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DIVISION: 03—CONCRETE
Section: 03210—REINFORCING STEEL

REPORT HOLDER:

NELSON STUD WELDING, INC.
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EVALUATION SUBJECT:

NELSON PUNCHING SHEAR RESISTOR STUDS

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2006 *International Building Code*® (IBC)
- 1997 *Uniform Building Code*™ (UBC)

Properties evaluated:

Structural

2.0 USES

Nelson punching shear resistor (PSR) studs are large-headed shear studs that are welded to steel plates and are used as shear reinforcement in flat concrete slabs to replace stirrups, drop panels or column capitals in increasing the punching shear resistance of the slabs.

3.0 DESCRIPTION

3.1 Nelson Punching Shear Resistor (PSR) Studs:

The PSR studs are provided in $\frac{3}{8}$ -, $\frac{1}{2}$ -, $\frac{5}{8}$ - and $\frac{3}{4}$ -inch (9.5, 12.7, 15.9 and 19.1 mm) diameters and comply with the material requirements and specifications of the American Welding Society's Structural Welding Code—Steel, AWS D1.1:2004. The studs are made from ASTM A 29-05 Grades 1010 through 1020 steel satisfying the following physical requirements according to Table 7.1 of AWS D1.1:2004:

- Yield strength: 51,000 psi (350 MPa), minimum.
- Tensile strength: 65,000 psi (450 MPa), minimum.
- Elongation: 20 percent in 2 inches (51 mm), minimum.
- Reduction of area: 50 percent, minimum.

Figure 1 shows the stud configuration. The dimensions of the studs are shown in Table 1.

3.2 Shear Reinforcement Plates:

The rectangular steel plates to which the studs are welded must be formed from acceptable plate materials per AWS D1.1:2004 Structural Welding Code—Steel, Table 3.1, Groups 1 and 2, having the following physical properties:

- Yield strength: 44,000 psi (300 MPa), minimum.
- Tensile strength: 65,000 psi (450 MPa), minimum.
- Elongation: 20 percent in 8 inches (203 mm).
- Elongation: 23 percent in 2 inches (50 mm).

Dimensions of the shear reinforcement plates are shown in Table 2.

4.0 INSTALLATION AND DESIGN

4.1 General:

Installation of the stud/plate assemblies shall comply with Section 1912 of the IBC (Appendix D, ACI 318-05) or Section 1923.2 of the UBC, and the approved plans.

4.2 Welding:

The studs shall be welded in accordance with equipment and procedures recommended by Nelson Stud Welding. All welding must comply with requirements in Section 7 of AWS D1.1:2004.

4.3 Design:

4.3.1 General: General requirements for shear resistance design are presented in Section 11 of ACI 318-05 [ACI 318-05 is referenced in the 2003 *International Building Code*® (IBC), Section 1901] and Section 1911 of the 1997 *Uniform Building Code*™ (UBC). Since the stud/plate assembly is intended for reinforcing concrete slabs, special provisions in Section 11.12 of ACI 318-05 or Section 1911.12 of the UBC must be observed. ACI 421.1R-99 summarizes the design requirements as they apply to shear stud reinforcement.

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

- a. The number of studs per plate.
- b. Stud spacing (s).
- c. Stud/plate assembly height (OAH).
- d. Stud size.
- e. Distance between column face and first line of studs (so).
- f. Stud/plate material specifications.
- g. Plate thickness, width and length.

4.3.3 Earthquake Loads: The stud rail reinforcement may be used at slab-to-column connections of structures where the flat slab is used with primary lateral load resisting elements, such as shear walls, under the following conditions:

- Lateral force resisting elements of the structure may be designed using either the IBC or the UBC.
- If the IBC is used, the designs must be in accordance with requirements of Chapter 16 and 19, Section 1910, the special provisions for seismic design of Section 21 of ACI

318-05, and modifications to Section 21 of ACI 318-05 contained within IBC Sections 1908.1.2 to 1908.1.7.

- If the UBC is used, the designs must be in accordance with requirements of Chapter 16, Division IV, and Chapter 19, including specific provisions of Section 1921.
- Designs using the IBC or UBC must limit the story drift ratio to a maximum of 1.5 percent.

4.4 Special Inspection:

The fabricated shear stud reinforcement plate assemblies shall be welded by approved fabricators of structural steel components and structural steel welding as required by the provisions of AWS D1.1:2004. Continuous special inspection is required in accordance with Section 1701.5.1 of the UBC or Section 1704.4 of the IBC. The special inspector is responsible for verifying identification of the stud/plate assembly and its condition, positioning, clearances, and concrete cover.

5.0 CONDITIONS OF USE

The Nelson Punching Shear Resistor Studs 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 fabricated shear stud reinforcement plate assemblies manufactured using these studs are to be welded by approved fabricators of structural steel components and structural steel welding as required by the provisions of the UBC or the IBC.

5.2 The welded and fabricated shear stud reinforcement plate assemblies are designed in accordance with Section 4.3 of this report.

5.3 The design for the finished assemblies shall specify the details described in Section 4.3.2.

5.4 Installation of the finished assemblies shall be in accordance with Section 4.1 of this report.

5.5 Special inspection shall be provided in accordance with Section 4.4 of this report.

6.0 EVIDENCE SUBMITTED

Stud specifications and drawings; installation instructions; weld base qualification tests; weld base qualification tests; and calculations as contained in ACI-421.1R-99, "Shear Reinforcement for Slabs," and a quality control manual.

7.0 IDENTIFICATION

Nelson PSR studs shall be identified by the name "Nelson" and the letter "N" on the head of each stud, and are shipped in packaging bearing the Nelson Stud Welding, Inc., name, the evaluation report number (ESR-1170), the stud description, the part number, the heat number, the lot number and the number of pieces in each package. Certificates of compliance with AWS D1.1:2004 requirements and certified mill test reports on the steel used to form the studs shall be supplied by Nelson for each stud shipment.

TABLE 1—PSR STUD DIMENSIONS

STUD SHANK DIAMETER, D [inch (mm)]	HEAD DIAMETER, H [inch (mm)]	$\frac{H}{D}$	SHANK AREA, S_A [inch ² (mm ²)]	HEAD AREA, H_A [inch ² (mm ²)]	$\frac{H_A}{S_A}$	HEAD THICKNESS, T [inch (mm)]
$\frac{3}{8}$ (9.5)	1.19 (30.1)	3.17	0.110 (71)	1.112 (712)	10.1	0.26 (5.3)
$\frac{1}{2}$ (12.7)	1.58 (40.2)	3.16	0.196 (127)	1.961 (1269)	10.0	0.33 (7.1)
$\frac{5}{8}$ (15.9)	1.98 (50.2)	3.17	0.307 (199)	3.079 (1979)	10.0	0.40 (8.9)
$\frac{3}{4}$ (19.1)	2.37 (60.2)	3.16	0.442 (287)	4.412 (2846)	10.0	0.47 (10.7)

TABLE 2—RECTANGULAR SHEAR REINFORCEMENT PLATE DIMENSIONS

STUD DIAMETER, D [inch (mm)]	WIDTH, W [inches (mm)]	THICKNESS, T [inch (mm)]	LENGTH
$\frac{3}{8}$ (9.5)	1.00 (25.4)	0.188 (4.8)	Determined by the structural engineer
$\frac{1}{2}$ (12.7)	1.25 (31.8)	0.250 (6.5)	Determined by the structural engineer
$\frac{5}{8}$ (15.9)	1.75 (44.5)	0.313 (7.9)	Determined by the structural engineer
$\frac{3}{4}$ (19.1)	2.00 (50.8)	0.375 (9.5)	Determined by the structural engineer

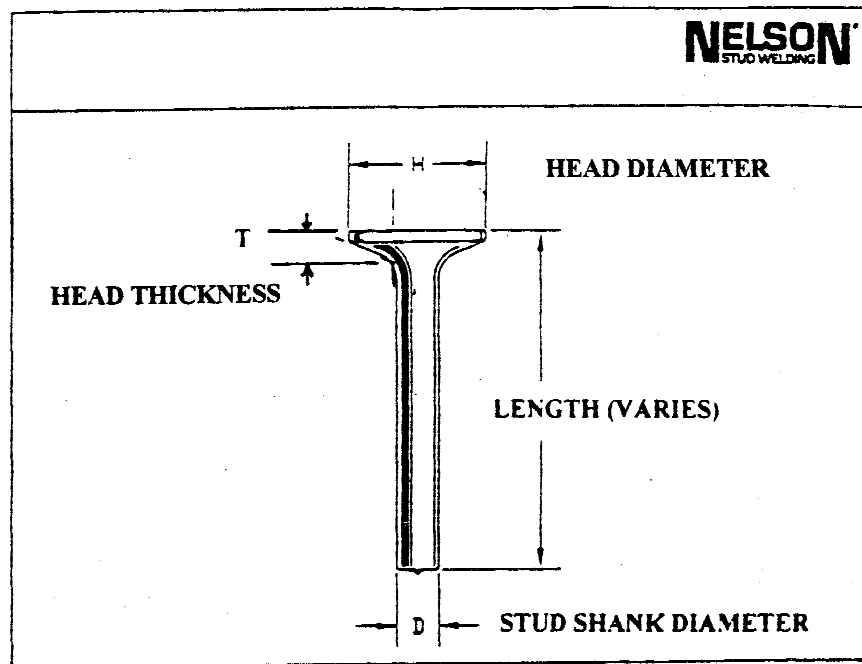


FIGURE 1—PSR STUD CONFIGURATION