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Test Procedure for Determining a Strength Value for a Roof Panel-to-Purlin-to-Anchorage Device Connection, 2013 Edition

American Iron and Steel Institute

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AISI STANDARD

Test Procedure for Determining a Strength Value for a Roof Panel-to-Purlin-to-Anchorage Device Connection

2013 Edition

Approved by

the AISI Committee on Specifications for the Design of

Cold-Formed Steel Structural Members

The material contained herein has been developed by the American Iron and Steel Institute (AISI) Committee on Specifications for the Design of Cold-Formed Steel Structural Members. The organization and the Committee have made a diligent effort to present accurate, reliable, and useful information on testing of cold-formed steel members, components or structures. The Committee acknowledges and is grateful for the contributions of the numerous researchers, engineers, and others who have contributed to the body of knowledge on the subject. With anticipated improvements in understanding of the behavior of cold-formed steel and the continuing development of new technology, this material will become dated. It is anticipated that future editions of this test procedure will update this material as new information becomes available, but this cannot be guaranteed.

The materials set forth herein are for general information only. They are not a substitute for competent professional advice. Application of this information to a specific project should be reviewed by a registered professional engineer. Indeed, in most jurisdictions, such review is required by law. Anyone making use of the information set forth herein does so at their own risk and assumes any and all resulting liability arising therefrom.

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PREFACE

The American Iron and Steel Institute Committee on Specifications developed this standard to obtain lower bound strength values for the roof panel-to-purlin-to-anchorage device connections in through-fastened and standing seam, multi-span, multi-purlin line roof systems, with or without intermediate braces. The test is not intended to determine the ultimate strength of the connections.

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.

Commentary is non-mandatory and copyrightable portion of this standard.

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AISI S912-13

Test Procedure for Determining a Strength Value for a Roof Panel-to-Purlin-to-Anchorage Device Connection

1. Scope

1.1 The purpose of this test procedure is to obtain lower bound strength values for the roof panel-to-purlin-to-anchorage device connections in through-fastened and standing seam, multi-span, multi-purlin line roof systems, with or without intermediate braces. The test is not intended to determine the ultimate strength of the connections.

1.2 This test method applies to an assembly consisting of through-fastened or standing seam panels, purlins of C- or Z-sections, and anchorage devices.

1.3 The test procedure is only for gravity-loading cases and only for a series of purlins with flanges facing in the same direction. It applies only to the anchorage configurations described in Section D6.3.1 of AISI S100.

1.4 All tests are conducted using roof panels, clips, fasteners, insulation, thermal blocks, discrete braces, and purlins as used in the actual roof system except as noted in Section 1.5.

1.5 Tests conducted with insulation are applicable to identical systems with thinner or no insulation.

Commentary:

Due to the many different types and methods of construction of steel roof systems, it is not practical to develop a generic method to predict the strength of the roof panel-to-purlin-to-anchorage device connections. The interaction of the three components near an anchorage location is a complex phenomenon and highly indeterminate.

The test method provides designers with a means of establishing a lower bound on the strength of the roof panel-to-purlin-to-anchorage device connections. An appropriate strength reduction factor or safety factor should be applied to test results for design use.

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:

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

S908-13, Test Standard for Base Test Method for a Standing Seam Roof System

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

A370-12a, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

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.

Anchorage System. A series of components which carry forces in the roof sheathing to the primary structural system of the building.

Failure. A state at which the specimen will accept no further loading.

Field Erection Drawings. Drawings issued by a metal roof manufacturer to field erectors showing parts and assembly procedure(s).

Fixed Clip. A hold-down clip which does not allow the roof panel to move independently of the roof substructure.

Insulation. Glass fiber blanket or rigid board.

Lateral. A direction normal to the span of the purlins in the plane of the roof sheathing.

Thermal Block. Strips of rigid insulation located directly over the purlin between clips.

Pan-Type Standing Seam Roof. A U-shaped panel which has vertical sides.

Rib-Type Standing Seam Roof. A panel which has ribs with sloping sides and forms a trapezoidal shaped void at the sidelap.

Sliding Clip. A hold down clip which allows the roof panel to move independently of the roof substructure.

Standing Seam Roof System. A roof system in which the sidelaps between the roof panels are arranged in a vertical position above the roof line. The roof panel system is secured to the purlins by means of concealed hold-down clips that are attached to the purlins with mechanical fasteners.

Test Engineer. An engineer or designated representative responsible for supervising the test assembly, collection of test data, and preparation of the test report.

Through Fastened Roof System. A roof system in which the sidelaps between the roof panels are arranged in a vertical position above the roof line. The roof panel system is secured to the purlins by means of self-drilling or self-tapping fasteners through the panels and into the purlins.

4. Units of Symbols and Terms

Any compatible system of measurement units is 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. Apparatus

5.1 A test setup shall be capable of supporting simulated gravity loading. Loading shall be applied by differential pressure or by using weight. The test assembly is permitted to be flat or sloped as required to determine the strength value in the up-slope or down-slope direction.

5.2 The length, width, number of purlins, and number of spans of the test setup shall be at the discretion of the test engineer. The height of the assembly shall be enough to permit assembly of the specimen and to ensure adequate clearance at the maximum deflection of the specimen.

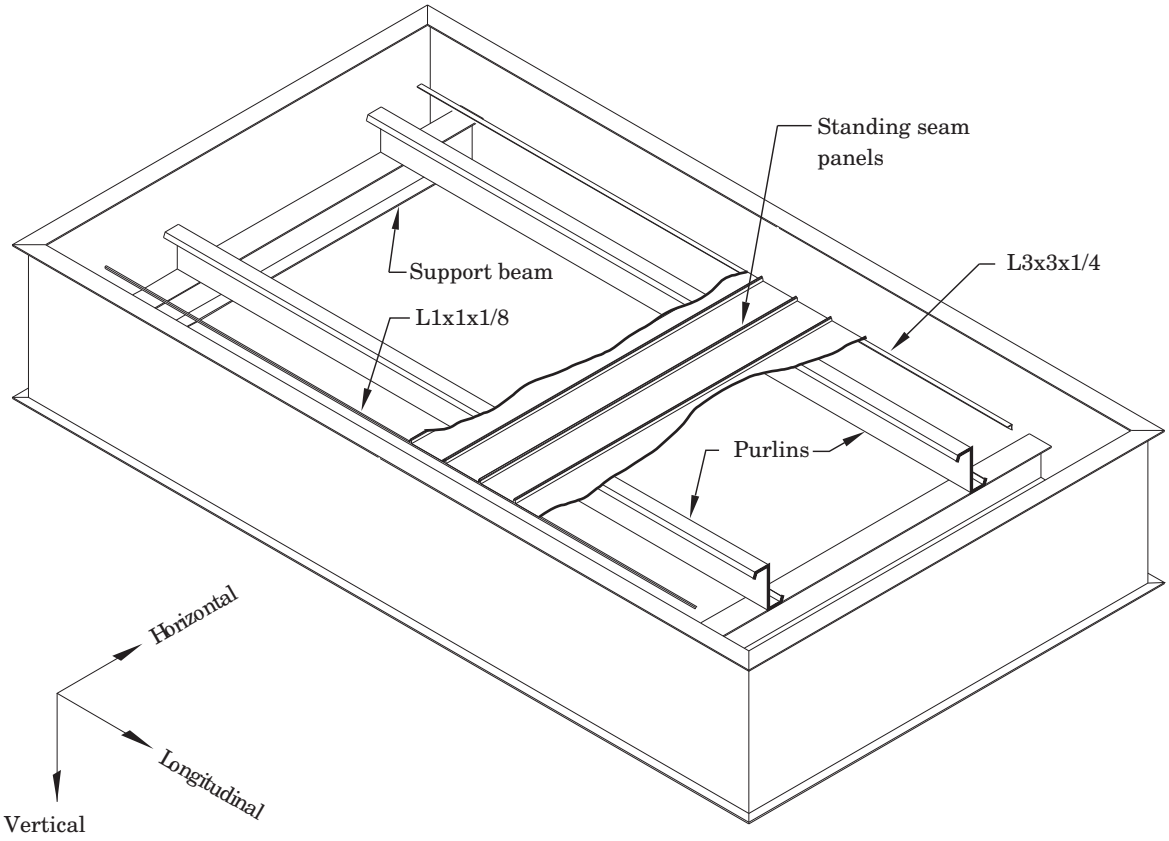

Figure 1 – Test Chamber

5.2.1 Differential Pressure Loading Procedure

A rectangular vacuum box shall be constructed of any material with enough strength and rigidity to provide the desired pressure differential without collapse. See Figure 1 for a typical test chamber. Other chamber orientations are permitted.

The width of the chamber shall be determined by the maximum panel length. Allowance shall be made in the interior chamber dimensions to accommodate structural supports for the secondary members and enough clearance on all sides to prevent interference of the chamber wall with the test specimen as it deflects.

Sections 6.4 to 6.9 of AISI S908 shall be followed.

5.2.2 Weight Loading Procedure

Uniformly distributed weights placed in increments shall be used. Placement of the

weights shall be such that bridging does not occur. The weights are permitted to be small steel plates, concrete or masonry bricks, or larger plates or rods whose bending stiffness is less than 20 percent of the bending stiffness of the sheathing.

Sections 6.4 to 6.9 of AISI S908 shall be followed.

6. Test Specimens

6.1 Test purlins shall be supported at each end by a steel beam. The beams shall be simply supported and all but one of the beams shall be sufficiently free to translate laterally to relieve any longitudinal catenary forces in the assembly. Purlins shall be connected to the supporting beams as shown in the field erection drawings.

6.2 Panel-supporting clips, fasteners, and panels shall be installed as required by the field erection drawings.

6.3 The means of providing purlin restraint shall be as required for use in actual field application, and shall be installed as shown in the field erection drawings.

6.4 For tests including intermediate discrete point braces, the braces used in the test shall be installed in such a manner so as not to impede the vertical deflection of the specimen.

6.5 For standing seam roof systems, a 1 in. x 1 in. (25 mm x 25 mm) continuous angle with a maximum thickness of 1/8 in. (3 mm) or a member of compatible stiffness shall be attached to the underside at each end of the panels to prevent separation of the panels at the ends of the seam. Fasteners shall be placed on both sides of each major rib.

6.6 Panel joints shall not be taped and no tape shall be used to restrict panel movement.

7. Test Procedure

7.1 A test series shall be conducted for each roof panel-to-purlin-to-anchorage device system. The setup shall consist of any number of purlin lines and any number of purlin spans. All purlin flanges shall face in the same direction. The anchorage system shall be located along an external purlin line and is permitted to consist of any of the anchorage combinations specified in Section D6.3.1 of AISI S100.

7.2 A test series shall consist of no fewer than three tests for each anchorage system.

7.3 The physical properties of all components shall be measured and recorded prior to testing. The yield stress of the panel, purlin and anchorage device materials used in the tests shall be determined in accordance with ASTM A370. Coupons shall not be taken from areas where cold-working stresses could affect the results.

7.4 To simulate gravity loading, differential pressure or weights shall be applied to the system to produce simulated gravity-loading moments in the system.

7.5 An initial load equal to 5 psf (0.25 kPa) shall be applied and removed to set the zero readings before actual system loading begins.

7.6 It shall not be required to load the system to failure. If it is loaded to failure, the mode of failure shall be noted. If the test must be stopped due to a flexural failure of the panel or purlin, or web crippling of the purlin, the result is permitted to be included in the test program.

7.7 Horizontal deflection near the top of each anchorage device shall be measured. Vertical deflection measurements shall be taken at the mid-span of at least two purlins in each span. The deck deflection in the horizontal direction shall be measured at the seam joint nearest the center of each span of the test assembly.

7.8 Deflections and loads shall be recorded at loading intervals equal to a maximum of 10 percent of the anticipated maximum load.

8. Test Evaluation

8.1 The lower bound strength of each roof panel-to-purlin-to-anchorage device connection used in the test shall be determined by calculating the anchorage force, P_L, at that location using the provisions in Section D6.3.1 of AISI S100. The lesser of load corresponding to a measured deflection of ½ in. (13 mm) at the top of the anchorage device and the maximum applied load in the test shall be used for this calculation.

8.2 The nominal strength of the panel-to-purlin-to-anchorage device connections shall be taken as the mean of the calculated anchorage forces minus one standard deviation.

8.3 The lower bound available strength shall be determined using a resistance factor, ϕ, of 0.9 or safety factor, Ω, of 1.67.

9. Test Report

9.1 The report shall include the name of the individual who performed the test and a brief description of the system being tested.

9.2 The documentation shall include all test details with a drawing that shows the test assembly and indicates the components and their locations, as well as the locations of all instrumentation. A written description of the test setup detailing the basic concept, loadings, measurements, and assembly shall be included.

9.3 The report shall include a drawing that shows the measured geometry of all components and nominal material specifications. Material test results defining the actual material properties—material thickness, yield stress, tensile strength, and percent elongation—shall be included.

9.4 The report shall include the test designation, loading increments, all measured deflections, maximum applied load or failure load and the corresponding failure mode if failure occurred, and a description of the condition of each assembly at the end of each test.

9.5 The report shall include calculations used to determine the lower bound strength for each test and the nominal strength of the roof panel-to-purlin-to-anchorage device connection tested, and a description summarizing the test program results that includes specimen type, span, and the supporting calculations.

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