

ICC-ES Evaluation Report

ESR-3821

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DIVISION: 03 00 00—CONCRETE
Section: 03 15 00—Concrete Accessories
Section: 03 21 00—Reinforcing Steel

REPORT HOLDER:

PJ'S REBAR INC.
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EVALUATION SUBJECT:
PJ'S PUNCHING SHEAR RESISTOR (PSR) STUD RAILS
1.0 EVALUATION SCOPE
Compliance with the following codes:

 2012, 2009 and 2006 *International Building Code*® (IBC)

Property evaluated:

Structural

2.0 USES

The PJ's PSR Stud Rails are used as shear reinforcement in flat concrete slabs to replace stirrups, drop panels or column capitals for the purpose of increasing the punching shear resistance of the slabs.

3.0 DESCRIPTION
3.1 General:

The PJ's PSR Stud Rails are reinforcement assemblies that are formed by welding large-headed shear studs to flat steel base rails. The studs are $\frac{3}{8}$ -, $\frac{1}{2}$ -, $\frac{5}{8}$ - and $\frac{3}{4}$ -inch-diameter (9.5, 12.7, 15.9 and 19.1 mm) headed studs recognized in ICC-ES evaluation report ESR-1170 or ESR-2822 as complying with the requirements of ASTM A1044, as required by the stud rail manufacturer's approved quality documentation. The stud dimensions and base rail dimensions are shown in Tables 1 and 2, respectively. The PJ's PSR Stud Rail assemblies and typical installation requirements are shown in Figures 1 and 2, respectively.

The PJ's PSR Stud Rails comply with the provisions of ASTM A1044 and Section 3.5.5 of ACI 318-11 and ACI 318-08.

3.2 Materials:

3.2.1 Studs: The studs are produced from steel complying with ASTM A29 Grades 1010 through 1020, and conform to the following physical and mechanical requirements in accordance with the prescribed values in Table 1 of ASTM A1044:

■ Tensile strength, min, psi [MPa]:	65,000 [450]
■ Yield strength, min, psi [MPa]:	51,000 [350]
■ Elongation in 2 in. [50 mm], min, %:	20
■ Reduction of area, min, %:	50

3.2.2 Base Rails: The base rails are produced from ASTM A36 steel plates conforming to the following physical and mechanical requirements in accordance with the prescribed values in Table 2 of ASTM A1044:

■ Tensile strength, min, psi [MPa]:	65,000 [450]
■ Yield strength, min, psi [MPa]:	44,000 [300]
■ Elongation in 8 in. [200 mm], min, %:	20

3.3 Stud Welding: The headed studs are factory-welded by PJ's Rebar Inc. to the flat steel base rails using welding equipment in accordance with procedures recommended by the headed stud manufacturer(s). All welding complies with ASTM A1044 and AWS D1.1 requirements.

4.0 DESIGN AND INSTALLATION
4.1 Design:

4.1.1 General: Structural design and installation of PJ's PSR Stud Rails used as punching shear reinforcement in reinforced concrete slabs must comply with the applicable provisions of ACI 318-11 for the 2012 IBC (ACI 318-08 for the 2009 IBC). Under the 2006 IBC, structural design and installation of PJ's PSR stud rails used as punching shear reinforcement in reinforced concrete slabs must comply with ACI 318-05, and Sections 3.5.5, 7.7.5, and 11.11.5 of ACI 318-08.

4.1.2 Design Considerations: The structural design shall determine and specify the following items, based on design requirements in this report:

- The number of studs per rail.
- Stud spacing (S).
- Shear rail assembly overall height (OAH).
- Stud shank diameter.
- Distance between column face and first line of studs (S_o).
- Base rail plate length (L).

4.1.3 Earthquake Loads: Stud rail reinforcement may be used at slab-to-column connections of structures where a flat concrete slab is used together with primary seismic force-resisting systems in Seismic Categories C, D, E and F, such as concrete shear walls, under the following conditions:

4.1.3.1 General: Lateral force-resisting elements of the structure are designed using the IBC.

4.1.3.2 Shear Strength: The nominal shear strength provided by the concrete in the presence of the shear studs referenced in 11.11.5 of ACI 318-11 for the 2012 IBC (ACI 318-08 for the 2009 and 2006 IBC) must be revised as follows,

$$V_c = 1.5\lambda\sqrt{f'_c}b_o d$$

This revision also results in revisions to the nominal shear strength, V_n , and the maximum shear stress, v_n .

Two-way slabs without beams designated as part of the seismic force-resisting system, must comply with the provisions in Section 21.3.6.8 of ACI 318-11 for the 2012 IBC (ACI 318-08 for the 2009 and 2006 IBC), except that V_c must be limited as set forth in this section.

Two-way slabs without beams, which are not designated as part of the seismic force-resisting system, must comply with the provisions in Section 21.13.6 of ACI 318-11 for the 2012 IBC (ACI 318-08 for the 2009 and 2006 IBC), except that V_c must be limited as set forth in this section and the design story drift ratio specified in Section 21.13.6(b) of ACI 318-11 (ACI 318-08 for the 2009 and 2006 IBC) must not exceed the drift ratio referenced in Table 12.12-1 of ASCE/SEI 7.

4.2 Installation:

Installation of the PJ's PSR Stud Rails must comply with the applicable provisions of the 2012, 2009 and 2006 IBC and the approved engineering plans. The PJ's PSR Stud Rails must be positioned correctly around columns and set in accordance with the IBC and the approved engineering plans and details. Concrete cover must comply with ACI 318-11 Section 7.7 for the 2012 IBC (IBC Section 1907.7 for the 2009 and 2006 IBC). See Figure 2 for typical installation details.

4.3 Special Inspection:

Special inspection of PJ's PSR stud rails and its installation at the jobsite must comply with Section 1705.3 for the 2012 IBC (Section 1704.4 for the 2009 and 2006 IBC). The special inspector is responsible for verifying identification

of the shear rail assembly per Section 7.0 of this report, along with its condition, positioning, clearances, and concrete cover.

5.0 CONDITIONS OF USE

The PJ's PSR Stud Rails 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 PJ's PSR Stud Rails must be designed, manufactured, and installed in accordance with this report and the approved plans. In the event of a conflict between this report and the approved plans, the more restrictive requirements govern.
- 5.2** Design details and drawings must be in compliance with the design requirements of Section 4.1 of this report and must be approved by the code official. The calculations and drawings must be prepared by a registered design professional when required by the statutes of the jurisdiction in which the project is to be built.
- 5.3** Special inspections must be provided in accordance with Section 4.3 of this report.
- 5.4** The PJ's PSR Stud Rails are manufactured at the PJ's Rebar Inc. facility in Stockton, California, or Fremont, California, under a quality control program with third-party inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Headed Shear Stud Reinforcement Assemblies for Concrete Slabs and Footings (AC395), dated October, 2008 (editorially revised February 2012).

7.0 IDENTIFICATION

The PJ's PSR Stud Rails are identified on the packaging with the product name (PSR Stud Rails), size, production date, tag number, job number, manufacturer's name (PJ's Rebar Inc.) and address, and the ICC-ES evaluation report number (ESR-3821).

TABLE 1—PSR STUD DIMENSIONS

SHANK DIAMETER, D [in. (mm)]	HEAD DIAMETER, H [in. (mm)]	H/D RATIO	SHANK AREA, S _A [in. ² (mm ²)]	HEAD AREA, H _A [in. ² (mm ²)]	H _A /S _A RATIO	HEAD THICKNESS, T [in. (mm)]
³ / ₈ (9.5)	1.19 (30.1)	3.17	0.110 (71)	1.112 (712)	10.1	0.24 (6.1)
¹ / ₂ (12.7)	1.58 (40.2)	3.16	0.196 (127)	1.961 (1269)	10.0	0.33 (8.4)
⁵ / ₈ (15.9)	1.98 (50.2)	3.17	0.307 (199)	3.079 (1979)	10.0	0.40 (10.2)
³ / ₄ (19.1)	2.37 (60.2)	3.16	0.442 (287)	4.412 (2846)	10.0	0.47 (12.0)

TABLE 2—RECTANGULAR SHEAR REINFORCEMENT PLATE DIMENSIONS

SHANK DIAMETER, D [in. (mm)]	PLATE WIDTH, W [in. (mm)]	PLATE THICKNESS, TH [in. (mm)]	PLATE LENGTH, L
³ / ₈ (9.5)	1.00 (25.4)	³ / ₁₆ (4.8)	Determined by the registered design professional
¹ / ₂ (12.7)	1.25 (31.8)	¹ / ₄ (6.5)	
⁵ / ₈ (15.9)	1.75 (44.5)	⁵ / ₁₆ (7.9)	
³ / ₄ (19.1)	2.00 (50.8)	³ / ₈ (9.5)	

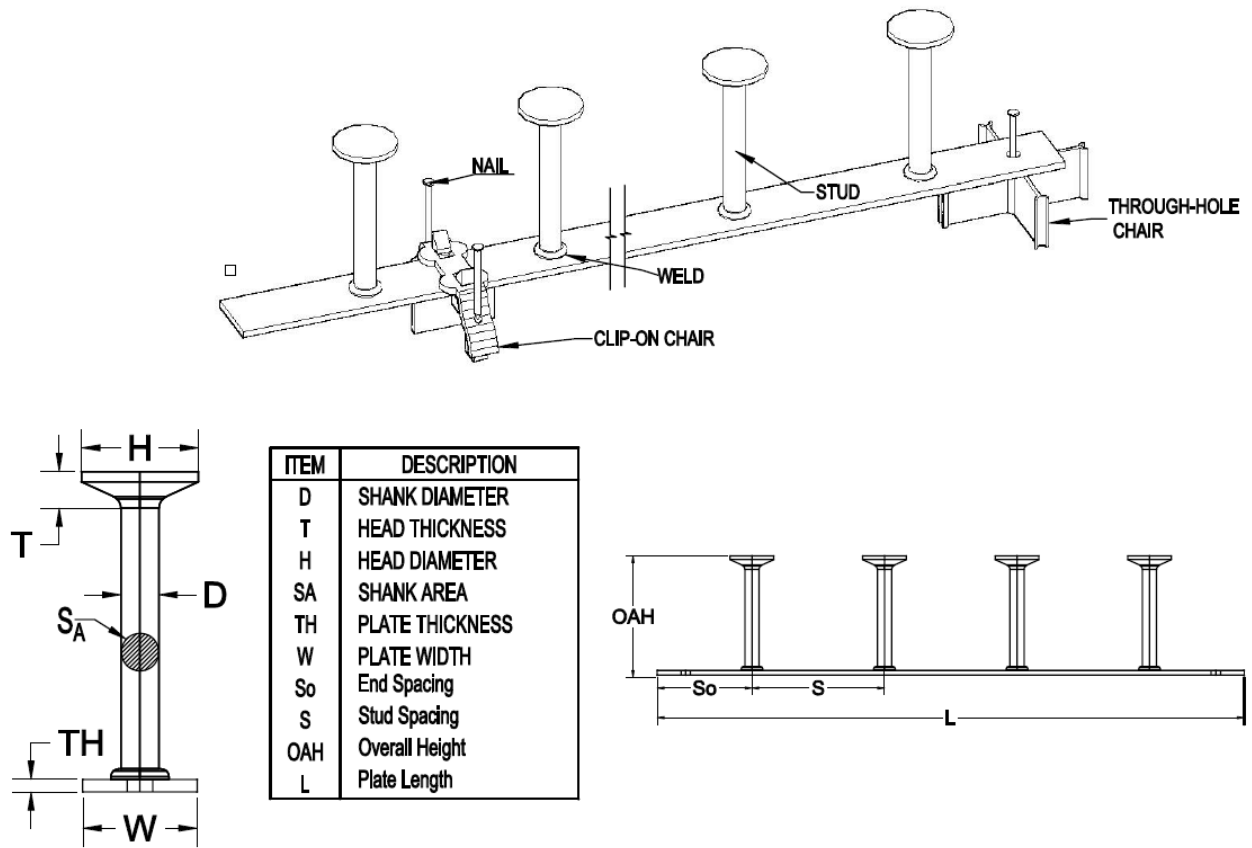


FIGURE 1—TYPICAL PJ'S PSR STUD RAIL REINFORCEMENT SYSTEM ASSEMBLY

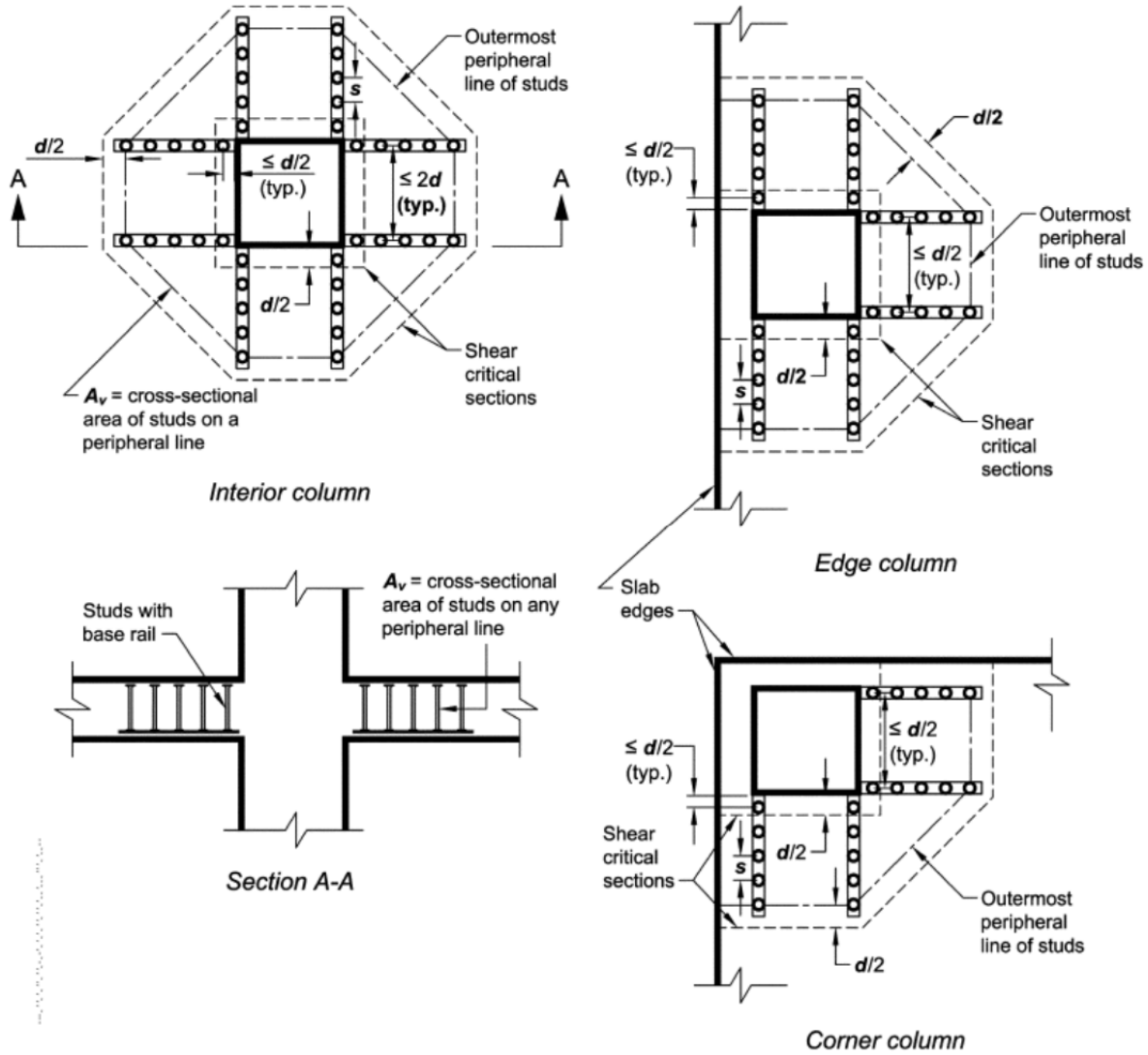


FIGURE 2—TYPICAL PJ'S PSR STUD RAIL REINFORCEMENT SYSTEM DETAILS