

ICC-ES Evaluation Report

ESR-3645

Reissued June 2024


This report also contains:

- CBC Supplement

Subject to renewal June 2025

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<p>DIVISION: 03 00 00— CONCRETE</p> <p>Section: 03 15 00— Concrete Accessories</p> <p>Section: 03 21 00— Reinforcement Bars</p>	<p>REPORT HOLDER:</p> <p>STRUCTURAL TECHNOLOGIES, LLC</p>	<p>EVALUATION SUBJECT:</p> <p>VSL HEADED SHEAR STUD REINFORCEMENT ASSEMBLIES</p>	
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1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2018, 2015, and 2012 [International Building Code® \(IBC\)](#)

Property evaluated:

- Structural

2.0 USES

The VSL Headed Shear Stud Reinforcement Assemblies are used as shear reinforcement in flat concrete slabs and footings to replace or supplement stirrups, drop panels or column capitals in increasing the punching shear resistance of the flat slabs and footings.

3.0 DESCRIPTION

3.1 General:

The VSL Headed Shear Stud Reinforcement Assemblies are formed by welding large-headed shear studs to steel flat bars (base rails). The stud dimensions are given in [Table 1](#), and base rail dimensions are given in [Table 2](#). The VSL reinforcement assembly and its installation are shown in [Figure 1](#).

The VSL reinforcement assemblies comply with the provisions of ASTM A1044 and Section 20.5.1 of ACI 318-14, or Section 3.5.5 of ACI 318-11.

3.2 Materials:

3.2.1 Punching Shear Resistor Studs: The shear studs used in the VSL reinforcement assemblies 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) punching shear resistor (PSR) studs recognized in an ICC-ES evaluation report, as described in the approved quality documentation. The studs meet the material requirements and specifications of ASTM A1044. The studs are produced from carbon steel complying with ASTM A29 Grades 1010 through 1020 steel and conform to the following physical and mechanical requirements prescribed 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 and conform 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 studs are factory-welded by the VSL to the flat steel rails in accordance with the approved VSL quality documentation. 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 the VSL reinforcement assemblies used as punching shear reinforcement in reinforced concrete slabs or footings must comply with the applicable provisions of ACI 318-14 for the 2018 and 2015 IBC, or ACI 318-11 for the 2012 IBC. The specified yield strength of transverse reinforcement, f_{yt} , must not exceed the specified yield strength of the shear studs defined in Section 3.2.1.

4.1.2 Design Considerations: The structural design must 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 peripheral line of studs (S_o)
- Base rail length
- Arrangement of headed shear stud reinforcement

4.1.3 Earthquake Loads: The stud rail reinforcement may be used at slab-to-column connections of structures where a flat slab is used together with the 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 in accordance with 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 Section 22.6.6.1 of ACI 318-14, or Section 11.11.5 of ACI 318-11, must be revised as follows,

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

This revision requires 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 18.4.5.8 of ACI 318-14 or Section 21.3.6.8 of ACI 318-11, except V_c must be limited as set forth in Section 4.1.3.2 of this report.

Two-way slabs without beams, which are not designated as part of the seismic force-resisting system, must comply with the provisions in Section 18.14.5.1 of ACI 318-14 or Section 21.13.6 of ACI 318-11, except that V_c must be limited as set forth in Section 4.1.3.2 of this report and the design story drift ratio specified in Section 18.14.5.1 of ACI 318-14 or Section 21.13.6(b) ACI 318-11 must not exceed the drift ratio referenced in Table 12.12-1 of ASCE/SEI 7-10.

4.2 Installation:

Installation of the VSL headed shear stud reinforcement assemblies must comply with the applicable provisions of the 2012 IBC and the approved engineering plans. The VSL reinforcement assemblies 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 Section 20.6.1.3.5 of ACI 318-14 (2018 or 2015 IBC, or ACI 318-11 Section 7.7 for the 2012 IBC. See [Figure 1](#) for typical installation details.

4.3 Special Inspection:

Special inspection of shear rail reinforcement and its installation at the jobsite must comply with Section 1705.3 for the 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, location, positioning, clearances and concrete cover.

5.0 CONDITIONS OF USE:

The VSL headed shear stud reinforcement assemblies described in this report comply with, or are suitable alternatives to what is specified in, those codes noted in Section 1.0 of this report, subject to the following conditions:

- 5.1 The VSL reinforcement assemblies 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 governs.
- 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 VSL reinforcement assemblies are manufactured by Structural Technologies, LLC., in Fort Worth, Texas; Pompano Beach, Florida; and Manassas, Virginia under a quality control program with 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 or Footings \(AC395\)](#), dated June 2017 (editorially revised November 2017).

7.0 IDENTIFICATION

- 7.1 The VSL headed shear stud reinforcement assemblies are identified on the packaging with the product model, product name, product size, manufacturer's name (Structural Technologies, LLC.) and address, and the evaluation report number (ESR-3645).
- 7.2 The report holder's contact information is the following:

STRUCTURAL TECHNOLOGIES, LLC.
15600 TRINITY BOULEVARD, SUITE 118
FORT WORTH, TEXAS 76155
(817) 545-4807
www.structuraltechnologies.com
lboudtaroth@structuraltec.com

TABLE 1—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 (SHEAR RAIL) DIMENSIONS

SHANK DIAMETER, D [in. (mm)]	PLATE WIDTH, W [in. (mm)]	PLATE THICKNESS, TH [in. (mm)]	PLATE LENGTH
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)	2.00 (50.8)	⁵ / ₁₆ (7.9)	
³ / ₄ (19.1)	2.00 (50.8)	³ / ₈ (9.5)	

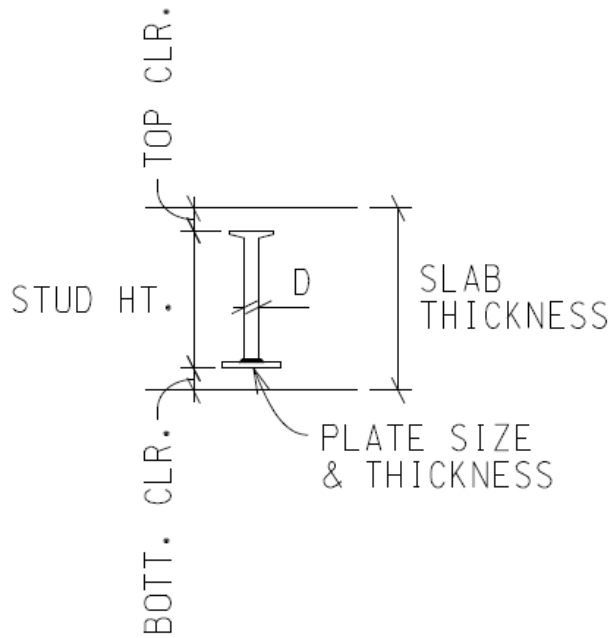
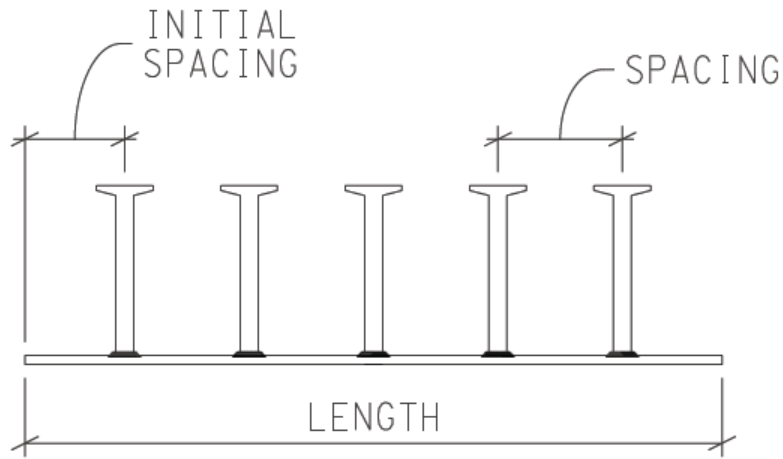


FIGURE 1—THE VSL HEADED SHEAR STUD REINFORCEMENT ASSEMBLY AND

DIVISION: 03 00 00—CONCRETE
Section: 03 15 00—Concrete Accessories
Section: 03 21 00—Reinforcement Bars

REPORT HOLDER:

STRUCTURAL TECHNOLOGIES, LLC

EVALUATION SUBJECT:

VSL HEADED SHEAR STUD REINFORCEMENT ASSEMBLIES

1.0 REPORT PURPOSE AND SCOPE**Purpose:**

The purpose of this evaluation report supplement is to indicate that VSL Headed Shear Stud Reinforcement Assemblies, described in ICC-ES evaluation report ESR-3645, have also been evaluated for compliance with the code(s) noted below.

Applicable code edition:

- 2019 *California Building Code* (CBC)

For evaluation of applicable chapters adopted by the California Office of Statewide Health Planning and Development (OSHPD) AKA: California Department of Health Care Access and Information (HCAI) and the Division of State Architect (DSA), see Sections 2.1.1 and 2.1.2 below.

2.0 CONCLUSIONS**2.1 CBC:**

The VSL Headed Shear Stud Reinforcement Assemblies, described in Sections 2.0 through 7.0 of the evaluation report ESR-3645, comply with CBC Chapter 19, provided the design and installation are in accordance with the 2018 *International Building Code*® (IBC) provisions noted in the evaluation report and the additional requirements of 16, 17 and 19, as applicable.

2.1.1 OSHPD: The applicable OSHPD Sections and Chapters of the CBC are beyond the scope of this supplement.

2.1.2 DSA: The applicable DSA Sections and Chapters of the CBC are beyond the scope of this supplement.

This supplement expires concurrently with the evaluation report, reissued June 2024.