Designation: E 1233 – 00

Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Cyclic Air Pressure Differential[1]

This standard is issued under the fixed designation E 1233; 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.

1. Scope

1.1 This test method describes the determination of the structural performance of exterior windows, curtain walls, and doors under cyclic air pressure differential, using a test chamber. This test method is applicable to all 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 Procedure A shall be used for life cycle test loads.

1.4 Procedure B shall be used for wind event test loads.

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. Specific hazard statements are given in Section 7.*

2. Referenced Documents [2]

2.1 *ASTM Standards:*

E 330 Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference[3]

E 631 Terminology of Building Constructions[3]

E 997 Standard Test Method for Structural Performance of Glass in Exterior Windows, Curtain Walls, and Doors Under the Influence of Uniform Static Loads by Destructive Method[3]

E 998 Standard Test Method for Structural Performance of Glass in Windows, Curtain Walls, and Doors Under the Influence of Uniform Static Loads by Nondestructive Method[3]

E 1886 Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials[3]

E 1996 Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Wind Borne Debris in Hurricanes[3]

2.2 *ASCE Standard:*[4]

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

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology E 631, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *design wind load*, *n*—the uniform static air pressure difference, inward or outward, for which the specimen 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 *one cycle*, *n*—beginning at a specified air pressure differential, the application of positive (negative) pressure to achieve another specified air pressure differential and returning to the initial specified air pressure differential.

3.2.3 *permanent deformation*, *n*—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.

3.2.4 *positive (negative) cyclic test load*, *n*—the specified differential in static air pressure, creating an inward (outward) loading, for which the specimen is to be tested under repeated conditions, expressed in pascals (or pounds-force per square foot).

3.2.5 *positive (negative) maximum test load*, *n*—the specified differential in static air pressure, creating an inward

[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 Component Performance of Windows, Curtain Walls, and Doors.

Current edition approved June 10, 2000. Published August 2000. Originally published as E 1233 – 88. Last previous edition E 1233 – 97.

[2] Additional information on curtain wall assemblies can be obtained from the American Architectural Manufacturers' Association, 1827 Walden Office Square, Suite 104, Schaumburg, IL 60173.

[3] *Annual Book of ASTM Standards*, Vol 04.11.

[4] Available from the American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191.

(outward) load, for which the specimen is to be tested for required minimum ultimate strength, expressed in pascals (or pounds-force per square foot).

3.2.6 *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.

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

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

3.2.9 *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 in accordance with a specific test loading program at the rate required to maintain the test pressure differential across the specimen, and observing, measuring, and recording the deflection, deformations, and nature of any structural distress or failures of the specimen.

4.2 The test loading program calls for the application of a specified spectrum of pressure cycles followed by the application of positive and then negative maximum test loads. The specifier must provide the information required in Section 10.

5. Significance and Use

5.1 This test method is a standard procedure for determining structural performance under cyclic air pressure differential. This typically is intended to represent the long-term effects of repeated applications of wind load on exterior building surface elements or those loads that may be experienced during a hurricane or other extreme wind event. This test method is intended to be used for installations of window, curtain wall, and door assemblies for which the effects of cyclic or repeated loads may be significant factors in the in-service structural performance of the system and for which such effects cannot be determined by testing under a single application of uniform static air pressure. This standard is not intended to account for the effect of windborne debris. This test method is considered appropriate for testing unique constructions or for testing systems that have insufficient in-service records to establish their performance under cyclic loading.

5.1.1 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 window, curtain wall, 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 **(1-12)**[5].

5.2 This test method is not intended for use in evaluating the adequacy of glass for a particular application. When the structural performance of glass is to be evaluated, the procedure described in Standard Test Method E 997 or E 998 shall be used.

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

5.4 Two types of cyclic air pressure differentials are defined: (Procedure A) Life cycle load (X1.1) and (Procedure B) Wind event load (X1.2). When testing under uniform static air pressure to establish structural performance, including performance under proof load, Standard Test Method E 330 applies. Consideration of windborne debris in combination with cyclic air pressure differential representing extreme wind events is addressed in Standard Test Method E 1886 and Standard Specification E 1996.

5.5 Typical practice in the United States for the design and testing of exterior windows, curtain walls, and doors has been to consider only a one-time application of design wind load, increased by an appropriate factor of safety. This design wind load is based on wind velocities with actual average probabilities of occurrence of once in the design life of the structure. The actual in-field performance of such assemblies, however, is dependent on many complex factors, and there exists significant classes of applications where the effects of repeated or cyclic wind loading will be the dominating factor in the actual structural performance, even though the magnitudes of such cyclic loads may be substantially lower than the peak load to which the assembly will be subjected during its design life. Examples of assemblies for which the effects of cyclic loading may be significant are included in Appendix X2.

5.5.1 When cyclic load effects are significant, the actual in-field performance of the assembly will depend on the complete load history to which the assembly is subjected. The history includes variable sustained loads as well as gusts, which occur at varying frequencies and durations. Such load histories are not deterministic, requiring the specifier to resort to a probabilistic approach for test parameters. The resistance of an assembly to cyclic loading is similarly complex. When available, endurance curves (stress/number *(S/N)* curves) can be used to estimate the fatigue resistance of a particular material. A major uncertainty in applying these data, however, is that the stress in an element induced by a unit pressure load is usually not known a priori. The problem is further complicated by the fact that the load to which the in situ assembly is subjected is not a repetitive load of given magnitude but one that varies in frequency, duration, and magnitude such as loads associated with a wind event.

[5] The boldface numbers in parentheses refers to the list of references at the end of this test method.