



**INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS
UNIFORM EVALUATION SERVICES**

EVALUATION CRITERIA FOR

Self-Tapping, Self-Drilling Standoff Screws

**EC 023-2015
(Adopted June 2015)**

1.0 INTRODUCTION

- 1.1 Purpose:** The purpose of this evaluation criteria is to establish requirements for alternative methods of longitudinal shear transfer, other than welded stud shear connectors, at the interface between a concrete slab and supporting composite joist, to be recognized in an Evaluation Report independently reviewed and issued by an evaluation agency under the 2012 and 2015 *International Building Codes*[®] (IBC). The basis for the recognition is IBC Section 104.11.

The reason for development of this criteria is to provide requirements for establishing the design standards for self-drilling, self-tapping, shear connectors. Currently, SJI-CJ provides the design criteria for proportioning shear connection strength using only welded stud connectors in SJI-CJ Section 103.6(d). The purpose of this evaluation criteria is to provide design information for standoff screws that would replace the requirements of SJI-CJ Section 103.6(d) in their entirety.

- 1.2 Scope:** This evaluation criteria applies to self-drilling, self-tapping standoff screws used for shear transfer at the interface of the concrete slab and the supporting steel member as an alternative to welded stud shear connectors, currently prescribed by SJI-CJ. Standoff screws provide shear resistance and are used to develop composite action between a structural concrete slab and the supporting steel joist to resist bending moment induced by vertical loads. The concrete slab may be supported by cold-formed steel deck or be formed to span directly between the supporting steel members. This evaluation criteria focuses on determining the strength of shear connection as an alternative to the requirements of SJI-CJ Section 103.6(d) within the scope of SJI-CJ. Other product characteristics, such as fire-resistance ratings, shall comply with the governing code provisions or IAPMO UES evaluation criteria, as applicable.

- 1.3 Definitions:** For terms not defined in this section, applicable codes, or referenced standards shall have the ordinary accepted definition for the context for which they are intended.

1.3.1 Base Steel: The top chord, flange, or horizontal surface of a supporting steel member into which a standoff screw is drilled.

1.3.2 Base Steel Thickness: The thickness of the base steel, exclusive of all coatings and galvanization.

1.3.3 Shear Connection: Structural elements of a composite connection at the interface of the concrete slab and the supporting steel joists, which includes fasteners, concrete, and base steel. The connection strength and ductility shall be determined from the mechanical and geometric properties of the elements and the structural interaction among each element.

- 1.3.4 Standoff Screw Embedment Length:** The length of the as-installed fastener portion embedded in concrete, measured from the top of the fastener to the top of the base steel.
- 1.3.5 Standoff Screw Exposed Length:** The length of the as-installed fastener portion located below the bottom of the supporting base steel member.
- 1.3.6 Standoff Screw Total Length:** The length of the fastener measured from the top of the fastener to the tip of the drill point.
- 1.3.7 Load-bearing Threaded Shank Length:** The as-installed length determined as the length of the portion of the threaded fastener shank embedded into and in bearing with the supporting base steel member.
- 1.3.8 Nominal Strength:** Strength of a structure or component (without a resistance factor or safety factor applied) to resist load effects, as determined in accordance with the applicable building code.
- 1.3.9 Self-Drilling, Self-Tapping, Standoff Screws:** Externally threaded fasteners with the ability to self-drill into the base steel through formation or cutting of their own internal mating threads during assembly. A self-drilling, self-tapping, shear connector has the following portions: the portion embedded within the concrete slab, the load-bearing portion of the threaded shank in bearing within the supporting steel member, and the exposed length.
- 1.3.10 Steel Deck Profile:** A specific configuration of formed steel deck geometry, including deck height, thickness, flange widths, web angles, and bend radii.

2.0 REFERENCED STANDARDS

Standards shall be applied consistent with the specific edition of the code(s) for which the Evaluation Report is prepared unless otherwise approved by UES.

2.1 American Concrete Institute

- Building Code Requirements for Structural Concrete, ACI 318

2.2 American Society for Testing and Materials

- Standard Test method for Weight [Mass] of Coatings on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M
- Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, ASTM A123/A123M
- Standard Test Methods and Definitions for Mechanical Testing of Steel Products, ASTM A370
- Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality, ASTM A529/A529M
- Standard Practice for Making and Curing Concrete Test Specimens in the Field, ASTM C31/C31M
- Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete, ASTM C138/C138M

2.3 International Code Council

- International Building Code, IBC

2.4 Steel Joist Institute

- Standard Specification for Composite Steel Joists, SJI-CJ

3.0 BASIC INFORMATION**3.1 Description:**

The following information shall be submitted:

3.1.1 Product Description: The product description for the Self-Drilling, Self-Tapping Standoff Screw shall include:

3.1.1.1 Description of each included fastener, including brand name, fastener grade, manufacturer's catalog number, and a detailed description of fastener geometry, including nominal fastener diameter, fastener embedment length, total length, thread size, thread pitch, and description of the drill point style and geometry.

3.1.1.2 Specifications for raw materials and for final products, including all aspects that affect the fastener performance, including provisions for chemical composition, mechanical properties, heat treatment, and coatings. The specifications shall be specific as to the requirements for each part of the fastener, such as drill point and adjacent threads, load-bearing portion of the threaded shank, fastener drive head, unthreaded shank, and top head.

3.1.1.3 Details or product drawings that describe dimensions and tolerances for each unique part of each fastener, including drill point and adjacent threads, load-bearing portion of the threaded shank, fastener drive head, unthreaded shank, and top head.

3.1.1.4 Head markings used on each fastener, where applicable.

3.1.1.5 Sample fastener (one of each unique applicable geometry).

3.1.1.6 Manufacturing process.

3.1.2 Installation Instructions: Manufacturer's published installation instructions shall be submitted and shall include all applicable installation requirements, such as description of the required tool, the required tool operation, such as speed during installation, operator certification, drilling capacity, and other criteria as applicable to each particular fastener evaluated. The instructions shall be consistent with applicable requirements in SJI-CJ, except as justified by the data specified in this criteria.

3.1.3 Packaging and Identification: The method of packaging and identifying the fasteners shall be reported. The identifying information on each box or package of fasteners shall include the brand name and model number, nominal fastener size (number, fraction or decimal equivalent), nominal fastener embedment length (fraction or decimal equivalent), point style, the evaluation report holder's name, and the Evaluation Report number.

- 3.2 Test Reports:** Test reports shall include all applicable information required in Section 3.1, the applicable test standard, UES Test Report Requirements Procedure No. ES-025, Annex A, and the following:
- Detailed description and documentation, with illustrations, of test setup and specimens.
 - The source of the test specimens.
 - Test standard with date of issue and an explanation of any deviation from the standard.
 - Location of load points and gages.
 - Description of failure mode.
 - Method and amount of product sampling from the manufacturing site.
 - Identity of the personnel from the accredited laboratory who conducted or witnessed and verified construction of the assemblies.
 - Drawings, calculations, photographs, material specification, measured yield strength of the base steel, measured tensile strength of the base steel, base steel thickness, measured concrete compressive strength.
 - Interpretation of results.
 - Certificate showing testing laboratory is accredited as complying with ISO/IEC Standard 17025 for the testing reported issued by an accreditation body conforming to ISO/IEC 17011 that is a signatory to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA).
- 3.3 Product Sampling:** The fabrication of the test assemblies shall be witnessed by or verified by the testing laboratory. The fasteners shall be representative of later production, and shall be proven to be identical, within specified tolerance limits, to production fasteners by confirming dimensions, material specifications, and performance requirements set forth in the applicable specification or standard.

4.0 TESTING AND PERFORMANCE REQUIREMENTS

- 4.1 General:** Section 4.0 describes tests required under this criteria, which include the following: testing of materials in Section 4.2 and testing of composite connections in Sections 4.3, 4.4, and 4.5. Section 4.4 describes the conditions of acceptance for the push-out tests, while Section 4.5 describes the push-out test process. The testing described shall be conducted on materials of the same heat and manufacturing batch for steel and the same mix design and the delivery for concrete from those of the assembly tests in Section 4.5.

4.2 Testing of Materials:

4.2.1 Shear Connector (Standoff Screw Fastener):

4.2.1.1 Dimensions: The purpose of testing in this section is to determine the actual geometric properties of the shear connectors. All pertinent dimensions, such as length, diameter, radius, thickness of all fastener parts, including top head, unthreaded shank, drive head, threaded shank, and drill point, shall be measured by the testing laboratory and compared with the nominal dimensions in the fastener production drawings. If any dimension is outside the dimensional tolerances prescribed in the product drawings, the fastener shall not be used for testing under this criteria.

4.2.1.2 Materials: Critical constituent materials shall be verified by the testing laboratory for conformance to mechanical and chemical specifications using direct tests, certified mill test reports for steels, or similar certified documents for other materials.

4.2.1.3 Other: Surface finishes, coatings, and markings shall be examined by the testing and evaluation agency for conformance to the drawings and specifications.

- 4.2.2 Supporting Steel:** Testing of supporting steel, such as coupons of a steel joist top chord, shall be conducted by a testing laboratory to ensure compliance with the joist top chord material standard, such as ASTM A529/A529M. Material test reports from the manufacturer of the heat of steel utilized to produce the steel support member are an acceptable alternative, provided traceability to steel joist production is verified. The steel yield strength, tensile strength, elongation, and area of reduction shall be determined in accordance with ASTM A370. The dimensions of the supporting steel including base steel thickness of the steel shall be measured. Coating weight and thickness shall be determined in accordance with ASTM A90 or A123.
- 4.2.3 Steel Deck:** For each deck type and deck profile, geometrical dimensions such as depth of the steel deck profile, top flange width, web width, bottom flange width, and average concrete rib width shall be determined.
- 4.2.4 Concrete:** Concrete testing, mix and proportions, and reinforcement shall conform to the requirements of Chapter 19 of the IBC and ACI 318.
- 4.2.4.1** Strength tests shall be the average of the strengths of at least two cylinders made from the same sample of concrete. Two strength tests shall be performed and the average compressive strength reported. The two strength tests shall be conducted such that one test is within a 24-hour period immediately preceding and the other test immediately after the composite connection test series (minimum four cylinders). Each configuration of replicate test specimen shall be specific to a single nominal concrete weight (i.e., normal-weight, lightweight, or sand-lightweight) and the concrete weight shall be determined as defined per ASTM C138 and recorded.
- 4.2.5 Reinforcing Steel:** Welded wire reinforcement (WWR) shall conform to specifications permitted by ACI 318.
- 4.3 Testing of Composite Connections (Push-out Test):** Push-out tests shall be conducted in accordance with Section 4.5, on composite connection assemblies described in a test plan in accordance with Section 4.5.1. The result of push-out tests shall satisfy the conditions of acceptance prescribed in Section 4.4 in order to qualify the fasteners as an alternative method of shear transfer. The connection strengths are determined per the following sections.
- 4.4 Conditions of Acceptance for Push-out Tests:** Each set of replicate tests shall comply with the following requirements:
- 4.4.1 Nominal Capacity:** The nominal capacity, Q_n , is the average peak strength of the replicate test specimens per fastener.
- 4.4.2 Coefficient of Variation:** The Coefficient of Variation (COV) of the tests performed shall not exceed 0.10 for the sample size including a group of at least five individual tests of the same mode of failure. Alternatively, the COV shall not exceed 0.13 for the sample size including a group of at least 10 individual tests of the same mode of failure, or 0.15 for the sample size including a group of at least 24 individual tests of the same mode of failure.
- 4.5 Push-out Testing:**
- 4.5.1 General:** Push-out tests shall be conducted on composite connection specimens, which include fasteners, concrete, supporting steel members, with or without steel deck panels.

A testing plan documenting all material elements of the tested configuration shall be submitted for approval to the evaluation agency prior to testing.

4.5.2 Number of Replicate Specimens: A minimum of three replicate composite connection specimens shall be tested for each combination of variables that affect the performance of the composite connection assembly, provided the deviation of the maximum strength of any individual test result from the average value does not exceed ± 15 percent. If such a deviation of maximum strength from the average value exceeds ± 15 percent, additional specimens of the same kind shall be tested until the deviation of any individual maximum strength from the average value obtained from the replicate tests does not exceed ± 15 percent or until at least three additional tests have been made. No test result shall be eliminated unless a rationale for its exclusion can be given.

4.5.3 Preparation of Specimens:

4.5.3.1 Concrete slabs shall be cast in the horizontal position to ensure that concrete is properly cured and bonds to the shank of the standoff screws.

4.5.3.2 Prior to placement of the steel deck or light gauge steel sheet on the flanges of the steel supporting member, the top flanges of the steel supporting member shall be greased. This grease reduces the static coefficient of friction between the steel supporting member and underside of the steel deck or light gauge sheet. There shall be no additional fastening of the steel deck panel to the steel support members of the test assemblies other than the fasteners, which are used as an alternative to the welded stud shear connectors and are evaluated under this criteria.

4.5.3.3 All test specimens shall be stored and cured the same way as that of the corresponding concrete cylinders.

4.5.4 Test Procedure: Once the concrete has reached its targeted compressive strength, as specified in the test plan, the two halves of the push-out test specimen will be stood up and bolted together forming an "I" section. To assure the two concrete slabs have uniform bearing pressure across their entire edge surface area in contact with the floor, an elastomeric bearing pad shall be placed under each test specimen. Axial load shall be applied to the steel I-section, which induces shear force at the interface between concrete and the steel I-section, in such a manner that the load is equally applied to both halves of the push-out test specimen. Confirmation that equal load is being applied to both halves of the push-out test specimen is achieved by comparison of the slip measurements along each half of the specimen during the load application. If a deviation in slip exceeding 15 percent from one side to the other occurs, the specimen shall be unloaded and the centering of the loading apparatus checked and realigned as necessary. A normal load, perpendicular to the axial load direction and parallel to the fastener shank direction, equal to 10 percent of the axial load shall be applied concurrently to the surface of the two concrete slabs. Axial and normal load shall be applied until a load of approximately 80 percent of the expected capacity is reached. The load shall be applied in no more than 2,000 pound (8,896 N) increments. From this point forward, slip control shall be utilized, i.e., the load is applied until the slip increases in a fixed amount. During the displacement control phase, the load shall be applied such that the average slip increment does not exceed 0.050 inch (1.27 mm). The longitudinal slip between each concrete slab and the steel section will be measured continuously during loading or at each load increment. The load and slip will be measured at least until the load has dropped to 30 percent below the peak load. Mode of failure shall be noted and recorded on the test report.

5.0 QUALITY CONTROL

5.1 Quality documentation complying with the UES Minimum Requirements for Listee's Quality Assurance System (UES-010) shall be submitted.

5.2 Inspections of manufacturing facilities are required for this product, by agencies accredited for the required tasks in accordance with ISO/IEC 17020, ISO/IEC Guide 65, or ISO/IEC 17065.

6.0 EVALUATION REPORT RECOGNITION

Evaluation reports shall include the following information:

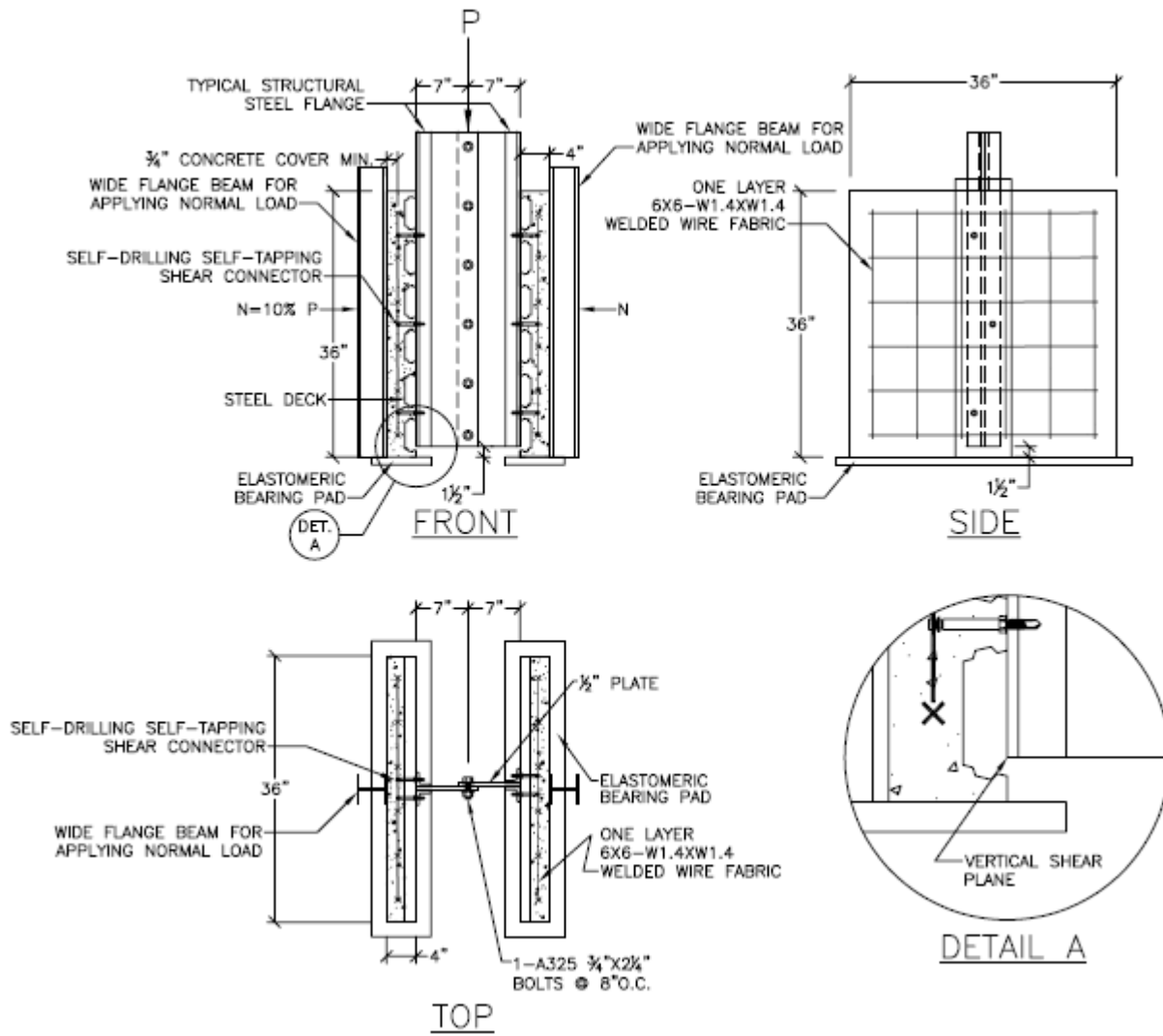
- 6.1 Basic summary product information, including assembly and component description, installation procedures and packaging and identification.
- 6.2 The evaluation report shall recognize only tested products, and identify the nominal shear strength, Q_n , and the slip at nominal shear strength, for each tested fastener of each specific combination of fastener, concrete, steel deck (if applicable) and supporting steel. Nominal shear strength, Q_n , which is the mean tested strength of each unique configuration for the self-drilling, self-tapping standoff screw, shall be utilized as an alternative to Q_n , for a welded shear connector as outlined in SJI-CJ Section 103.6(d). Recognition of alternative combinations of fastener, concrete, steel deck, and supporting steel is permitted provided justification is submitted in a test plan proposal in accordance with Section 4.5.1 and has been agreed upon by the evaluation agency prior to commencement of testing.
- 6.3 Information described in Section 3.1 of this criteria.
- 6.4 A description of the elements of the composite connections recognized in the evaluation report, including geometrical properties, material (mechanical) properties, including concrete specific weight determined per ASTM C138, and the arrangement of the elements in the composite connections.
- 6.5 A statement that the nominal load values for fasteners or for fastener connections are not permitted to be increased for short-duration loads.
- 6.6 The following statement: Calculations and details showing that the fasteners and the composite connections are adequate to resist the applied loads shall be submitted to the code official for approval. The calculations and details shall be signed and sealed by a registered design professional, when required by the statutes of the jurisdiction in which the project is to be constructed.
- 6.7 The following statement: This evaluation report addresses only a method of shear transfer that is an alternative to the code prescribed [under the auspices of SJI-CJ Section 103.6(d)] welded stud shear connectors, which are used to develop composite action between a structural concrete slab and the supporting steel joists to resist bending induced by vertical loads. Conformance with other aspects of the code, such as requirements for a complete structural system and fire-resistance ratings, is outside of the scope of this evaluation report.
- 6.8 The following statement: Fasteners shall be installed in accordance with the manufacturer's published installation instructions and this report. In the event of a conflict between this report and the manufacturer's published installation instructions, this report governs.
- 6.9 Guidance regarding allowable edge and end distances and spacing of fasteners.
- 6.10 The following statement: Ductility of shear connection shall be considered in the design of composite joists.
- 6.11 The following statement: Use of the standoff screws as part of the lateral force resisting system (wind or seismic) has not been evaluated and is beyond the scope of this report.

Annex A

Test Report Content

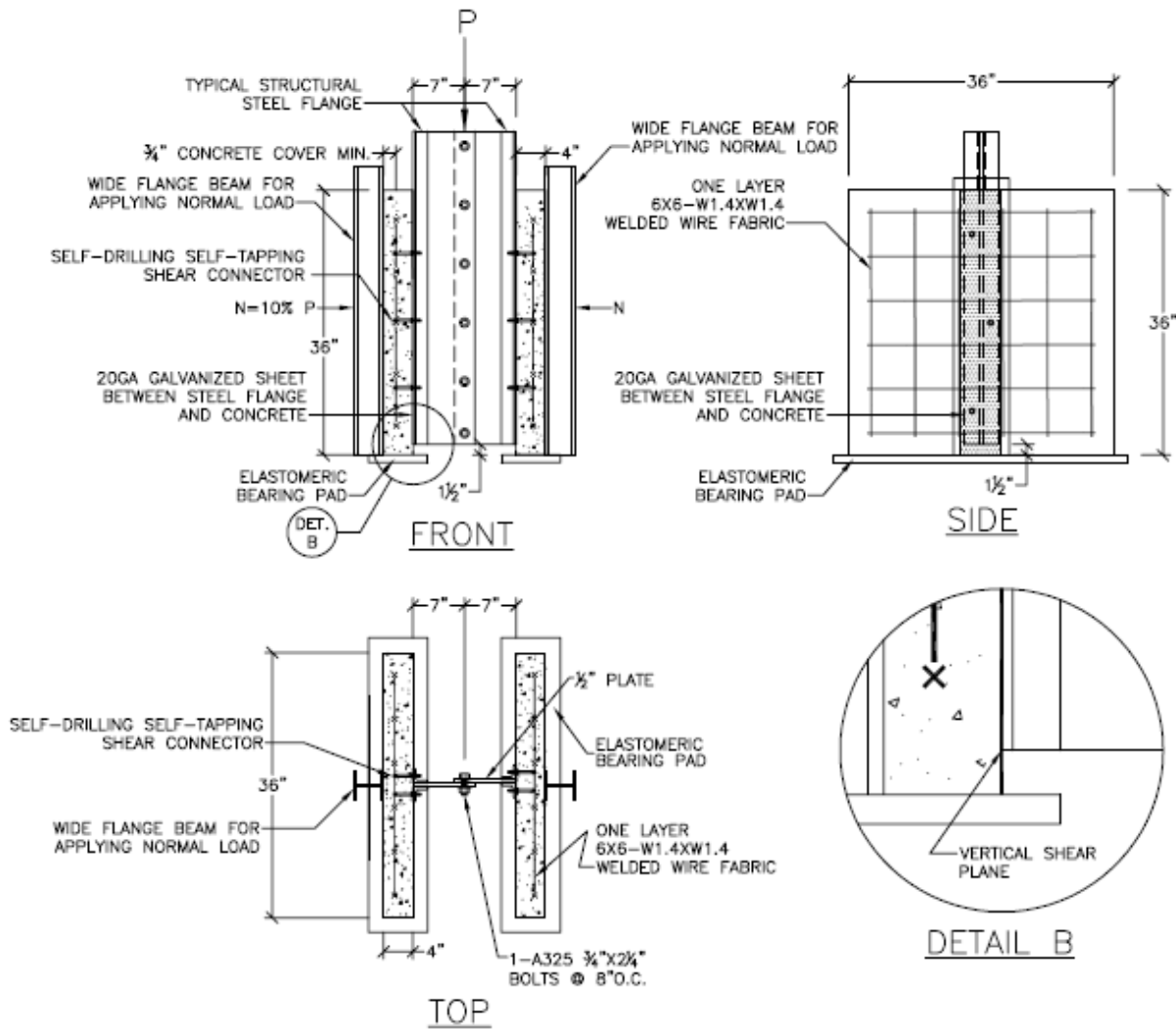
- 1.0** The services performed by the testing laboratory shall be documented by a retrievable report that accurately, clearly, objectively, and unambiguously presents measurements, observations, examinations, and test results in accordance with the reporting requirements of test method(s). Each test or inspection report also shall include the following unless the code, evaluation criteria, or the test standard requirements specify otherwise:
- 1.1** A title, for example, "Report of Push-Out Tests;"
 - 1.2** The name, address, and contact information of the laboratory.
 - 1.3** A unique identification of the report (such as report number), the issue date, a sequential number for each page, and the total number of pages.
 - 1.4** The name and address of client.
 - 1.5** Description of, condition of, and clear identification of the item tested.
 - 1.6** Date test(s) were conducted.
 - 1.7** Identification of test standards or description of any non-standard methods used.
 - 1.8** Any deviations from, additions to, or exclusions from, the test standard and any other information relevant to the specific test, such as environmental conditions;
 - 1.9** Measurements, observations, examinations, and test results, supported by tables, graphs, sketches, and photographs, as appropriate, including a description of the failure mode or condition of item at conclusion of the tests;
 - 1.10** Conclusions or summary statements, including, when applicable, a statement indicating whether the product passed or failed the test;
 - 1.11** A statement the results apply only to the items tested;
 - 1.12** A statement that the report shall not be reproduced, except in full, without the prior written approval of the laboratory; and
 - 1.13** Name(s) of individual(s) performing the tests;
 - 1.14** A signature and title, or an equivalent identification, of the person(s) accepting responsibility for the content of the report on behalf of the laboratory.
 - 1.15** Identification of results obtained from tests subcontracted by the laboratory to others. The laboratory shall not represent the services of others as its own.
- 2.0** In addition to the requirements of Sections 1.0, 2.0 and 3.0, each test report, where necessary for the proper interpretation or understanding of the report, shall include the following:
- 2.1** Project title and reference designation.
 - 2.2** Reference to relevant code, evaluation criteria, or other requirement(s).
 - 2.3** A statement indicating compliance with relevant code, evaluation criteria, or other requirement(s).
 - 2.4** Other reporting requirements of the evaluation agency, the client, or relevant authority.
- 3.0** In addition to the requirements of Sections 1.0, 2.0, 3.0 and 4.0, test reports presenting results shall include the following with respect to sampling:
- 3.1** Date of sampling or date sample received, as appropriate.
 - 3.2** Clear identification of the material sampled including manufacturer, brand name, lot number, source, or similar unique information, as applicable.
 - 3.3** Sampling location, where relevant, using an explicit description, diagram, sketch, or photograph, as applicable.
 - 3.4** Identification of sampling methods used, or sampling plan or procedure if a non-standard method was used.
 - 3.5** Deviations from, additions to, or exclusions from standard sampling methods or predetermined sampling plans or procedures.
 - 3.6** Details of environmental conditions present during the sampling such as rain or freezing weather that may have affected the testing of the sample or the interpretation of the test results.
 - 3.7** If assemblies are tested (structural assemblies, fire-rated assemblies, etc.), identification of the assemblies, preferably with illustrations. The report shall identify the parties constructing the assemblies and shall also address witnessing and/or verifying the construction.

- 4.0** When interpretations of tests are included in the report, the basis for the interpretations shall be clearly explained. Interpretations commonly include determination of compliance or noncompliance of the results with requirements of the test method or evaluation criteria.
- 5.0** Material revisions or additions to a report after initial issue shall be made in a further document clearly indicating the revised information and clearly referencing the original report identification. Such revisions or additions shall meet the relevant requirements of Section 2.0.
- 6.0** Transmission of test reports by electronic means shall follow documented procedures to ensure that the requirements of this evaluation criteria are met and that confidentiality is preserved.



Note: This figure is for illustrative purposes only and shows the level of detail required to fully define each unique configuration to be tested. This level of detail is to be replicated within each evaluation report.

Figure No.1 – Push-off Test Specimen with Steel Decks



Note: This figure is for illustrative purposes only and shows the level of detail required to fully define each unique configuration to be tested. This level of detail is to be replicated within each evaluation report.

Figure No.2 – Push-off Test Specimen without a Steel Deck