AISI S906-17

American Iron and Steel Institute

AISI STANDARD

Test Standard for Determining the Load-Carrying Strength of Panels and Anchor-to-Panel Attachments for Roof or Siding Systems Tested in Accordance with ASTM E1592

2017 Edition

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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.

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PREFACE

The American Iron and Steel Institute Committee on Specifications developed this Standard to extend and provide methodology for the interpretation of the results of tests performed according to ASTM E1592.

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.

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AISI S906-17
TEST STANDARD FOR DETERMINING THE LOAD-CARRYING STRENGTH OF PANELS AND ANCHOR-TO-PANEL ATTACHMENTS FOR ROOF OR SIDING SYSTEMS TESTED IN ACCORDANCE WITH ASTM E1592

1. Scope

This procedure extends and provides methodology for the interpretation of the results of tests performed according to ASTM E1592.

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:

S100-16, *North American Specification for the Design of Cold-Formed Steel Structural Members*

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

A370-16, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

E6-15, *Standard Terminology Relating to Methods of Mechanical Testing*

E1592-05 (2012), *Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference*

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

c. Factory Mutual, Corporate Offices, Johnson, RI:

FM4471, *Approval Standard for Class 1 Panel Roofs*, 2010

User Note:
CEGS-07416 is listed as an optional test for roofs that were previously tested and approved:

U. S. Army Corps of Engineers, Washington, DC:

CEGS-07416, *Guide Specification for Military Construction, Structural Standing Seam Metal Roof (SSSMR) System*, 1995

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.

3.1 Refer to Section 3, ASTM E1592.

3.2 Additional or Modified Terminology

Clip. A single or multiple element device that frequently attaches to one edge of a panel and is fastened to the secondary structural members with one or more screws.

Field. Area that is not included in high-pressure edge strip conditions. For purposes of the test, a *field* condition is modeled when the *pan* distortions are independent of end and edge restraint.

Pan. Relatively flat portion of a panel between ribs.

Tributary Area. Area directly supported by the structural member between adjacent supports.

Trim. Sheet metal used in the finish of a building, especially around openings, and at the intersection of surfaces such as roof and walls.

Maximum Load. Difference in static air pressure at which failure of the specimen occurs, expressed in load per unit area. It is further defined as the point where the panel system cannot sustain additional loading.

Unlatching Failure. Disengagement of a panel seam or anchor that occurs in an unloaded assembly due to permanent set or distortion that occurred when the assembly was loaded. This permanent set is not always detectable from readings taken normal to the panel. It is deemed to be a serviceability limit state until a strength limit state occurs, as defined in *maximum load*.

4. Summary of Test Method

4.1 Refer to the requirements of Section 4, ASTM E1592.

5. Significance and Use

5.1 Refer to the requirements of Section 5, ASTM E1592.

5.2 The end use of the procedure is the determination of load-carrying strength [factored resistance] of panels and/or their anchors under gravity or suction loading for use in a design procedure.

6. Apparatus

6.1 Refer to the requirements of Section 6, ASTM E1592.

7. Safety Precautions

7.1 Refer to the requirements of Section 7, ASTM E1592.

8. Test Specimens

8.1 Refer to the requirements of Section 8, ASTM E1592.

8.2 Edge seals shall not contain attachments that restrict deflection of the test panel in the *field* in any way. No additional structural attachments that would resist deflection of the *field* of the test panels shall be permitted.

8.2.1 The test panel ribs shall be installed parallel to the long side of the test chamber.

8.3 Number of Tests

8.3.1 Tests shall use minimum thickness of support members (secondary structures) and maximum panel span. If results are to be interpolated for other values, the other extremes shall be tested in order to justify an interpolation procedure.

8.3.2 Tests shall be conducted to evaluate the *field* condition.

8.3.3 The minimum number of spans shall be as defined in Table 1.

9. Calibration

9.1 Refer to the requirements of Section 9, ASTM E1592.

10. Procedure

10.1 Refer to the requirements of Section 10, ASTM E1592.

11. Test Evaluation

11.1 Safety factors and resistance factors shall be determined in accordance with Section I6.3.1 of AISI S100.

11.2 If a separate test series is performed to evaluate edge conditions and the results exceed the *field* case by greater than one standard deviation, a separate design strength [factored resistance] is permitted to be established for edge conditions.

11.3 A qualified design professional shall analyze deflections and permanent set data to ensure that deflections and permanent set are acceptable at service loads.

Table 1
Minimum Number of Equal Spans to Comply with 8.3*

Span Length, L ft (m)	Ends With Crosswise Restraint**		
	2 end restraints	1 end restraint	No end restraints
12 ft-0 in. (3.7 m) or more	2	2	2
Below 12 ft-0 in. (3.7 m) to 8 ft-0 in. (2.4 m)	3	2	2
Below 8 ft-0 in. (2.4 m) to 6 ft-0 in. (1.8 m)	4	3	2
Below 6 ft-in. (1.8 m) to 5 ft-0 in. (1.5 m)	5	3	2
Below 5 ft-0 in. (1.5 m) to 4 ft-0 in. (1.2 m)	24/L (7.3/L)	3	3
Below 4 ft-0 in. (1.2 m) to 3 ft-4 in. (1.0 m)	24/L (7.3/L)	4	3
Below 3 ft-4 in. (1.0 m) to 3 ft-0 in. (0.9 m)	24/L (7.3/L)	4	4
Below 3 ft-0 in. (0.9 m) to 2 ft-6 in. (0.8 m)	24/L (7.3/L)	5	4
Below 2 ft-6 in. (0.8 m) to 2 ft-0 in. (0.6 m)	24/L (7.3/L)	5	5
Below 2 ft-0 in. (0.6 m)	24/L (7.3/L)	1+8/L (1+2.4/L)	10/L (3.0/L)

* Count fractional spans as whole numbers; that is, for L=4 ft-9 in. (1.4 m), 24/4.75 =5.05 (or 7.3/1.4=5.2), use 6 spans.

** L is measured in feet (when L is measured in meters, the corresponding formula in the parentheses is used).

12. Test Report

12.1 Refer to the requirements of Section 11, ASTM E1592.

12.2 Report the nominal strength [resistance] of the standing seam roof panel system as follows:

12.2.1 For ASTM E1592, the nominal strength [resistance] shall be the ultimate load as defined by that test procedure.

12.2.2 For FM 4471, the nominal strength [resistance] shall be the minimum uplift pressure recorded for windstorm classification achieved.

User Note:
For CEGS-07416, the nominal strength [resistance] is the ultimate load.

12.3 If intermediate values are to be calculated for different spacings of anchors or secondary structures, the basis of the interpolation shall be stated in the report. If the failure modes are different on any two tests, interpolation between these two tests is permitted provided the lower bounds of the two failure modes are used.

12.4 The design professional shall include in the report the observation as to the acceptability of deflections and permanent set data at service loads.

AISI S906-17-C
COMMENTARY ON TEST STANDARD FOR DETERMINING THE LOAD-CARRYING STRENGTH OF PANELS AND ANCHOR-TO-PANEL ATTACHMENTS FOR ROOF OR SIDING SYSTEMS TESTED IN ACCORDANCE WITH ASTM E1592

1. Scope

The scope of the procedure is for testing single-skin panel systems. The procedure is based on ASTM E1592 with specific additions to define the required safety factors for a design procedure. Edge strip detail confirmation is permitted by the test method.

2. Referenced Documents

The standards, ASTM E1592, U. S. Army Corps of Engineers CEGS-07416, and Factory Mutual 4471 have been used in the development of this procedure. Note that the U.S. Army Corps of Engineers has replaced its roof uplift test requirement with the ASTM E1592 test, but CEGS-07416 is still listed as an optional test for roofs that were previously tested and approved.

3. Terminology

To promote accuracy and understanding, frequently used terms need mutual understanding. This list includes the terms from ASTM E1592 with additions and modifications.

5. Significance and Use

Currently, there are several organizations that have test procedures to determine product performance, but the procedures are limited to one product configuration and do not have provisions to provide the basis for a complete design procedure covering the evaluation of a safety factor for a range of product configurations. Therefore, this Standard Procedure was developed.

6. Apparatus

The apparatus defined in this section is specific enough to accomplish the purpose, yet broad enough to allow many facilities to perform tests. The size of the specimen is the most important criterion. Whether or not the apparatus consists of two sections with the specimen in between is not a major issue.

Measurement of rib spread has dubious value except when seam disengagement is the failure mechanism. In that case, measurements tend to substantiate the failure mechanism.

7. Safety Precautions

In addition to other precautions, care must be exercised in taking the deflection readings required in this procedure.

8. Test Specimens

The size of a test specimen has been found to be an important element in demonstrating product performance. Minimum sizes are defined, but larger sizes are allowed. It is understood that many products are offered to the marketplace that have insufficient usage to justify a large test program, yet proof of performance to some degree is required. The procedure was developed to allow a single test with a corresponding penalty due to the reduced degree of demonstrated reliability with only a single test. The procedures of Section K2.1 of AISI S100 provide for the reward/penalty relationship developed with the increasing number of tests and the associated coefficient of variation.

Minimum specimen size is as required in ASTM E1592 with the addition of the specimen configuration with both ends open. This is consistent with the 1995 edition of E1592 and is included for tests previously conducted according to that protocol. Reports from manufacturers using these test results suggest that these tests formed the basis of adequate designs. The minimum specimen length of 24 ft (7.3 m) for the condition of constraint at both ends is consistent with the requirements of FM 4471. However, in the FM tests, panels may be fastened down at all edges and it is termed a *field* test. It is the manufacturer's option to fasten the ends down or leave them open. The details of the FM test may not meet the ASTM E1592 Number of Equal Spans requirement in some cases. A purlin space of 5 ft (1.5 m) requires five spans with both ends restrained. If one end is left free, the FM test will meet ASTM E1592. The application is also different in many cases because FM tests may be run with both ends restrained, and this is used as a *field* test. Different results may be obtained when using the two variations of panel end restraints in the test procedure that are allowed by ASTM E1592.

When totaling the number (n) of anchors tested for evaluation of C_p under Section I6.3.1 of AISI S100, it is permissible to include all fasteners with the same *tributary area* as that associated with a failed anchor instead of merely totaling the number of physical tests run on a complete assembly. When totaling the number (n) of panels tested for evaluation of C_p under SectionI6.3.1 of AISI S100, it is permissible to include all panels with the same *tributary area* as that associated with a failed panel instead of merely totaling the number of physical tests run on a complete assembly

Consideration is given to the minimum spacings and material thicknesses. If the available strength [factored resistance] developed under this procedure are intended to be used in a design procedure that encompasses different secondary structural support spacings or thinner sections for anchors to attach to, the extremes must be tested in order for interpolation to be valid. This precedent is established in AISI S908, *Base Test Method for Purlin Supporting a Standing Seam Roof System* (2017) for validating the performance of purlins braced by standing seam roof panels.

10. Procedure

The procedures for loading the specimen, while not complicated, need to be defined consistent with other existing and recognized standards. A significant difference between this procedure and the AISI S908 (2017) is the return to zero load after each load increment.

11. Test Evaluation

See Section I6.3.1 of the *Commentary* for AISI S100.

12. Test Report

The definition of items to be included in the report includes the typical list of failure loads and plots of load versus deformation. Of paramount importance is the calculation of the resistance factor and safety factor of design strength [factored resistance] or allowable design strength for panels and anchors. This procedure is an addition to those required in ASTM E1592-05 (2012). If interpolation is to be a part of the resulting design process, then appropriate interpolation procedure should be set forth in the report.

References

American Iron and Steel Institute (2016), S100-16, *North American Specification for the Design of Cold-Formed Steel Structural Members*, 2016.

American Iron and Steel Institute (2016), S100-16-C, *Commentary on North American Specification for the Design of Cold-Formed Steel Structural Members*, 2016.

American Iron and Steel Institute (2017), S908-17, *Base Test Method for Purlin Supporting a Standing Seam Roof System*, AISI Standards for Test Procedures, 2017.

ASTM International (2012), E1592-05 (2012), *Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference*, 2012.

U. S. Army Corps of Engineers (1995), CEGS-07416 (1995), *Guide Specification for Military Construction, Structural Standing Seam Metal Roof (SSSMR) System*, July 1995.

Factory Mutual Research (2010), "Approval Standard for Class I Panel Roofs, Class Number 4471", March 2010.

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