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Test Standard for Through-the-Web Punchout Cold-Formed Steel Wall Stud Bridging Connectors, 2015 Edition

American Iron and Steel Institute

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Approved by

the AISI Committee on Specifications for the Design of

Cold-Formed Steel Structural Members

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PREFACE

The American Iron and Steel Institute Committee on Specifications developed this Standard to provide the methodology to determine the strength and deformation behavior of through-the-web *punchout bridging connectors* for cold-formed steel wall *stud* bracing for nonstructural and structural wall *studs* in light-frame construction.

This Standard applies to *bridging connectors* attached to a cold-formed steel wall *stud* and the *bridging member* by mechanical fastening.

The Committee acknowledges and is grateful for the contribution of the numerous engineers, researchers, producers and others who have contributed to the body of knowledge on this subject.

User Notes and Commentary are non-mandatory and copyrightable portions of this standard.

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AISI S915-15
TEST STANDARD FOR THROUGH-THE-WEB PUNCHOUT COLD-FORMED STEEL WALL STUD BRIDGING CONNECTORS

1. Scope

1.1 This Standard provides the methodology to determine the strength and deformation behavior of through-the-web *punchout bridging connectors* for cold-formed steel wall *stud* bracing for structural and nonstructural wall *studs* in light-frame construction. This standard applies to *bridging connectors* attached to a cold-formed steel wall *stud* and the *bridging member* by mechanical fastening, welds or other means to resist torsional moment and axial force. See Figure 1 for illustration. This Standard does not apply to other types of *bridging systems* or to bridging systems that do not use a connector between the wall *stud* web and the *bridging member*.

User Note:
ASTM E72-15, *Standard Test Methods of Conducting Strength Tests of Panels for Building Construction*, provides a methodology to determine the axial compression and transverse strength of fully assembled wall panels. ASTM E72 may be used to confirm the overall strength of cold-formed steel walls with the bridging system and *bridging connector*.

1.2 *Bridging connector assembly rotational strength* is determined by testing a *bridging connector assembly* in accordance with this Standard. This strength value is used to design bracing for laterally loaded cold-formed steel wall *studs*.

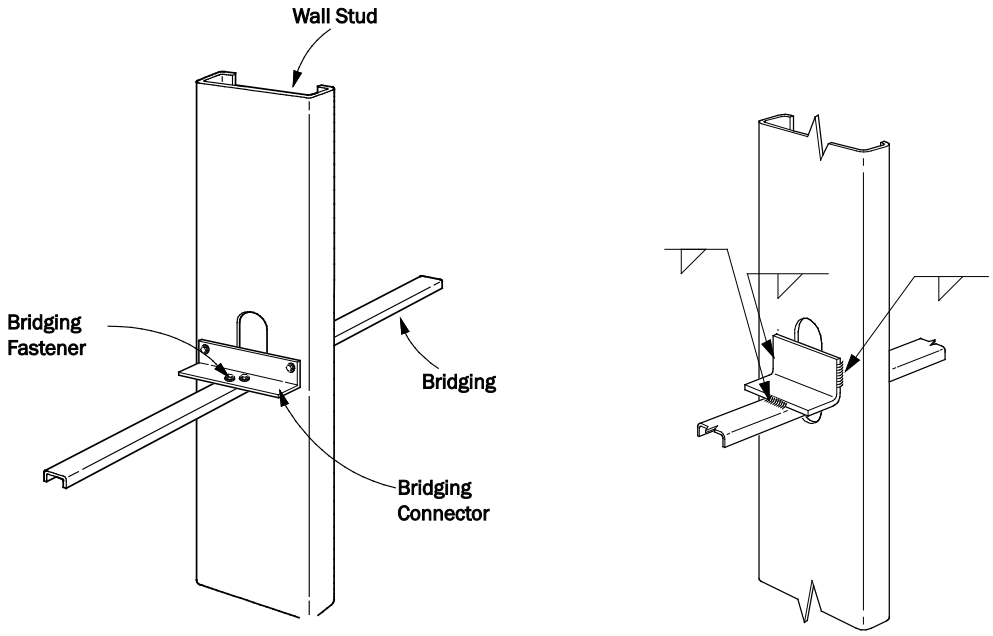

Figure 1 – Examples of Bridging Connector Assemblies

1.3 *Bridging connector lateral brace strength* is determined by testing a *bridging connector* assembly in accordance with this Standard. This strength value is used to design bracing for cold-formed steel wall *studs* axially loaded in compression.

1.4 *Bridging connector* deformation behavior is determined by testing the *bridging connector*

assembly in accordance with this Standard. This deformation value is used to calculate connection stiffness in order to design bracing for cold-formed steel wall *studs* axially loaded in compression.

1.5 This Standard consists of Sections 1 through 11 inclusive.

2. Referenced Documents

The following documents or portions thereof are referenced within this standard and shall be considered as part of the requirements of this document:

a. American Iron and Steel Institute (AISI), Washington, DC:

AISI S100-12, *North American Specification for the Design of Cold-Formed Steel Structural Members*

b. ASTM International (ASTM), West Conshohocken, PA:

ASTM A370-14, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM E6-09be1, *Standard Terminology Relating to Methods of Mechanical Testing*

IEEE/ASTM SI10-10, *American National Standard for Metric Practice*

3. Terminology

Where the following terms appear in this Standard, they shall have the meaning as defined herein. Terms not defined in Section 3 of this Standard, AISI S100, or ASTM E6 shall have the ordinary accepted meaning for the context for which they are intended.

Brace Stiffness. The stiffness to restrain lateral translation at a brace point for an individual wall *stud* subjected to axial compression.

Bridging Connector. Device attaching the *bridging member* to the cold-formed steel wall *stud* and used to transmit forces between them.

Bridging Connector Assembly. An assembly consisting of the following components: (1) a *bridging connector*, (2) a *bridging member* with specified dimensions and properties, (3) a wall *stud* with specified dimensions and properties, and (4) fasteners or welds used to attach the *bridging connector* to a wall *stud* and *bridging member*.

Bridging Member. Continuous cold-formed steel member extending through the wall *stud punchout* and attached to and bracing the cold-formed steel wall *stud*.

Fastener. Bolts, screws, power-actuated fasteners, clinches, or other mechanical fasteners.

Lateral Brace Strength. Strength to resist lateral translation at a brace point for an individual wall *stud* subjected to axial compression.

Punchout. A hole made during the manufacturing process in the *web* of a wall *stud*.

Rotational Strength. Strength of the *bridging connector assembly* to resist the rotation of the wall *stud* about its longitudinal axis through the shear center.

Stud. A vertical framing member in a wall system or assembly.

4. Units of Symbols and Terms

Any compatible system of measurement units shall be permitted to be used in this Standard, except where explicitly stated otherwise. The unit systems considered in this Standard shall include U.S. Customary units (force in kips and length in inches) and SI units (force in Newtons

and length in millimeters) in accordance with IEEE/ASTM SI10.

5. Precision

5.1 Loads shall be recorded to a precision of ±1 percent of the anticipated ultimate load during application of test loads.

5.2 Deflections shall be recorded to a precision of 0.001 in. (0.025 mm).

5.3 Devices used to measure loads and deflections shall be maintained in good operating order, used only in the proper range, and calibrated periodically.

5.4 Instrument calibration readings taken over the full range anticipated in the tests shall be accurate to no less than the precision requirements for the device given above.

6. Test Fixture

The test fixture shall consist of either:

(a) A hydraulic- or screw-operated testing machine capable of operating the removable crosshead at a constant rate of motion or a constant rate of loading, and a calibrated force-measuring device, or

(b) A loading device with a steel fixture, and a calibrated load cell.

> **User Note:**
> It is recommended that ASTM E4-14, *Standard Practices for Force Verification of Testing Machines*, be used as applicable.

7. Test Specimen

7. 1 The specimen shall consist of the *bridging connector assembly* and *fasteners*, welds, or other means used to connect the *bridging member* to the wall *stud*.

7.2 The minimum number of specimens tested shall comply with the requirements of Section F1 of AISI S100.

7.3 The steel properties of the *bridging connector*, *bridging member*, and wall *stud*, including yield stress, tensile strength, percent elongation, and uncoated base steel thickness shall be determined. Standard tension tests of the steel from which the *bridging connector assembly* was produced shall be conducted in accordance with ASTM A370 and Section F1.1(c) of AISI S100.

7.4 *Fasteners* used in *bridging connector* testing shall be selected at random from one manufacturer's lot and installed in a manner that is representative of field conditions. Fastener strength shall be determined in accordance with AISI S100 or shall be determined in accordance with the published manufacturers' catalog.

7.5 Welding, clinching or other fastening techniques are permitted in a manner that is representative of field conditions. The weld strength shall be determined in accordance with AISI S100.

8. Test Setup

8.1 General

8.1.1 The *bridging connector assembly* test setup shall consist of: (1) the *bridging connector*, (2) the *bridging member*, (3) the wall *stud* with *punchout*, and (4) *fasteners* or welds used to attach

the *bridging connector* to the wall *stud* and the *bridging member*.

8.1.2 The assemblies shall be tested in such a manner to simulate the essential function of the *bridging connector assembly*. Test loads shall be applied with reference to the intended end-use application of the *bridging connector assembly*.

User Note:
As the bridging assembly is subjected to load, through-the-web *punchout* bridging may interact with the stud web to provide resistance. The test setup should not inhibit web deformations that would occur under field conditions.

8.2 Bridging Assembly Rotational Strength Test

8.2.1 For the *rotational strength* assembly testing, a load shall be applied in a manner that will induce torsion in the wall *stud*.

User Note:
Figure 2 illustrates a force couple applied in a distributed manner to the wall *stud* flanges. Other test setups are also permitted. For instance, it is acceptable to apply the load to the *bridging member* while restraining the wall *stud* flanges. Whatever test setup is used, it is important to ensure that torsion can be measured by load cells via the applied load and the reactions, and that the minimum of the two measured values is used for *rotational strength*.

8.2.2 The *bridging member* shall extend half the length of the end-use wall *stud* spacing on either side of the wall *stud* with enough width to provide adequate contact surface for the *bridging connector*.

8.2.3 Reaction forces shall be measured with load cells at each end of the *bridging member* as the ends represent the inflection points of the end-use application.

User Note:
Although outside of the scope of this Standard, rotational stiffness can also be measured.

8.2.4 To avoid an unintentional load path, the wall *stud*s used in the assembly test shall be of adequate length to prevent contact between the *bridging connector* and any element other than the *bridging member* and wall *stud*.

8.2.5 In narrow depth wall *studs* where the stiffener lips would otherwise come into contact with the *bridging connector* or *bridging member* during loading, the stiffener lips are permitted to be removed.

User Note:
In some assembly scenarios, it is possible that the *bridging connector* and/or *bridging member* will come into contact with the wall *stud* stiffener lips before failure is achieved, and this could result in unconservative results.

8.3 Bridging Assembly Lateral Brace Strength and Stiffness Test

8.3.1 For the *lateral brace strength* assembly testing (illustrated by Figure 3(a)), initial tests shall be performed to determine whether the bridging loaded in compression or loaded in tension governs the performance of the *bridging connector assembly* (illustrated by Figure 3(b), Section View A-A; or Figure 3(c), Section View B-B). The remaining tests are then permitted to be used for the governing loading condition.

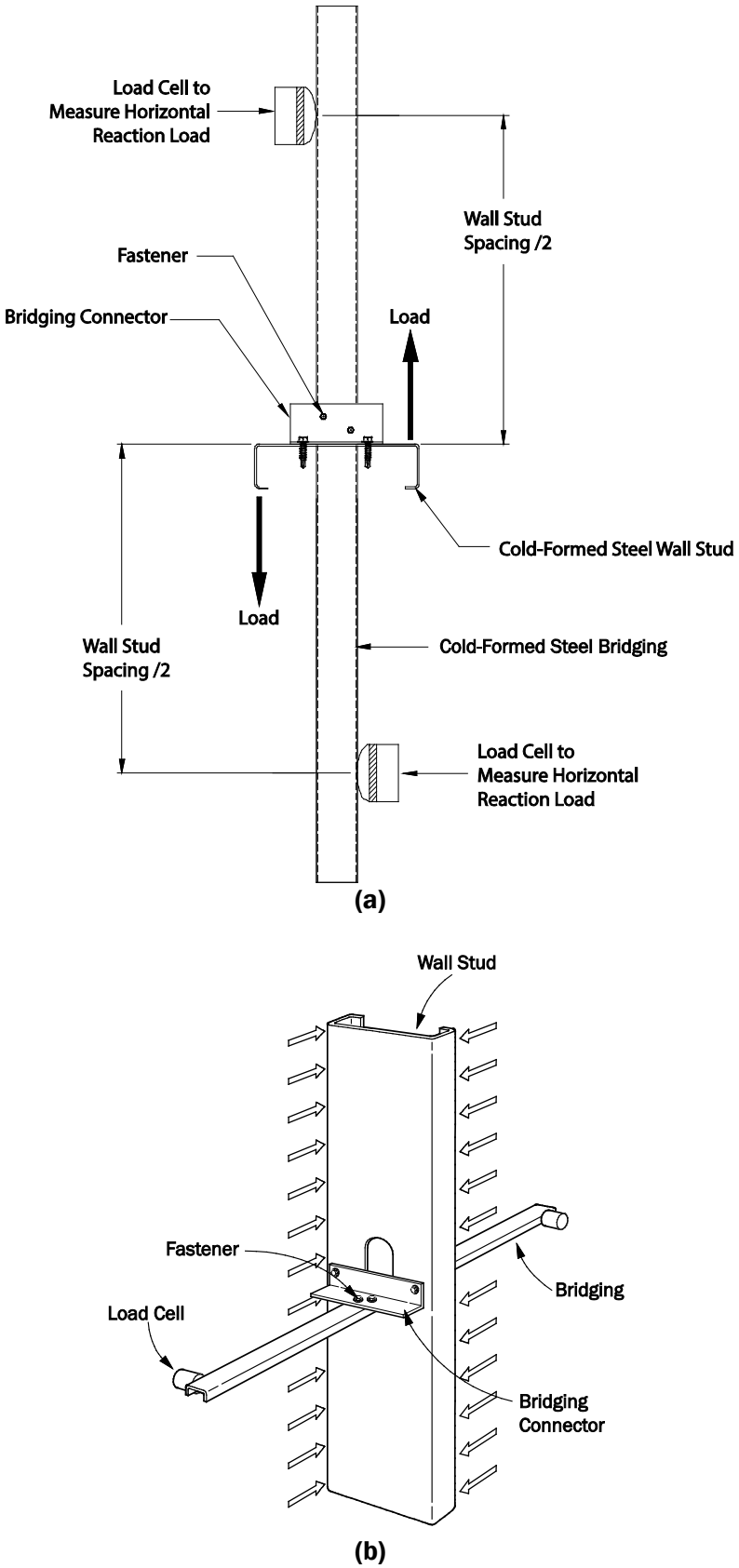

Figure 2 Rotational Strength Test Setup for Bridging Connector Assembly

8.3.2 Depending on the results from testing in accordance with Section 8.3.1, a compression or tension load shall be applied to the *bridging member,* which is attached to the wall *stud* by the *bridging connector*.

8.3.3 The deflection measuring device(s) shall measure the deflection of the *bridging member* from the load cell to the test fixture anchorage to the test bed (see Figure 3 (b), Section View A-A; or Figure 3 (c), Section View B-B). The base of the device(s) shall be located such that measurements include the deflection resulting from the wall *stud* web deformation, *bridging connector* deformation, *bridging member* deformation, and *fastener* slip.

8.3.4 The wall *stud* flanges shall be supported with bearing restraints without the use of *fasteners* that could alter the flexural response of the web. Each bearing surface shall be no more than 1/2 in. (12.7 mm) wide.

User Note:
Depending on the *bridging connector* geometry and installation instructions, it is important that each bearing does not interfere with the *bridging connector*. Therefore, as illustrated by Figure 3, each bearing may be discontinuous in the vicinity of the *bridging connector*.

8.3.5 To avoid an unintentional load path, the wall *studs* used in the assembly shall be of adequate length and width to prevent contact between the *bridging connector* and any element other than the intended test fixture restraints.

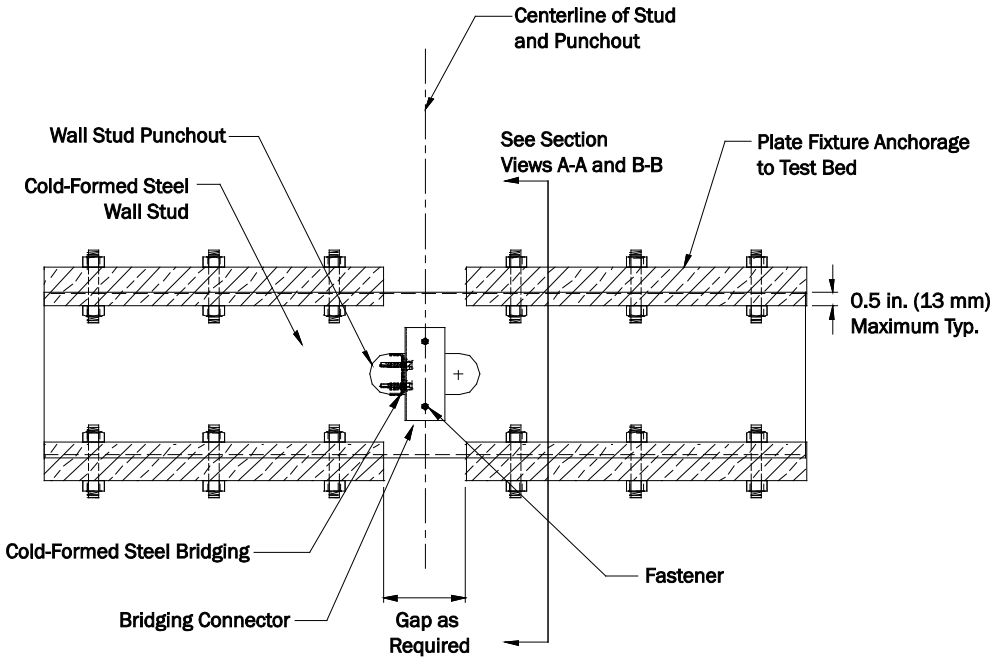

Figure 3(a) Lateral Brace Strength Test Setup for Bridging Connector Assembly

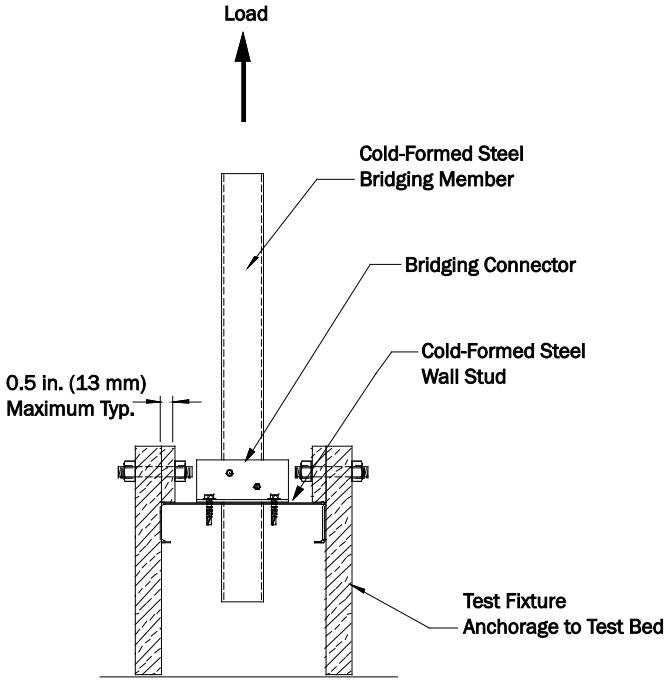

Figure 3 (b) Section View A-A
(Cutting-Plane Line Shown in Figure 3(a))

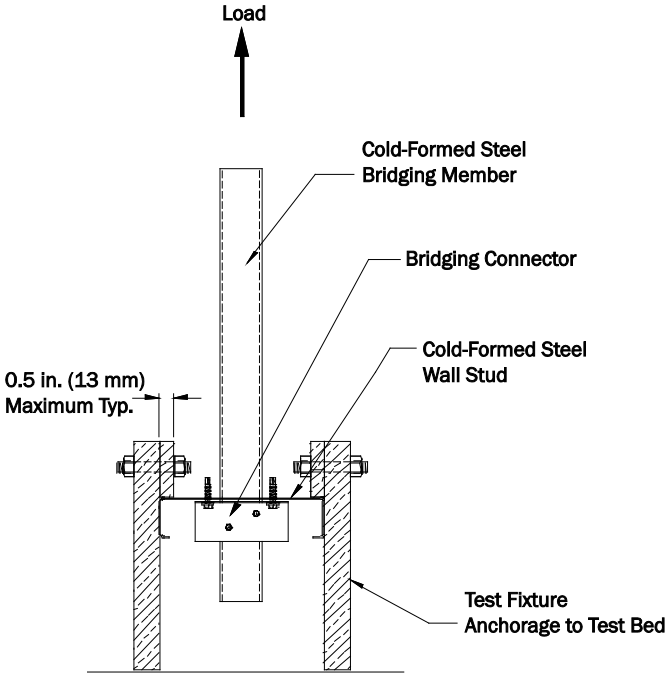

Figure 3 (c) Section View B-B
(Cutting-Plane Line Shown in Figure 3(a))

9. Test Procedure

9.1 An initial load, or preload, shall not be applied for *rotational strength* load testing of the *bridging connector assembly*. For *lateral brace strength* load testing, a preload is permitted to be applied to the assembly. This preload shall not exceed 10 percent of the average ultimate load.

9.2 The assemblies shall be loaded such that the load is applied in reference to the intended application of the *bridging connector*. The test load shall be applied at a uniform rate not to exceed 0.03 radians per minute for 6-in. (152-mm) and 8-in. (203-mm) studs, and 0.06 radians per minute for 3-5/8-in. (92-mm) and 4-in. (102-mm) studs for the *rotational strength* test and a uniform rate not to exceed 0.1 in. (2.54 mm) per minute for the *lateral brace strength* test until failure or a maximum load is reached or when any portion of the wall *stud* other than the web comes in contact with the *bridging member* or *bridging connector*. Loads shall be recorded to a precision of ± 1 percent of the ultimate load during application of test loads.

User Note:
The rotation in the *rotational strength* test should be measured by dividing the summation of the horizontal displacements of the load cells at the bridging by the stud spacing if the stud is restrained, or the stud web rotation should be measured if the bridging is restrained. A rotational rate of 0.03 radians per minute is equivalent to 0.10 inch (2.54 mm) per minute on an 8-inch (203-mm) *stud* depth. A rate of 0.06 radians per minute is equivalent to 0.10 inch (2.54 mm) per minute on a 3-5/8-in. (92.1-mm) *stud* depth.

9.3 Load-deflection characteristics of the *bridging connector* shall be determined. The deflections shall be recorded to the nearest 0.001 in. (0.025 mm). Deflections shall be recorded at a sufficient number of load levels to permit the establishment of a load-deflection curve. At least eight readings shall be taken prior to reaching the load value for stiffness evaluation. Readings shall be taken throughout the test and not be grouped during a portion of the test, such as at the beginning, middle or end of test.

10. Data Evaluation

10.1 Evaluation of the test results and the determination of the available strength (allowable strength for ASD and design strength for LRFD) shall be made in accordance with the procedures described in Section F1 of AISI S100.

10.2 In cases where the stiffener lip is removed during the *rotational strength* assembly test, as permitted in Section 8.2.5, the available strength of the *bridging connector* shall also be limited to the load at which the *bridging member* or *bridging connector* would have engaged the stiffener lip.

10.3 For a *bridging connector* used to brace a wall *stud* loaded in axial compression, the *stiffness* shall be determined from the average values of the load-versus-deflection curves at 40 percent of the ultimate load.

Commentary:
The *stiffness* is determined from the average of load-versus-deflection curve at 40 percent of the maximum load as it was observed that the load-versus-deflection curve was initially linear within this load range. This is consistent with the approach that determines the stiffness of diaphragm systems. See AISI S907-13, *Test Standard for Cantilever Test Method for Cold-Formed Steel Diaphragms*.

10.4 No test results shall be eliminated unless a rationale for their exclusion can be given.

11. Report

11.1 The test report shall include a description of the tested *bridging connector assembly*, including a drawing that details all pertinent dimensions of the assembly. The description shall also include information concerning each component of the tested *bridging connector assembly*.

11.2 The test report shall include the measured mechanical properties of the *bridging connector, bridging member,* and wall *stud*.

11.3 The test report shall include a description of any modifications made to the cold-formed steel members used in the *bridging connector assembly* testing.

11.4 The test report shall include a description of all the *fasteners*, welds, and other methods of attachment that are used in the test, including locations of fasteners and lengths of welds.

11.5 The test report shall include a description of the loading procedure and the test method, including a detailed drawing of the test setup, depicting location and direction of load application, location of deflection measurement instrumentation and their point of reference, and details of any deviations from the test requirements stipulated in Sections 6, 8 and 9. Additionally, photographs shall supplement the detailed drawings of the test setup.

11.6 For the *lateral brace strength* test, the test report shall include individual and average load-versus-deformation values and curves as plotted directly or as reprinted from data acquisition systems. For the *rotational strength* test, the test report shall include individual and average load-versus-rotation values and curves as plotted directly or as reprinted from data acquisition systems.

> **User Note:**
> For the *rotational strength* test, load-versus-rotation curves are not required but may be included in the report.

11.7 The test report shall include individual and average maximum test load values observed; description of the nature, type and location of failure exhibited by each *bridging connector* tested; and a description of the general behavior of the test assembly during load application. Additionally, photographs shall supplement the description of the failure mode(s).

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