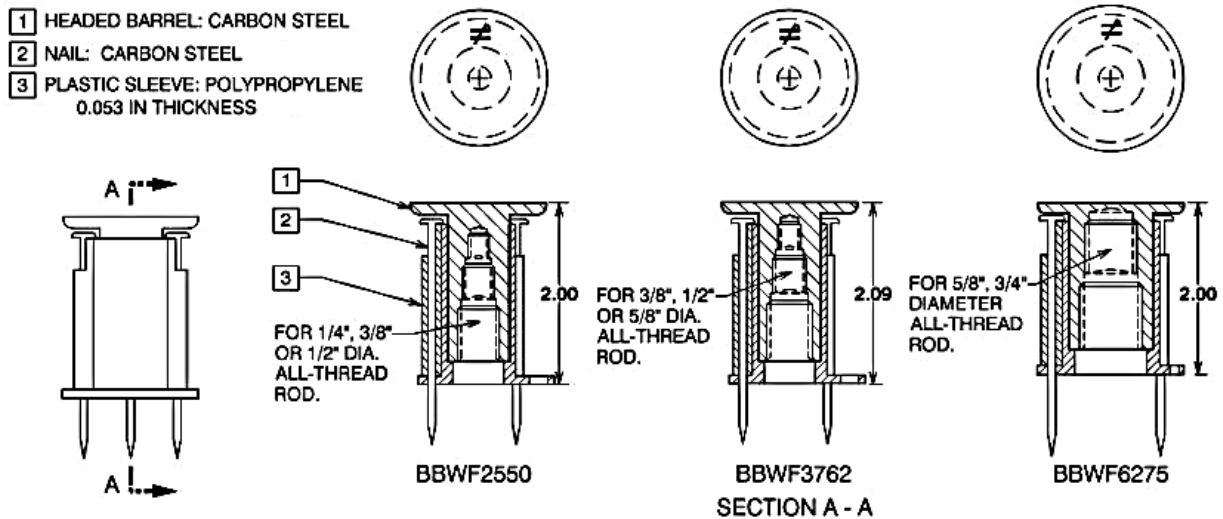


FIGURE 1—WOOD FORM INSERTS

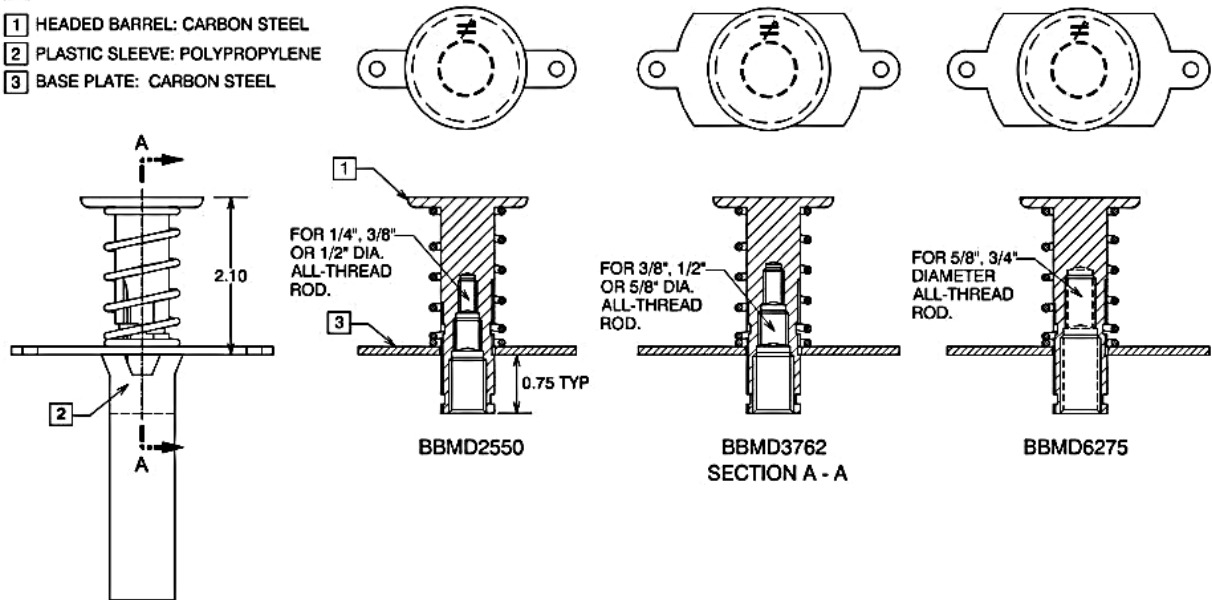


FIGURE 2—METAL DECK INSERTS

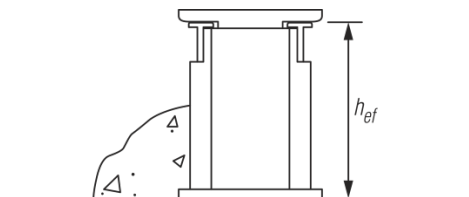
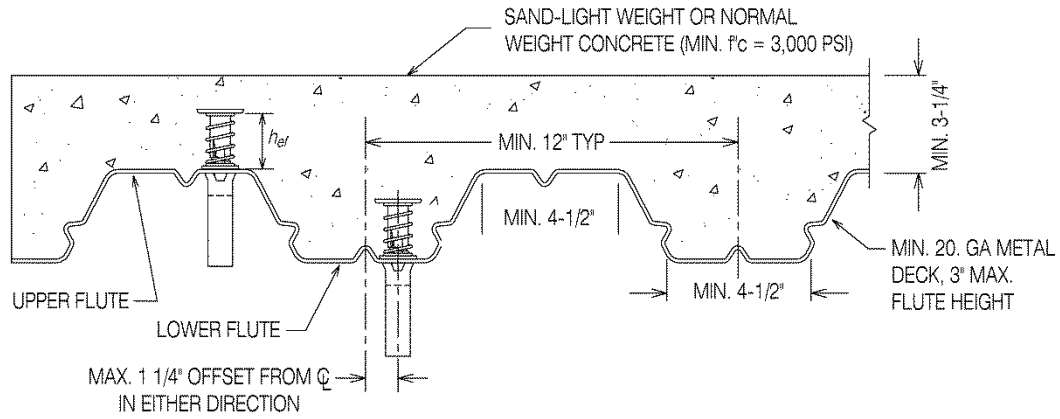


FIGURE 3—WOOD FORM INSERT INSTALLED IN SOFFIT OF FORM POUR CONCRETE FLOOR AND ROOF ASSEMBLIES



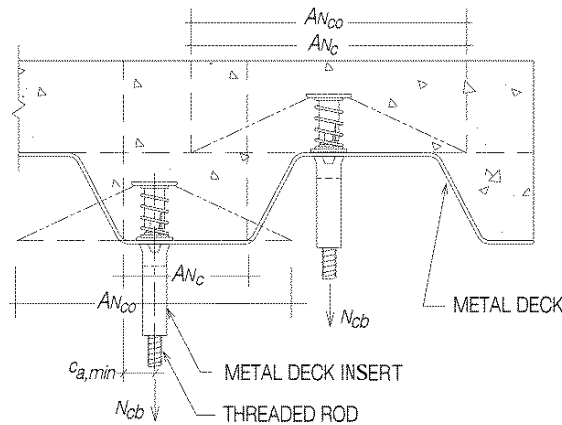
**FIGURE 4—METAL DECK INSERTS INSTALLED IN SOFFIT OF CONCRETE OVER METAL DECK FLOOR AND ROOF ASSEMBLIES<sup>1,2,3,4</sup>**

<sup>1</sup>Deck inserts may be placed in the upper flute or lower flute of the steel deck assembly. Upper flute installations require a minimum 3/4" concrete cover above the head of the insert. Inserts in the lower flute may be installed with a maximum 1 1/4" offset in either direction from the center of the flute. Inserts in upper flute may be installed anywhere across upper flute.

<sup>2</sup>Axial spacing along the flute length shall be minimum  $3h_{ef}$ .

<sup>3</sup>Upper flute Metal Deck Inserts not subject to metal pan deck dimension limitations or minimum gauge (tension only) limitations.

<sup>4</sup>Lower flute installations in flute widths less than 4 1/2" allowed if the following three conditions are met: 1) the application is limited to tension only; 2) insert meets cover requirements in [ACI 318-14](#) Section 20.6.1 or [ACI 318-11](#), Section 7.7; 3) applicable edge effects ( $\psi_{ed,N}$ ) are considered.



**FIGURE 5—IDEALIZATION OF CONCRETE ON DECK FOR DETERMINATION OF CONCRETE BREAKOUT STRENGTH IN ACCORDANCE WITH ACI 318**

TABLE 1—WOOD FORM INSERT DESIGN INFORMATION<sup>1,2,3,4,5,6,7,8</sup>

DESIGN INFORMATION	SYMBOL	UNITS	BBWF2550	BBWF3762	BBWF6275
Insert O.D.	$d_a(d_o)$	in. (mm)	0.811 (20.6)	1.000 (25.4)	1.102 (28.0)
Effective embedment depth	$h_{ef}$	in. (mm)	1.875 (47.6)	1.954 (49.6)	1.875 (47.6)
Insert steel characterization	-	-	Non-ductile	Non-ductile	Non-ductile
Modification factor for insert tension strength for inserts located in a region of a concrete member where analysis indicates no cracking at service load levels.	$\psi_{C,N}$	-	1.25	1.25	1.25
Nominal tension strength of single insert in tension as governed by steel strength	$N_{sa,insert}$	lb (kN)	8,415 (37.4)	16,755 (74.5)	18,685 (83.1)
Nominal seismic tension strength of single insert in tension as governed by steel strength	$N_{sa,insert,eq}$	lb (kN)	7,695 (34.2)	8,195 (36.4)	7,695 (34.2)
Nominal steel shear strength of single insert	$V_{sa}$	lb (kN)	6,810 (30.3)	8,210 (36.5)	8,760 (39.0)
Nominal steel shear strength of single insert for seismic loading	$V_{sa,eq}$	lb (KN)	6,810 (30.3)	8,210 (36.5)	8,760 (39.0)

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.

<sup>1</sup>Concrete must be normal weight concrete with  $f'_c$  of 3,000 psi minimum. Installation must comply with Sections 4.1.10 and 4.3, and [Figure 3](#) of this report.

<sup>2</sup>Only the largest size of threaded rod specified for each insert must be used for applications resisting shear loads.

<sup>3</sup>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 for cast-in headed anchors. The value of  $k_c$  shall be in accordance with the value for cast-in anchors in ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2.

<sup>4</sup>Strength reduction factors shall be taken from ACI 318-14 17.3.3 or ACI 318-11 D.4.3 for cast-in headed anchors.

<sup>5</sup>Strength reduction factor for load combinations of ACI 318-14 5.3 or ACI 318-11 9.2 governed by steel strength shall be taken as 0.65 for tension and 0.60 for shear.

<sup>6</sup>The concrete tension strength of headed cast-in specialty inserts shall be calculated in accordance with ACI 318-14 Chapter 17 or ACI 318-11 Appendix D and [Figure 1](#).

<sup>7</sup>Insert OD is the outside diameter of the plastic sleeve.

<sup>8</sup>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.



TABLE 2—METAL DECK INSERT DESIGN INFORMATION<sup>1,2,3,4,5,6,8</sup>

DESIGN INFORMATION	SYMBOL	UNITS	BBMD2550 <sup>9</sup>	BBMD3762	BBMD6275
Insert O.D. <sup>7</sup>	$d_a(d_o)$	in. (mm)	0.940 (23.9)	1.160 (29.5)	1.290 (32.8)
Effective embedment depth	$h_{ef}$	in. (mm)	1.980 (50.3)	1.980 (50.3)	1.980 (50.3)
Insert steel characterization	-	-	Non-ductile	Non-ductile	Non-ductile
Modification factor for insert tension strength for inserts located in a region of a concrete member where analysis indicates no cracking at service load levels.	$\psi_{C,N}$	-	1.25	1.25	1.25
Nominal tension strength of single insert in tension as governed by steel strength	$N_{sa,insert}$	lb (kN)	10,085 (44.9)	16,655 (74.1)	14,200 (63.2)
Nominal seismic tension strength of single insert in tension as governed by steel strength	$N_{sa,insert,eq}$	lb (kN)	7,920 (35.2)	7,920 (35.2)	7,920 (35.2)
Nominal steel shear strength of single insert in the soffit of concrete on metal deck, lower flute	$V_{sa,deck,lower}$	lb (kN)	3,105 (13.8)	2,610 (11.6)	3,345 (14.9)
Nominal steel shear strength of single insert in the soffit of concrete on metal deck, upper flute	$V_{sa,deck,upper}$	lb (kN)	3,500 (15.6)	1,710 (7.6)	5,565 (24.8)
Nominal steel shear strength of single insert in the soffit of concrete on metal deck, for seismic loading, lower flute	$V_{sa,deck,lower,eq}$	lb (kN)	3,105 (13.8)	2,610 (11.6)	3,345 (14.9)
Nominal steel shear strength of single insert in the soffit of concrete on metal deck, for seismic loading, upper flute	$V_{sa,deck,upper,eq}$	lb (kN)	3,500 (15.6)	1,710 (7.6)	5,565 (24.8)

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.

<sup>1</sup>Concrete must be normal weight or light weight concrete with  $f'_c$  of 3,000 psi minimum. Installation must comply with Sections 4.1.10 and 4.3, and [Figure 4](#) of this report.

<sup>2</sup>Only the largest size of the threaded rod specified for each insert must be used for applications resisting shear loads.

<sup>3</sup>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 for cast-in headed anchors. The value of  $k_c$  shall be in accordance with the value for cast-in anchors in ACI 318-14 17.4.2.2 or ACI 318-11 D.5.2.2.

<sup>4</sup>Strength reduction factors shall be taken from ACI 318-14 17.3.3 or ACI 318-11 D.4.3 for cast-in headed anchors.

<sup>5</sup>Strength reduction factor for load combinations of ACI 318-14 5.3 or ACI 318-11 Section 9.2 governed by steel strength shall be taken as 0.65 for tension and 0.60 for shear.

<sup>6</sup>The concrete tension strength of headed cast-in specialty inserts in the soffit of concrete on metal deck assemblies shall be calculated in accordance with ACI 318-14 Chapter 17 or ACI 318-11 Appendix D and [Figure 5](#).

<sup>7</sup>Insert OD is the outside diameter of the spring.

<sup>8</sup>The strengths shown in the table are for inserts only. Design professional is responsible for checking threaded rod strength in tension, shear, combined tension and shear, and with the influence of bending on tension values when loaded in shear, as applicable.

<sup>9</sup>Threaded rods used with the BBMD2550 in tension shall have maximum tensile strengths,  $f_{uta}$ , as follows: <sup>3</sup>/<sub>8</sub>-inch diameter 105,000 psi (725 MPa); <sup>1</sup>/<sub>2</sub>-inch diameter 60,000 psi (415 MPa).

TABLE 3—EXAMPLE ASD ALLOWABLE TENSION DESIGN VALUES FOR ILLUSTRATIVE PURPOSES<sup>1,2,3,4,5,6,7,8,9,10,11,12</sup>

THREADED ROD DIAMETER (in.)	BBWF2550 (lbs)	BBWF3762 (lbs)	BBWF6275 (lbs)	BBMD2550 (lbs)	BBMD3762 (lbs)	BBMD6275 (lbs)
1/4	1,820	NA	NA	985	NA	NA
3/8	1,820	1,935	NA	985	985	NA
1/2	1,820	1,935	NA	985	985	NA
5/8	NA	1,935	1,820	NA	985	985
3/4	NA	NA	1,820	NA	NA	985

For **SI**: 1 pound = 4.45 N, 1 psi = 0.00689 MPa, 1 psi = 0.00689 MPa. For pound-inch unit: 1 inch = 25.4 mm.

<sup>1</sup>Concrete  $f'_c = 3000$  psi normal weight concrete for Wood Form Inserts;  $f'_c = 3000$  psi light weight or normal concrete for Metal Deck Inserts at lower flute.

<sup>2</sup>Single anchors with static tension load. Installation must be in accordance to [Figure 3](#) for Wood Form Inserts and [Figure 4](#) for Metal Deck Inserts.

<sup>3</sup>Concrete determined to remain uncracked for the life of the anchorage.

<sup>4</sup>Load combinations from ACI 318-14 5.3 or ACI 318-11 9.2 (no seismic loading).

<sup>5</sup>30% dead load and 70% live load, controlling load combination 1.2D + 1.6 L.

<sup>6</sup>Calculation of the weighted average for  $\alpha = 0.3 \cdot 1.2 + 0.7 \cdot 1.6 = 1.48$ .

<sup>7</sup>Assuming no edge distance influence with  $\Psi_{ed,N} = 1.0$  and no side-face blowout in tension for Wood Form Inserts and upper flute Metal Deck Inserts.

<sup>8</sup>Edge distance  $\Psi_{ed,N} = 0.7 + 0.3c_{a,min}/1.5h_{ef} = 0.8$  for lower flute Metal Deck Inserts, see [Figure 5](#).

<sup>9</sup> $h \geq h_{min}$  according to ACI 318-14 17.7 or ACI 318-11 D.8.

<sup>10</sup>Values are for Condition B where supplementary reinforcement in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3 is not provided.

<sup>11</sup>NA (not applicable) denotes that this value is not applicable for design.

<sup>12</sup>The allowable loads shown in the table are for inserts only. For Wood Form Inserts, design professional is responsible for checking threaded rod strength in tension, shear, and combined tension and shear, as applicable. For Metal Deck inserts, design professional is responsible for checking threaded rod in tension, shear, and with the influence of bending on tension values when loaded in shear, additionally.

TABLE 4—EXAMPLE ASD ALLOWABLE SHEAR DESIGN VALUE FOR ILLUSTRATIVE PURPOSES<sup>1,2,3,4,5,6,7,8,9,10,11,12</sup>

THREADED ROD DIAMETER (in.)	BBWF2550 (lbs)	BBWF3762 (lbs)	BBWF6275 (lbs)	BBMD2550 (lbs)	BBMD3762 (lbs)	BBMD6275 (lbs)
1/4	NA	NA	NA	NA	NA	NA
3/8	NA	NA	NA	NA	NA	NA
1/2	1,820	NA	NA	1,260	NA	NA
5/8	NA	1,940	NA	NA	1,060	NA
3/4	NA	NA	1,820	NA	NA	1,355

For **SI**: 1 pound = 4.45 N, 1 psi = 0.00689 MPa, 1 psi = 0.00689 MPa. For pound-inch unit: 1 inch = 25.4 mm.

<sup>1</sup>Concrete  $f'_c = 3000$  psi normal weight concrete for Wood Form Inserts;  $f'_c = 3000$  psi light weight or normal concrete for Metal Deck Inserts at lower flute.

<sup>2</sup>Single anchors with static shear load. Installation must be in accordance to [Figure 3](#) for Wood Form Inserts and [Figure 4](#) for Metal Deck Inserts.

<sup>3</sup>For shear application, the largest size of threaded rod specified for each insert must be used.

<sup>4</sup>Concrete determined to remain uncracked for the life of the anchorage.

<sup>5</sup>Load combinations from ACI 318-14 5.3 or ACI 318-11 9.2 (no seismic loading).

<sup>6</sup>30% dead load and 70% live load, controlling load combination 1.2D + 1.6 L.

<sup>7</sup>Calculation of the weighted average for  $\alpha = 0.3 \cdot 1.2 + 0.7 \cdot 1.6 = 1.48$ .

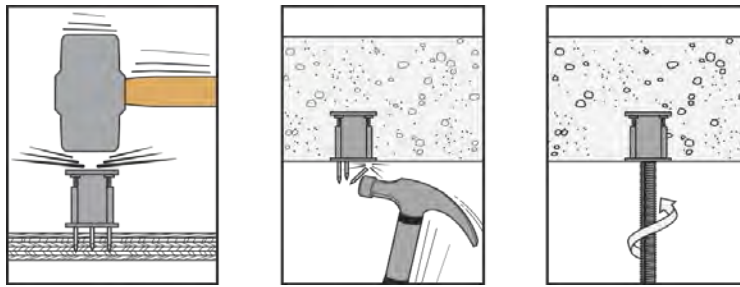
<sup>8</sup>Assuming no need for checking concrete breakout in shear for Wood Form Inserts with edge distance  $c_{a1}$  larger enough so  $V_b$  does not control.

<sup>9</sup> $h \geq h_{min}$  according to ACI 318-14 17.7 or ACI 318-11 D.8.

<sup>10</sup>Values are for Condition B where supplementary reinforcement in accordance with ACI 318-14 17.3.3 or ACI 318-11 D.4.3 is not provided.

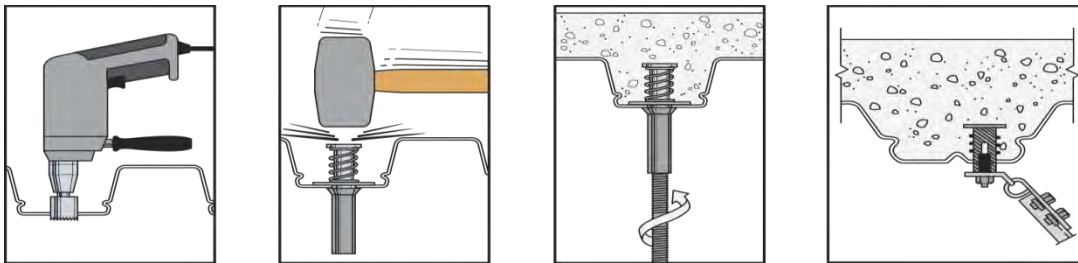
<sup>11</sup>NA (Not applicable) denotes that this value is not applicable for design.

<sup>12</sup>The allowable loads shown in the table are for inserts only. For Wood Form Inserts, design professional is responsible for checking threaded rod strength in tension, shear, and combined tension and shear, as applicable. For Metal Deck Inserts, design professional is responsible for checking threaded rod strength in tension, shear, combined tension and shear, and with the influence of bending on tension values when loaded in shear, as applicable.



1. Position on wood form. Impact WOOD FORM INSERT driving nails all the way into wood until plastic base sits flush and tight against form. 2. After concrete pour and wood form removal, break away exposed nails. 3. **Vertical Support Anchorage:** Screw threaded rod into WOOD FORM INSERT and tighten rod until fully seated. 4. **Seismic Restraint Anchorage:** Using the largest rod diameter that the insert will accept, insert threaded rod fastener into threads of steel barrel. Tighten rod until fully seated. Mount seismic bracket on exposed rod and flush with underside of deck. Install hex nut hand tight plus  $\frac{1}{2}$  turn minimum.

FIGURE 6A—WOOD FORM INSERT INSTALLATION INSTRUCTIONS



1. Make hole in metal deck of following diameter using step-driller, hole saw or deck punch: BBMD2550 (7/8" dia.), BBMD3762 (1 3/16" dia.), BBMD6275 (1 1/4" dia.). 2. Position METAL DECK INSERT in hole. Impact head with sufficient force to compress spring and drive flared plastic fins completely thru hole. Screw attach METAL DECK INSERT metal base plate to deck for additional stability (optional). 3. **Vertical Support Anchorage:** Insert threaded rod through finned plastic nozzle until contact with steel barrel. Engage METAL DECK INSERT internal threads. Tighten rod until fully seated. 4. **Seismic Restraint Anchorage:** From beneath deck, trim away plastic nozzle flush with projecting  $\frac{3}{4}$ " long metal barrel of METAL DECK INSERT. Using the largest rod diameter that the insert will accept, insert threaded rod fastener into threads of steel barrel. Tighten rod until fully seated. Mount seismic bracket on exposed rod and up against insert barrel. Install hex nut hand tight plus  $\frac{1}{2}$  turn minimum.

FIGURE 6B—METAL DECK INSERT INSTALLATION INSTRUCTIONS

<p><b>Given:</b>                  Two 1/2-inch ASTM A193 B7 threaded rods with BBWF2550 under st tension load.                  Normal weight concrete, <math>f'_c = 3,000</math> psi                  No supplementary reinforcement (Condition B per ACI 318-11 D.4.3 c)                  Assume cracked concrete since no other information is available.</p> <p><b>Needed:</b> Using Allowable Stress Design (ASD) calculate the allowable tension load for this configuration.</p>		
<p>Calculation per ACI 318-11 Appendix D and this report.</p>	<p>Code Ref.</p>	<p>Report Ref.</p>
<p>Step 1. Calculate steel capacity: <math>\phi N_{sa} = \phi A_{se,N} f_{uta} \times 2 = 0.65 \times 0.142 \text{ in.}^2 \times 125 \text{ ksi} \times 2 = 23,075 \text{ lb}</math> for (2) anchors                  Not to exceed <math>\phi N_{sa,insert} = 0.65 \times 8415 \text{ lb} \times 2 = 5,470 \text{ lb} \times 2 = 10,940</math> for (2) anchors</p>		<p>§4.1.2 Table 1</p>
<p>Step 2. Calculate concrete breakout strength of anchor in tension:</p> $N_{cbg} = \frac{A_{Nc}}{A_{Nco}} \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$	<p>D.5.2.1</p>	<p>§ 4.1.3</p>
<p>Step 2a. Verify minimum member thickness, spacing, and edge distance:  <math>h_{ef} = 1.874 \text{ in.} \leq 6 \text{ in.}</math> – concrete clear cover = <math>6'' - 3/4'' = 5 1/4'' \therefore \text{OK}</math>                  Spacing (s) = 6 in. &gt; <math>4d_a = 4 \times 0.811 \text{ in.} = 3.2 \text{ in.} \therefore \text{OK}</math>                  Edge distance = 4 in. &gt; cover distance required for the corresponding rebar. <math>\therefore \text{OK}</math></p>	<p>D.8</p>	<p>Table 1 Fig. 3</p>
<p>Step 2b. Calculate <math>A_{Nco}</math> and <math>A_{Nc}</math> for the anchorage:  <math>A_{Nco} = 9h_{ef}^2 = 9 \times (1.874 \text{ in.})^2 = 31.6 \text{ in.}^2</math>                  No overlapping breakout cone:  <math>A_{Nc} = 2A_{Nco}</math></p>	<p>D.5.2.1</p>	
<p>Step 2c. Determine <math>\psi_{ec,N}</math>: <math>e'_N = 0 \therefore \psi_{ec,N} = 1.0</math></p>	<p>D.5.2.4</p>	
<p>Step 2d. Calculate <math>N_b</math>: <math>N_b = k_{cr} \lambda_a \sqrt{f'_c} h_{ef}^{1.5} = 24 \times 1.0 \times \sqrt{3,000} \times 1.874^{1.5} = 3,372 \text{ lb}</math></p>	<p>D.5.2.2</p>	
<p>Step 2e. Calculate modification factor for edge distance: <math>c_{a,min} = 4 \text{ in.} &gt; 1.5 h_{ef}</math>, so <math>\psi_{ed,N} = 1.0</math></p>	<p>D.5.2.5</p>	
<p>Step 2f. Calculate modification factor for cracked concrete: <math>\psi_{c,N} = 1.0</math> (cracked concrete)</p>	<p>D.5.2.6</p>	
<p>Step 2g. Calculate modification factor for splitting: <math>\psi_{cp,N} = 1.0</math> (for cast-in anchor)</p>	<p>D.5.2.7</p>	
<p>Step 2h. Calculate <math>\phi N_{cbg}</math>: <math>\phi N_{cbg} = 0.7 \times \frac{63.2}{31.6} \times 1.0 \times 1.0 \times 1.0 \times 3,372 = 4,721 \text{ lb}</math></p>	<p>D.5.2.1</p>	<p>§ 4.1.3</p>
<p>Step 3. Check face-side breakout strength: <math>h_{ef} &lt; 2.5 c_{a1}</math>, no check required.</p>	<p>D.5.4</p>	<p>§ 4.1.4</p>
<p>Step 4. Controlling strength: <math>\phi N_{cbg} = 4721 \text{ lb} &lt; \phi N_{sa} \therefore \phi N_{cbg}</math> controls</p>		
<p>Step 5. To convert to ASD, assume U = 1.2D + 1.6L: <math>T_{ASD} = \frac{4,721}{1.48} = 3,190 \text{ lb}</math></p>		<p>§ 4.2</p>

FIGURE 7—EXAMPLE CALCULATION