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ESR-2961

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DIVISION: 05 00 00—METALS

SECTION: 05 05 23—METAL FASTENINGS

DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES

SECTION: 06 05 23—WOOD, PLASTIC, AND COMPOSITE FASTENINGS

REPORT HOLDER:

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EVALUATION SUBJECT:

**POWER-ACTUATED FASTENERS FOR DIAPHRAGM ASSEMBLIES WITH STEEL
FRAMING AND WOOD STRUCTURAL PANELS**



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DIVISION: 05 00 00—METALS

Section: 05 05 23—Metal Fasteners

DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES

Section: 06 05 23—Wood, Plastic, and Composites Fastenings

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EVALUATION SUBJECT:

POWER-ACTUATED FASTENERS FOR DIAPHRAGM ASSEMBLIES WITH STEEL FRAMING AND WOOD STRUCTURAL PANELS

1.0 EVALUATION SCOPE

Compliance with the following codes:

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

Property evaluated:

Structural

2.0 USES

Jaaco NailPro hardened ballistic fasteners are used to attach oriented strand board (OSB) wood structural panels to cold-formed steel (CFS) framing for site-built horizontal diaphragm applications under the IBC to resist in-plane wind or seismic forces; and are limited to locations not exposed to the weather or damp environment. The fasteners may be used in structures regulated by the IRC, when an engineered design is submitted in accordance with IRC Section R301.1.3.

3.0 DESCRIPTION

3.1 Jaaco NailPro Hardened Ballistic Fasteners:

3.1.1 General: The fasteners are nail-shaped with a flat head. The fasteners are manufactured from steel wires complying with ASTM A510, Grade 1060 (UNS 10600), and are heat-treated to provide case and core hardness of 52 to 55 HRC. The fasteners have either electrodeposited zinc coatings with chromate finish or mechanically deposited zinc coatings complying, respectively, with ASTM B 633, Type II, SC 1, or ASTM B 695, Type 1 Class 12. The fasteners have a ballistic point with either a knurled or smooth shank, and are available loose in bulk containers; bundled in wire and plastic sheet coils; and collated in strips. Figure 1 shows the typical fasteners with knurled and smooth shank, and fastener head marking.

3.1.2 Knurled Shank Fasteners: The knurled shank fasteners (item number NP100K) have a nominal knurled shank diameter of 0.100 inch (2.69 mm), a nominal head diameter of 0.245 inch (6.20 mm), and a minimum length of 1¹/₂ inches (38 mm).

3.1.3 Smooth Shank Fasteners: The smooth shank fasteners (item number NP145S) have a nominal smooth shank diameter of 0.145 inch (3.66 mm), a nominal head diameter of 0.300 inch (7.60 mm), and a minimum length of 1¹/₂ inches (38 mm).

3.2 Wood Structural Panels (OSB):

Wood structural panels must be Structural 1, Exposure 1, OSB panels complying with DOC PS-2. The required span rating and nominal thickness of the rated OSB sheathing panels are given in Table 2.

3.3 Cold-formed Steel (CFS) Framing Members:

CFS framing members must be recognized in a current ICC-ES evaluation report and must be manufactured from steel complying with ASTM A 1003, ST Grade 50, Type H, or ASTM A 653 SS, Grade 50, Class 1, with a minimum coating designation of G60.

CFS diaphragm joists and blocking members must be C-shaped members with a designation thickness of 68 mils (1.73 mm) [a minimum 0.0677-inch (1.72 mm) uncoated base-steel thickness], a minimum flange width of 1⁵/₈ inches (41.3 mm), a minimum depth of 3⁵/₈ inches (92.1 mm), and a minimum flange stiffener (lip) length of 1/2 inch (12.7 mm).

CFS diaphragm perimeter framing members must be channel-shaped members with a designation thickness of

68 mils (1.73 mm) [a minimum 0.0677-inch (1.72 mm) uncoated base-steel thickness], a minimum flange width of 1½ inches (38 mm), and a minimum inside depth equal to the depth of the diaphragm joists.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 Single Fastener Connections: Allowable pullout and lateral loads for single fastener connections of OSB panels to CFS framing members are given in Table 1. The allowable lateral loads have been determined using a fastener-to-panel edge distance of ½ inch (12.7 mm) with loads parallel to the panel edge. Allowable loads in Table 1 are provided for comparison with other types of fasteners, such as tapping screws, and are not recognized for use in determining allowable loads for diaphragms

4.1.2 Horizontal Diaphragms: The maximum diaphragm aspect ratio (span-to-width ratio) is 2½:1. The OSB panels must be installed with the long dimension perpendicular to CFS joist framing and must be attached to the framing with the NailPro NP145S fasteners at the spacings noted in Table 2. Blocking may be used at the panel edge joints. Allowable shear loads for wind or seismic forces are given in Table 2. OSB panels must be capable of supporting vertical loads based on the panel span rating as indicated in Table 2. Diaphragm blocking may be required. If diaphragm blocking is required, it must be installed in accordance with the applicable code.

The deflection of a blocked OSB panel diaphragm uniformly fastened throughout must be calculated using the following equation, as applicable:

$$\delta = \frac{5vL^3}{8E_s A_c b} + \omega_1 \omega_2 \frac{vL}{\rho G t_{panel}} + \omega_1^{5/4} \omega_2 \omega_3 (\alpha) \left(\frac{v}{1.4\beta} \right)^2 + \frac{\sum_{i=1}^n \Delta_{ci} X_i}{2b}$$

For SI:

$$\delta = \frac{0.052vL^3}{E_s A_c b} + \omega_1 \omega_2 \frac{vL}{\rho G t_{panel}} + \omega_1^{5/4} \omega_2 \omega_3 (\alpha) \left(\frac{v}{0.00405\beta} \right)^2 + \frac{\sum_{i=1}^n \Delta_{ci} X_i}{2b}$$

where:

- A_c = Gross cross-sectional area of chord member, in square inches (mm²)
- b = Diaphragm depth parallel to direction of load, in feet (mm)
- E_s = Modulus of elasticity of steel = 29,500,000 psi (203,000 MPa)
- $G t_{panel}$ = OSB panel sheathing rigidity through the thickness = 83,500 lbf/in. of panel depth. See Table 2305.2 (2) of the IBC.
- L = Diaphragm length perpendicular to direction of load, in feet (mm)
- n = Number of splices in both diaphragm chords
- s = Maximum fastener spacing at panel edge, in inches (mm)
- t_{panel} = Nominal panel thickness, in inches (mm)
- t_{joist} = Nominal framing thickness, in inches (mm)
- v = Shear demand (V/2b), in pounds per linear foot (N/mm)
- V = Total lateral load applied to the diaphragm, in pounds (N)
- X_i = Distance between the "ith" chord-splice and the nearest support (braced wall line), in feet (mm)
- α = Ratio of the average load per fastener based on a non-uniform fastener pattern to the

average load per fastener based on a uniform fastener pattern (= 1 for a uniformly fastened diaphragm)

- β = 660 for OSB
- Δ_{ci} = Deformation value associated with "ith" chord splice, in inches (mm)
- ρ = 1.05 for OSB
- ω_1 = s/6 (for s in inches), s/152.4 (for s in mm)
- ω_2 = 0.033/ t_{joist} (for t_{joist} in inch) and 0.838/ t_{joist} (for t_{joist} in mm)
- δ = Calculated deflection, in inches (mm)

For an unblocked OSB panel diaphragm, δ must be multiplied by 2.5.

4.2 Installation:

The Jaaco NailPro hardened ballistic fasteners must be installed using pneumatic or fuel-powered tools recommended by Jaaco Corporation. The fasteners must be installed such that the fasteners' tips pierce the OSB panels being fastened and protrude through the CFS framing members a minimum of ½ inch (12.7 mm). The fasteners must be installed a minimum of ½ inch (12.7 mm) from the edge of OSB panels. The spacing of the fasteners must be a maximum of 6 inches (152 mm) on center in the field of the sheathing panel. The spacing of the fasteners at the panel edges must be a minimum of 2 inches (51 mm) and a maximum of 6 inches (152 mm), as specified by a registered design professional, based on Table 2.

The CFS diaphragm joists must be fastened to the diaphragm tracks, with one No. 10 by ¾-inch-long (19.1 mm), modified truss head, zinc-coated screws complying with ASTM C1513, through each flange.

5.0 CONDITIONS OF USE

The Jaaco NailPro hardened ballistic fasteners described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

- 5.1** The fasteners must be installed in accordance with the manufacturer's installation instructions and this report. In the event of a conflict between this report and the manufacturer's installation instructions, the more restrictive requirements govern.
- 5.2** Calculations demonstrating that the applied in-plane shear loads are less than the available diaphragm strength must be submitted to the code official for approval. The calculations must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is constructed.
- 5.3** Use of the fasteners described in this report is limited to dry, interior locations.
- 5.4** Use of the fasteners described in this report in contact with preservative-treated or fire-retardant-treated wood members is outside scope of this report.
- 5.5** An approved exterior roof covering must be installed over the wood structural panels when the panels are considered to be a weather-exposed roof surface, as defined by the applicable code.
- 5.6** The fasteners are manufactured under a quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Horizontal Diaphragms Consisting of Wood Structural Panel Sheathing Attached to Cold-formed Steel Framing (AC262), dated June 2016.

(Jaaco Corporation) or the additional listee (Pac Fast, Inc.), as indicated in Table 3 of this report; the product brand name and item number; nominal fastener size and length; coating type; and the ICC-ES evaluation report number (ESR-2961). Each fastener head must bear a marking as shown in Figure 1.

7.0 IDENTIFICATION

Each carton and packaging unit of the hardened ballistic fasteners described in this report must be identified by a label bearing the name and address of the report holder

TABLE 1—ALLOWABLE PULLOUT AND LATERAL LOADS IN POUNDS PER FASTENER DUE TO WIND OR SEISMIC FORCES FOR OSB WOOD STRUCTURAL PANELS ATTACHED TO COLD-FORMED STEEL (CFS) FRAMING MEMBERS WITH NAILPRO FASTENERS^{1,2,3,4,5}

FASTENER TYPE	SHANK TYPE	SHANK DIAMETER (in.)	MINIMUM CFS THICKNESS (mils)	NOMINAL THICKNESS OF WOOD STRUCTURAL PANELS (in.)	
				Pullout Loads (lbf)	Lateral Loads (lbf)
				¹⁵ / ₃₂	¹⁵ / ₃₂
NP100K	Knurled	0.100	43	25	-
NP145S	Smooth	0.145	68	45	95

For **SI**: 1 inch = 25.4 mm, 1 lbf = 4.45 N.

¹The tabulated values are for short-term loading due to wind or seismic forces. For shear loads of normal and permanent load duration as defined by the AF&PA NDS, the tabulated values must be multiplied by 0.75 and 0.67, respectively.

²The fasteners must be long enough to penetrate the steel framing members a minimum of 1/2 in. (12.7 mm).

³The minimum edge distance from a fastener to the panel edge must be 1/2 in. (12.7 mm).

⁴The tabulated values are for OSB panels described in Section 3.2. For OSB panels other than the OSB panels described in Section 3.2, covered in DOC PS-2, reduce loads by 10 percent.

⁵ Lateral strength of fastener connections are for general attachment of sheathing to CFS framing and must not be used to determine diaphragm capacities.

TABLE 2—ALLOWABLE SHEAR, FOR WIND OR SEISMIC FORCES, FOR HORIZONTAL DIAPHRAGMS CONSISTING OF OSB WOOD STRUCTURAL PANELS ATTACHED TO COLD-FORMED STEEL (CFS) FRAMING MEMBERS WITH NAILPRO 1.5-INCH-LONG NP145S FASTENERS^{1,2,3,4,5}

WOOD STRUCTURAL PANEL (32/16 OSB)		CFS FRAMING		BLOCKED DIAPHRAGM: FASTENER SPACING AT DIAPHRAGM BOUNDARIES (ALL CASES), AT CONTINUOUS PANEL EDGES PARALLEL TO LOAD (CASES 3 and 4) AND AT ALL PANEL EDGES (CASES 5 and 6)				UNBLOCKED DIAPHRAGM: FASTENER SPACED 6 INCHES MAXIMUM AT SUPPORTED EDGES	
Grade	Nominal Thickness (in.)	Minimum Thickness (mils)	Framing Width (in.)	6	4	2 1/2	2	Case 1 (no unblocked edges or continuous joints to load)	All Other Cases (Cases 2 through 6)
				Fastener Spacing at Other Panel Edges					
				6	6	4	3		
Structural I	¹⁵ / ₃₂	68	1 5/8	265	350	560	700	235	175
Rated Sheathing	¹⁵ / ₃₂	68	1 5/8	235	315	505	630	210	160

For **SI**: 1 inch = 25.4 mm, 1 lb/ft = 14.6 N/m.

¹The tabulated values are for short-duration loads due to wind and seismic forces. For shear loads of normal and permanent load duration as defined by the AF&PA NDS, the tabulated values must be multiplied by 0.75 and 0.67, respectively.

²The fasteners must be long enough to penetrate through the steel framing a minimum of 1/2 in. (12.7 mm).

³Wood structural panels must be installed with the long dimension perpendicular to steel joist framing. Blocking may be used at the panel edge joints. The minimum edge distance from the fastener to the wood structural panel edge must be 1/2 in. (12.7 mm). Fastener spacing must be 6 in. (152 mm) on center in the field of the wood structural panels.

⁴Framing is permitted to be oriented in either direction for diaphragms, provided sheathing is designed for vertical loads.

⁵Thicker OSB wood structural panels may be used, but provide no increase in allowable shear loads. The fastener penetration must comply with Footnote 2.

TABLE 3—COMPANY NAME/PRODUCT NAME CROSS-REFERENCE

COMPANY NAME	PRODUCT TRADE NAME
Jaaco Corporation	NailPro
Pac Fast Inc.	Preferred Fasteners



a. Smooth Shank Fastener

b. Knurled Shank Fastener

c. Fastener Head Marking

FIGURE 1—JAACO NAILPRO HARDENED BALLISTIC FASTENERS AND FASTENER HEAD MARK