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Standard Test Method for
Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference[1]

This standard is issued under the fixed designation E1592; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

Computations are the accepted method for determining the structural capacity of most metal products. However, some conditions are outside the scope of analysis by industry specifications.

Methods of computation and a discussion of these conditions are found in the following documents: AISI Specification for the Design of Cold-Formed Steel Structural Members and Load and Resistance Factor Specification for Cold-Formed Steel Structural Members and Aluminum Association Specifications for Aluminum Structures.

This test method is not to be considered as a wind design standard. It is a structural capacity test to determine the ability of a panel system (including attachments) to resist uniform static pressure. Actual wind pressure is nonuniform and dynamic. These uniform static test results should be used in conjunction with commonly recognized wind design standards, and will yield highly conservative results.

When additional fasteners are installed across panel flats at eaves, ridges, or reinforced end laps, the crosswise distortion is eliminated and *both flexural capacity and anchor-to-panel attachment strength can vary with the distance from such conditions.* This test procedure can be used to evaluate the strength of panels and attachments at any distance from end or edge perimeter conditions. The size of the specimen and limitations on air seals are designed to minimize any interference with the natural response of the panels under load.

1. Scope

1.1 This test method covers the evaluation of the structural performance of sheet metal panels and anchor-to-panel attachments for roof or siding systems under uniform static air pressure differences using a test chamber or support surface.

1.2 The provisions of this test method are applicable to standing seam, trapezoidal, ribbed, or corrugated metal panels in the range of thickness from 0.012 to 0.050-in. (0.3 to 1.3-mm) and apply to the evaluation of uniform pressure applied to single-skin construction or one sheet metal layer of multiple-skin construction. They do not cover requirements for the construction of a specimen to determine the load sharing that can occur with either composite or multiple-layer construction such as: *(1)* metal cladding over wood sheathing; or *(2)* field assemblies of insulation sandwiched between corrugated or formed metal panels.

1.3 Proper use of this test method requires knowledge of the principles of pressure and deflection measurement.

1.4 This test method describes optional apparatus and procedures for use in evaluating the structural performance of a given system for a range of support spacings or for confirming the structural performance of a specific installation.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 The text of this standard references notes and footnotes exclusive of those for tables and figures. These notes and footnotes provide explanatory material and shall not be considered as requirements of the standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements, see Section 7.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products

2.2 *Aluminum Association Standard:*[3]

Aluminum Formed-Sheet Building Sheathing Design Guide, Appendix B of *Specifications for Aluminum Structures*, Latest Edition

2.3 *AISI Standard:*[4]

Specification for the Design of Cold-Formed Steel Structural Members, Latest Edition

2.4 *Other Document:*[5]

ASCE 7 (Formerly ANSI A58.1) Minimum Design Loads for Buildings and Other Structures

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *anchor, n*—a fastener, bolt, screw, or formed device such as a clip that connects panels to the support structure.

3.1.2 *anchor failure, n*—any failure at the anchor device, including separation of the device from the panel, of the device itself, or of the connection to the structural support.

3.1.3 *crosswise restraint, n*—any attachment in the flat of a panel between structural elements that controls or limits pan distortion under pressure.

3.1.4 *failure, n*—fracture or disengagement of any of the components where the system is no longer capable of sustaining load, or the system no longer functions as a weathertight membrane.

3.1.5 *interior support, n*—any support other than those at either extreme in a series of supports for a continuous panel.

3.1.6 *pan distortion, n*—displacement under load of normally flat portions of a panel profile normal to the plane of the roof or wall surface.

3.1.7 *panel deflection, n*—displacement under load measured normal to the plane of the roof or wall surface of a longitudinal structural element as measured from a straight line between structural supports.

3.1.8 *permanent deformation, n*—the permanent displacement in any direction from an original position that remains after an applied load has been removed.[6]

3.1.9 *reference zero load, n*—nominal pressure applied to a specimen to provide a reference position free of variations from internal stresses or friction within the system assembly.

3.1.10 *rib spread, n*—panel distortion under load at the base of a rib or standing seam as measured crosswise to the rib in the plane of the roof or wall surface.

3.1.11 *span length, n*—the center-to-center distance between anchors or supports measured parallel to the longitudinal axis of the panel.

3.1.12 *specimen, n*—the entire assembled unit submitted for testing, as described in Section 8.

3.1.13 *specimen length, n*—the distance from center to center of the end supports; the sum of individual span lengths.

3.1.14 *structural element, n*—the width of a panel profile as measured between center lines of repeating longitudinal stiffeners for continuously supported panels in a positive load test or the width between anchor attachments to repeating stiffener elements in a negative load test.

3.1.15 *test load, n*—the difference in static air pressure (positive or negative) between the inside and outside face of the specimen, expressed in pounds-force per square foot (lbf/ft^2) or pascals (Pa).

3.1.16 *test panel length, n*—specimen length plus overhangs.

3.1.17 *ultimate load, n*—the difference in static air pressure (positive or negative) at which failure of the specimen occurs, expressed in pounds-force per square foot (lbf/ft^2) or pascals (Pa).

3.1.18 *unlatching failure, n*—disengagement of a panel seam or anchor that occurs in an unloaded assembly due to permanent set or distortion that occurred under a previous load condition.[7]

3.1.19 *yield load, n*—that pressure at which deflection increases are no longer proportional to the increase in pressure. Yielding is not failure.[8]

3.1.20 *zero load, n*—the absence of air pressure difference across the specimen.

4. Summary of Test Method

4.1 This test method consists of the following: (*1*) sealing the test specimen into or against one face of a test chamber; (*2*) supplying air to, or exhausting air from, the chamber at the rate required to maintain the test pressure difference across the specimen; and (*3*) observing, measuring, and recording the deflection, deformations, and nature of any failures of principal or critical elements of the panel profile or members of the anchor system.

4.2 The increments of load application shall be chosen such that a sufficient number of readings will be obtained to determine the load deformation curve of the system.

4.3 End and edge restraint shall be representative of field conditions, and the unit shall contain sufficient individual components to minimize the effect of variations in material and workmanship.

5. Significance and Use

5.1 This test method provides a standard procedure to evaluate or confirm structural performance under uniform static air pressure difference. This procedure is intended to represent the effects of uniform loads on exterior building surface elements.

5.2 It is also permissible to develop data for load-span tables by interpolating between the test results at different spans.

NOTE 1—When applying the results of tests to determine allowable design loads by application of a factor of safety, bear in mind that the performance of a wall or roof and its components, or both, can be a function of fabrication, installation, and adjustment. The specimen must represent the actual structure closely. In service, the performance can also depend on the rigidity of supporting construction and on the resistance of components to deterioration by various causes, to vibration, to thermal expansion and contraction, and so forth.

6. Apparatus

6.1 The description of apparatus is general in nature; any equipment capable of performing the test procedure within the allowable tolerances is permitted. Major components are shown in Fig. 1.

6.2 *Test Chamber*—A test chamber, air bag, or box with an opening, a removable mounting panel, or one open surface in which or against which the specimen is installed. Provide at least two static pressure taps located at diagonally opposite corners to measure the chamber pressure such that the reading

PLAN VIEW

SECTION AA – PARALLEL TO PANEL LENGTH
(Reference Paragraph 8.3)

SECTION CROSSWISE TO PANEL LENGTH
(Reference Paragraph 8.2)

A – Test Panels.
B – Anchors.
C – Crosswise supports or purlins.
D – Flexible end seal.
E – Structural element of panel.
F – Pressure or vacuum chamber.
M – Manometer locations.
P – Air supply or exhaust.
S – Flexible side seal.

FIG. 1 Schematic of Test Apparatus

is unaffected by the velocity of the air supply to or from the chamber or any other air movement. The air supply opening into the chamber shall be arranged so that the air does not impinge directly on the test specimen with any significant velocity. A means of access into the chamber to facilitate adjustments and observations after the specimen has been installed is optional.

NOTE 2—The test chamber or the specimen mounting frame, or both, must not deflect under the test load in such a manner that the performance of the specimen will be affected. In general, select anchor support members sufficiently rigid that deflection under the test load will be negligible. It is desirable to be able to observe the fit of the plastic film against the specimen as well as the metal surface. When the specimen is tested with plastic film on either side, it is recommended that windows, lighting, or other methods be used to allow observation of the opposite side.

6.3 *Air System*—A compressed air supply, an exhaust system, or controllable blower is to be provided to develop the required air pressure difference across the specimen. The system shall maintain an essentially constant air pressure difference for the required test period.

NOTE 3—It is convenient to use a reversible blower or separate pressure and exhaust systems to provide the required air pressure difference so that different test specimens can be tested for the effect of positive pressure or the effect of suction (negative pressure) without reversing the position of the test specimen. The use of the same specimen for both positive and

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[8] It is often impractical to take direct measurements on individual elements in an assembly of components. Readings made on a panel surface opposite an anchor clip include deflection of non-axial loads in the anchor base and panel profile as well as any slippage that occurs in the panel connection or between segments of a multiple-piece clip. They may decrease with increasing pressure and produce a bi-lineal curve. Subsequent small-scale tests may be required to determine whether nonlinear deflection readings represent tolerable distortions that do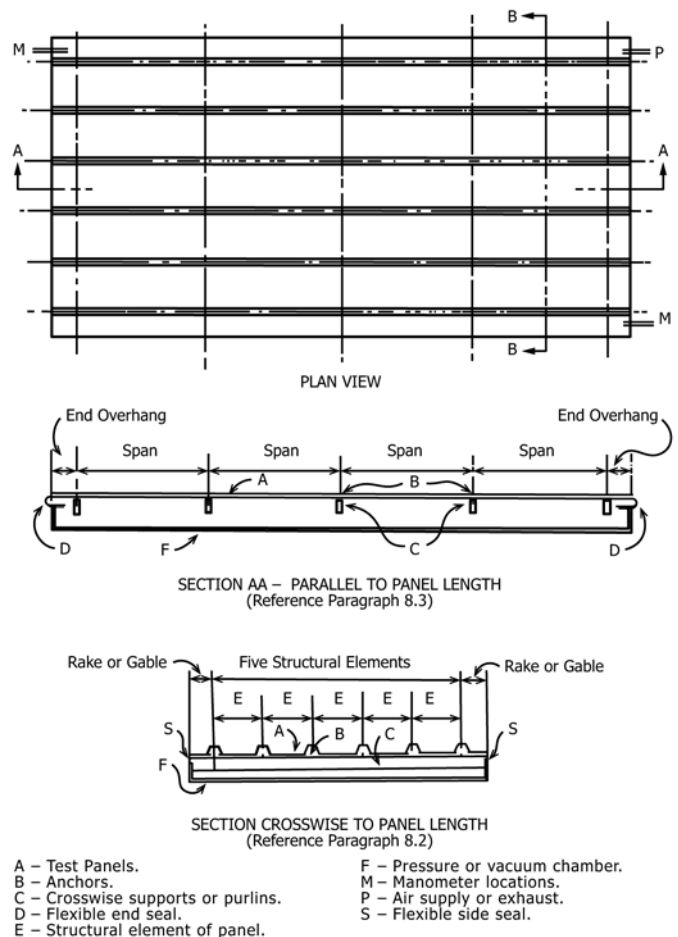 not interfere with long-term anchor performance.