Designation: E330 – 02

Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference[1]

This standard is issued under the fixed designation E330; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method describes the determination of the structural performance of exterior windows, doors, skylights, and curtain walls under uniform static air pressure differences, using a test chamber. This test method is applicable to curtain wall assemblies including, but not limited to, metal, glass, masonry, and stone components.

1.2 This test method is intended only for evaluating the structural performance associated with the specified test specimen and not the structural performance of adjacent construction.

1.3 The proper use of this test method requires a knowledge of the principles of pressure and deflection measurement.

1.4 This test method describes the apparatus and the procedure to be used for applying uniformly distributed test loads to a specimen.

1.4.1 Procedure A (see 11.2) shall be used when a load-deflection curve is not required.

1.4.2 Procedure B (see 11.3) shall be used when a load-deflection curve is required.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *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 and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see Section 7.

1.7 The text of this standard references notes and footnotes which provide explanatory materials. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

2. Referenced Documents [2]

2.1 *ASTM Standards:*[3]

E631 Terminology of Building Constructions

E997 Test Method for Structural Performance of Glass in Exterior Windows, Curtain Walls, and Doors Under the Influence of Uniform Static Loads by Destructive Methods

E998 Test Method for Structural Performance of Glass in Windows, Curtain Walls, and Doors Under the Influence of Uniform Static Loads by Nondestructive Method

E1233 Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Cyclic Air Pressure Differential

E1300 Practice for Determining Load Resistance of Glass in Buildings

E1886 Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials

E1996 Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

2.2 *ASCE Standard:*

ASCE 7 Minimum Design Loads for Buildings and Other Structures[4]

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology E631, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *design wind load*—the uniform static air pressure differences, inward and outward, for which the specimen

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.51 on Performance of Windows, Doors, Skylights and Curtain Walls.

Current edition approved Nov. 10, 2002. Published November 2002. Originally approved in 1967. Last previous edition approved in 1997 as E330 – 97$^{\varepsilon 1}$. DOI: 10.1520/E0330-02.

[2] Additional information on curtain wall assemblies can be obtained from the American Architectural Manufacturers' Association, 1827 Walden Office Square, Suite 550, Schaumburg, IL 60173.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.asce.org.

would be designed under service load conditions using conventional wind engineering specifications and concepts, expressed in pascals (or pounds-force per square foot). This pressure is determined by either analytical or wind-tunnel procedures (such as are specified in ASCE 7).

3.2.2 *permanent deformation*, *n*—the displacement or change in dimension of the specimen after the applied load has been removed and the specimen has relaxed for the specified period of time.

3.2.3 *proof load*—a test load multiplied by a factor of safety.

3.2.4 *stick system*, *n*—a curtain wall assembly composed of individually framed continuous members, vertical mullions, and horizontal rails that are installed in a sequential, piece-by-piece process. The completed system is assembled entirely in the field.

3.2.5 *structural distress*—a change in condition of the specimen indicative of deterioration or incipient failure, such as cracking, local yielding, fastener loosening, or loss of adhesive bond.

3.2.6 *test load*—the specified difference in static air pressure (positive or negative) for which the specimen is to be tested, expressed in pascals (or pounds-force per square foot).

3.2.7 *test specimen*, *n*—the entire assembled unit submitted for test (as described in Section 8).

3.2.8 *unit/panel system*, *n*—a curtain wall assembly composed of pre-assembled groups of individual framing members. The completed system is designed to be modular, transportable, and installed as a finished assembly.

4. Summary of Test Method

4.1 This test method consists of sealing the test specimen into or against one face of a test chamber, supplying air to or exhausting air from the chamber according to a specific test loading program, at the rate required to maintain the test pressure difference across the specimen, and observing, measuring, and recording the deflection, deformations, and nature of any distress or failures of the specimen.

5. Significance and Use

5.1 This test method is a standard procedure for determining structural performance under uniform static air pressure difference. This typically is intended to represent the effects of a wind load on exterior building surface elements. The actual loading on building surfaces is quite complex, varying with wind direction, time, height above ground, building shape, terrain, surrounding structures, and other factors. The resistance of many windows, curtain walls, and door assemblies to wind loading is also complex and depends on the complete history of load, magnitude, duration, and repetition. These factors are discussed in ASCE 7 and in the literature **(1-8)**.[5]

5.2 Design wind velocities are selected for particular geographic locations and probabilities of occurrence based on data from wind velocity maps such as are provided in ASCE 7. These wind velocities are translated into uniform static air pressure differences and durations acting inward and outward. Complexities of wind pressures, as related to building design, wind intensity versus duration, frequency of occurrence, and other factors must be considered. Superimposed on sustained winds are gusting winds which, for short periods of time from a fraction of a second to a few seconds, are capable of moving at considerably higher velocities than the sustained winds. The analytical procedures in ASCE 7, wind tunnel studies, computer simulations, and model analyses are helpful in determining the appropriate design wind loads on exterior surface elements of buildings. Generally, wind load durations obtained from ASCE 7 are 2 to 10 s and are dependent upon the specific time reference employed in determining the pressure coefficients.

5.3 Some materials have strength or deflection characteristics that are time dependent. Therefore, the duration of the applied test load may have a significant impact on the performance of materials used in the test specimen. The most common examples of materials with time-dependent response characteristics that are used are glass, plastics, and composites that employ plastics. For this reason, the strength of an assembly is tested for the actual time duration to which it would be exposed to a sustained or a gust load, or both, as discussed above. Generally, U.S. practice for wind load testing has been to require a minimum test period of 10 s for test loads equal to the design wind load and proof loads equal to 1.5 times the design wind load. Thus a safety factor is incorporated in the testing. With test loads for wind higher than those determined by ASCE 7 or of longer time duration than 10 s, the designer must consider what safety factors are appropriate. For test loads that represent design loads other than wind, such as snow load, consideration shall be given to establish an appropriate test period for both design and proof load testing.

5.4 This standard is not intended to account for the effect of windborne debris or cyclic loads. Consideration of cyclic air pressure differentials is addressed in Test Method E1233. Consideration of windborne debris in combination with cyclic air pressure differential representing extreme wind events is addressed in Test Method E1886 and Specification E1996.E1996

5.5 This test method is not intended for use in evaluating the structural adequacy of glass for a particular application. When the structural performance of glass is to be evaluated, the procedure described in Test Method E997 or E998 shall be used.

NOTE 1—In applying the results of tests by this test method, note that the performance of a wall or its components, or both, may be a function of fabrication, installation, and adjustment. The specimen may or may not truly represent every aspect of the actual structure. In service, the performance will also depend on the rigidity of supporting construction, temperature, and on the resistance of components to deterioration by various other causes, including vibration, thermal expansion and contraction, etc.

6. Apparatus

6.1 The description of the apparatus is general in nature; any equipment capable of performing the test procedure within the allowable tolerances is permitted.

6.2 *Major Components* (see Fig. 1):

[5] The boldface numbers in parentheses refer to the list of references appended to this test method.

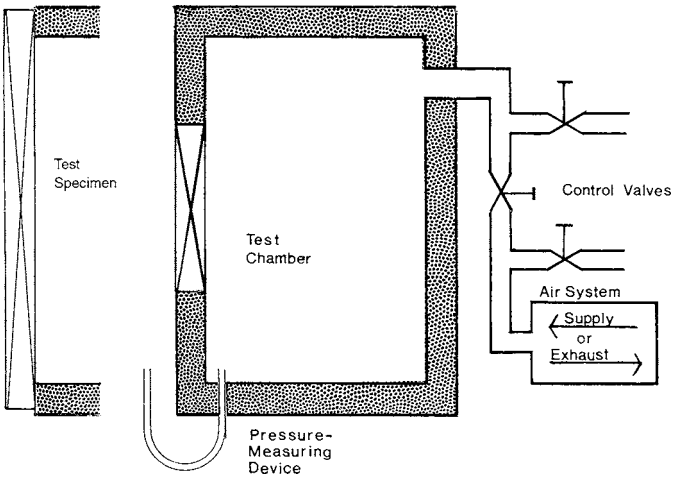

FIG. 1 General Arrangement of Testing Apparatus

6.2.1 *Test Chamber*, or a box with an opening, a removable mounting panel, or one open side in which or against which the specimen is installed. Provide a static pressure tap to measure the pressure difference across the test specimen. Locate the tap so that the reading is unaffected by the velocity of air supplied to or from the chamber or by any other air movements. 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 shall be provided to facilitate test specimen adjustments and observations. 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.

6.2.2 *Air System*, a controllable blower, a compressed-air supply, an exhaust system, or reversible controllable blower designed to provide the required maximum air-pressure difference across the specimen. The system shall provide an essentially constant air-pressure difference for the required test period.

NOTE 2—It is convenient to use a reversible blower or a separate pressure and exhaust system to provide the required air-pressure difference so that the test specimen can be tested for the effect of wind blowing against the wall (positive pressure) or for the effect of suction on the lee side of the building (negative pressure) without removing, reversing, and reinstalling the test specimen. If an adequate air supply is available, a completely airtight seal need not be provided around the perimeter of the test specimen and the mounting panel, although it is preferable. However, substantial air leakage will require an air supply of much greater capacity to maintain the required pressure differences.

6.2.3 *Pressure-Measuring Apparatus*, to measure the test pressure difference within a tolerance of ±2 % or ±2.5 Pa (±0.01 in. of water column), whichever is greater.

6.2.4 *Deflection-Measuring System*, to measure deflections within a tolerance of ±0.25 mm (±0.01 in.).

6.2.4.1 For Procedure A, any locations at which deflections are to be measured shall be stated by the specifier.

6.2.4.2 For Procedure B, maximum and end deflections of at least one of each type of principal member not directly and continuously supported by surrounding construction shall be measured. Additional locations for deflection measurements, if required, shall be stated by the specifier.

6.2.4.3 When deflections are to be measured, the deflection gages shall be installed so that the deflections of the components can be measured without being influenced by possible movements of, or movements within, the specimen or member supports.

6.2.4.4 For proof load tests, permanent deformation can be determined by the use of a straightedge-type gage applied to the members after preloading and again after the test load has been removed.

7. Hazards

7.1 Take proper precautions to protect the observers in the event of any failure. Considerable energy and hazard are involved at the pressures used in this test method. (**Warning—**At the pressure used in this test method, considerable hazards are involved. Do not permit personnel in negative pressure chambers during tests.)

8. Test Specimens

8.1 Curtain wall test specimens shall be of sufficient size and configuration to determine the performance of all typical parts of the system and to provide full loading on each typical vertical and horizontal framing member, including building corner details and end joints, if applicable. For multistory systems, the specimen height shall not be less than two full building stories plus the height necessary to include at least one full horizontal joint accommodating vertical expansion. If water testing is to be performed on the test specimens, at least one full horizontal joint accommodating vertical expansion shall be included and located in the bottom third of the specimen. The specimen shall include all typical expansion joints, connections, anchorages, and supporting elements including those at the top, bottom, and both sides of the specimen. Where the largest system or building wall is smaller than that required herein, the largest system or full size building wall shall be tested. (See Figs. 2 and 3 for optional specimen configurations.)

8.1.1 All parts of the curtain wall test specimen shall be full size, using the same materials, details and methods of construction, and anchorage as used on the actual building.

8.1.2 Conditions of structural support shall simulate, as accurately as possible, the structural conditions of the actual building. Separate tests of anchorage systems using the actual anchor substrates shall be conducted when specified.

8.2 A window, door, or other wall component test specimen shall consist of the entire assembled unit, including frame and anchorage as supplied by the manufacturer for installation in the building, or as set forth in a referenced specification, if applicable.

8.2.1 If only one specimen is to be tested, the selection shall be determined by the specifying authority.

NOTE 3—Since performance is likely to be a function of size and geometry, select specimens covering the range of sizes to be used in a building. In general, it is recommended that the largest size or most heavily or critically loaded of a particular design, type, construction, or configuration be tested. It is also recommended that the largest lite or panel in a system or building be used at each side of a horizontal or vertical framing member. The glass in a specimen should be of the same thickness and heat-treatment condition as to be used in the system or