



Standard Test Methods for Performance of Glass in Permanent Glass Railing Systems, Guards, and Balustrades¹

This standard is issued under the fixed designation E 2353; 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 These test methods describe procedures to be followed in testing the performance of glass in permanent railing systems, guards and balustrades installed in and for assembly, commercial, educational, industrial, institutional, stadiums, recreational, and residential buildings.

1.2 These test methods are applicable to such railing, guard, and balustrade systems having glass as the major structural component or the infill panel

1.3 These test methods can be used to determine whether permanent rails, guards and balustrades having a glass component comply with anticipated performance requirements of the applicable specifications, codes, and standards.

1.4 Specifically, these test methods cover procedures for determining the static strength, impact performance, and post breakage retention characteristics of railing systems, guards, and balustrades with a glass component installed in one, two, three and four side support systems that are fastened to concrete, masonry, wood, and metal as well as related products.

1.5 No consideration is given in these test methods to any possible deterioration of the railing, guard, or balustrade system or their connections and fasteners as resulting from adverse environmental or in-service conditions. The performance of special tests covering this aspect may be desirable.

1.6 These test methods are limited to the application of concentrated and linear loads and impact resistance described herein. Whenever uniformly distributed loads are to be resisted by a railing system, guard, or balustrade in accordance with governing specifications, codes and standards, the effects of such loads on the member stresses shall be determined by calculation and the corresponding concentrated and linear loads shall be tested. Should computations make it possible to provide the needed information, testing can be employed for verification.

1.7 These test methods address the capability of glass rails, guards, and balustrades in one, two, three and four sided support systems to continue in their function as a barrier by remaining in the designed framing system after impact or glass

breakage. This specification does not address structural limitation of glass rails, guards, and balustrades or vehicular guards except when in the area of a pedestrian walkway.

1.8 All values are stated in SI units and are to be regarded as standard. Values given in parentheses are for information only. Certain values contained in reference documents cited and quoted herein may be stated in inch-pound units and must be converted by the user.

1.9 *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.*

2. Referenced Documents

2.1 ASTM Standards:²

E 631 Terminology of Building Constructions

E 935 Test Method for Performance of Permanent Metal Railing Systems and Rails for Buildings

E 1481 Terminology of Railing Systems and Rails for Buildings

E 2025 Test Method for Evaluating Fenestration Components and Assemblies for Resistance to Impact Energies

2.2 Other Standards:

ANSI Z97.1

16 CFR Part 1201 CPSC

3. Terminology

3.1 *Definitions*—General terms used in this standard test method are defined in Terminologies E 631 and E 1481. Terms common to this standard test method and referenced test methods are defined in the respective document unless defined herein.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *failure load*—a load, which, if placed upon a specimen or test piece, causes fracture of the glass.

3.2.2 *glazing retention*—the property of maintaining the glass or glazing material, post breakage, in a system, such that

¹ This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.56 on Performance of Railing Systems and Rails for Buildings.

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² 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.

the glass must be held in the framing system with no opening sufficient to pass a 75 mm (3 in.) solid steel sphere through the system using a horizontally applied force of 18 N (4.0 lb).

3.2.3 *guard rail system*—a protective railing system along the outer edges of locations of an accessible roof, balcony, landing, platform, or ramp, designed to minimize the probability of an accidental fall from the walking surface.

3.2.4 *interlayer*—a layer of material acting as an adhesive between lites of glazing, which adds additional performance attributes to the finished product; for example: impact resistance, solar control, and acoustical insulation.

3.2.5 *lite*—a term for a single pane (or piece) of glass or other glazing material.

3.2.6 *specifying authority*—the design professional responsible for interpreting applicable regulations of authorities having jurisdiction and considering appropriate site specific factors to determine the appropriate values used to calculate the specified design load and furnishing other information required for performance of specified materials.

3.2.7 *stile*—one of the upright structural members of a frame or a framework of bars.

4. Types

4.1 For purposes of these test methods, glass rails, guards, and balustrade assemblies are classified as types and are described in 4.1.1 through 4.1.5 and as shown in Figs. 1-8.

4.1.1 *Type I*—A glass rail, guard, or balustrade assembly with a single full view glazing material that is fully captured on all sides (that is, four side support).

4.1.2 *Type II*—A glass rail, guard, or balustrade assembly with a single full view or multiple units of glazing material that are captured on two sides (that is, two side support).

4.1.3 *Type III*—A glass rail, guard, or balustrade assembly with a single full view glazing material that is held in place by a point fixed glazing system, corner brackets or other non-continuous brace along a portion of the glazing.

4.1.4 *Type IV*—A glass rail, guard, or balustrade assembly with a single full view glazing material that is fully captured on three sides (that is, three side support).

4.1.5 *Type V*—A glass rail, guard, or balustrade assembly that has a single full view glazing material is fully captured on only one side (that is, single side support). A decorative or protective top rail (Fig. 7), or a handrail may or may not be attached to the glass (Fig. 8), but does not offer structural support to the system.

5. Summary of Test Method

5.1 The procedure consists of preparing a specimen in accordance with the manufacturers or designers specifications.

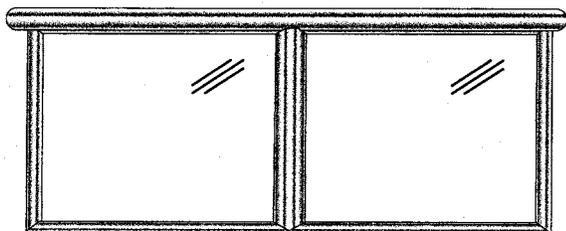


FIG. 1 Type I: Four-side Support—Infill

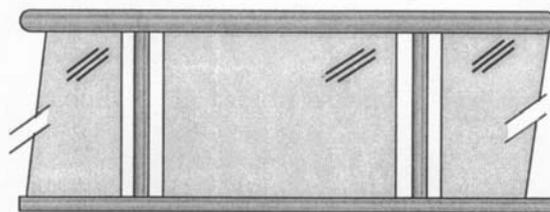


FIG. 2 Type II: Two-side Support—Single Lite Infill

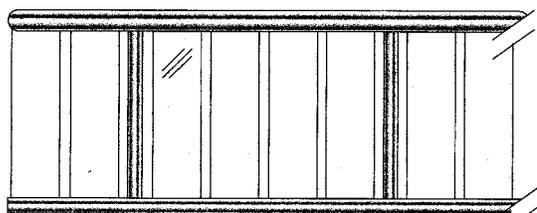


FIG. 3 Type II: Two-side Support—Multiple Lite Infill

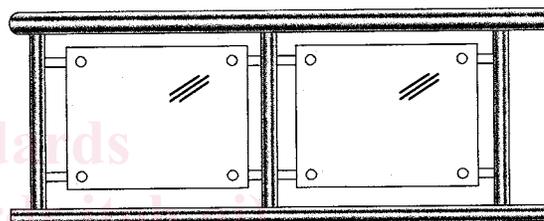


FIG. 4 Type III: Point Fixed Glazing System—Infill

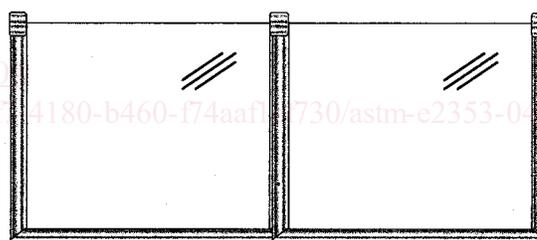


FIG. 5 Type IV: Three-side Support—Structural

The supporting and embedding materials shall be in accordance with intended use. The system or infill material is tested by applying loads and impacting the glazed portion of the assembly in the prescribed sequence, as outlined in Table 1. Asymmetrical systems shall be tested from both sides.

5.2 Acceptance criteria for performance levels shall be provided by the specifying authority. Adoption of performance criteria is a matter for authorities having specific jurisdiction.

6. Significance and Use

6.1 These test methods are intended to provide information from which applicable design data can be derived for the performance of glass in rails, guards and balustrade systems as infill panels that are fastened to concrete, masonry, wood and metal as well as related products, and to the performance of glass as the structural element of the rail, guard, or balustrade system.

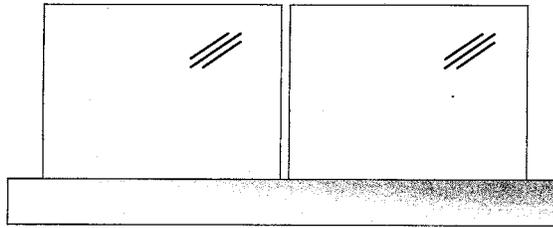


FIG. 6 Type V: One-side Support—Structural

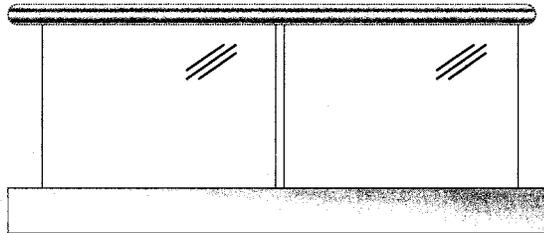


FIG. 7 Type V: One-side Support with Protective Top Rail—Structural

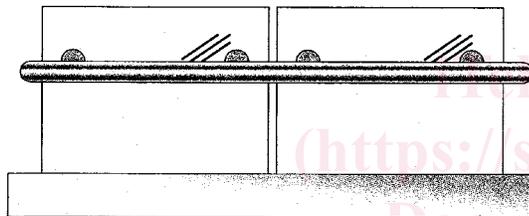


FIG. 8 Type V: One-side Support with Surface Attached / Bolted Handrail—Structural

TABLE 1 Test Summary

Type	Test 1: Frame ^A	Test 2: Glazing Infill Impact 1 ^B	Test 3: Glazing Infill Impact 2 ^C
I through V	A, B, and C	Shot Bag	Pendulum

^A Tests performed as outlined in Test Method E 935.

^B Tests performed as described in ANSI Z97.1 and 13.3 of this standard.

^C Tests performed as described in Test Method E 2025 and 13.4 of this standard.

7. Apparatus

7.1 *Instrumentation*, load and time-measuring devices with an accuracy of $\pm 2\%$ or the full scale shall be incorporated in the test setups. The scale ranges used shall assure that the performance levels are within an accuracy of $\pm 5\%$.

7.2 *Load Attachments*, brackets, fasteners, or other devices used in performing these tests shall be designed and attached so as to minimize their influence on the test results.

7.3 Shot Bag, Traction and Release System:

7.3.1 The test apparatus shall be capable of supporting a 45.4 kg (100 lb) shot bag and allowing unimpeded swinging of the shot bag from a drop height of 1220 mm (48 in.). The impactor system consists of the impactor, traction, release, and suspension devices as described in CPSC 16 CFR Part 1201.

7.3.2 The impactor shall consist of the leather bag described in Fig. 9, a commercial punching bag³ with its bladder left in place, or any other leather bag of nominally identical shape and size. The bag shall be filled with lead shot of 2.4 ± 0.1 mm diameter (nominal USA No. 7 1/2 or European No. 7 lead shot) and taped. After filling with lead shot, the top shall be either pulled over the metal sleeve and tied with a cord; or twisted around the threaded eyebolt shaft and tied below the metal sleeve, or both. To reduce bag damage during testing, the exterior of the leather bag surface shall be completely covered with glass filament reinforced pressure sensitive polyester adhesive tape,⁴ 12 to 15 mm (0.5 to 0.6 in.) in width and 0.15 mm (0.006 in.) thick. Tape the entire bag, using three (3) rolls or 165 m (180 yd) total length, and taping in a diagonal-overlapping manner. Tape the neck of the bag separately, with additional glass filament reinforced tape of the same kind. The total mass of the impactor assembly shall be 45.4 ± 0.1 kg (100 lb ± 4 oz), excluding traction system attachments.

7.3.3 A traction system shall be used which enables the impactor to be brought into its launch position. The launch position depends on the drop height selected. The traction cable is connected to the impactor traction system by a release mechanism, with provisions for rotating the impactor.

7.4 Pendulum Impactor:

7.4.1 Apparatus specified in Section 6 of Test Method E 2025 with the specifications noted in sections 6.4.2 and 6.4.3.

7.4.2 Impactor:

7.4.2.1 The impactor shall be a pendulum system made of steel and capable of delivering horizontal impacts of up to 100 J (74 ft-lbf). The striking end of the impactor shall have a removable steel hemispherical nose approximately 30 mm (1.25 in.) diameter.

7.4.3 Impact Nose:

7.4.3.1 The impact nose shall be 63 ± 5 mm (2.5 ± 0.2 in.) in diameter and the radial tolerance shall be within 3.2 mm ($1/8$ in.). The nose shall be made of steel. No chips, irregularities, or surface blemishes that may affect the outcome of the impact shall be present on the impact nose.

8. Hazards

8.1 Glass breakage may occur during the application of loads or forces required by the test methods. Take adequate precautions to protect personnel from broken glass.

8.2 Glazing anchorage, glass, and other test specimen components may suddenly fail when loads and forces are applied during these test methods, causing the assembly to rapidly move. Take adequate precautions to protect personnel from rapidly moving weights and test specimen components.

³ Such as 230 mm (9 in.) diameter by 360 mm (14 in.) high Everlast 4207 (raw, full grain 85-g (3-oz) cowhide) or Everlast 4212 (split 85-g (3-oz) cowhide) available from Everlast Sports, Bronx, New York, USA. These are tradenames. This information is given for the convenience of users and does not constitute an endorsement of any product named. Equivalent products may be used if they can be shown to lead to the same results.

⁴ Such as 3M No. 898 (a tradename), or equal. (See Footnote 2 regarding tradename).

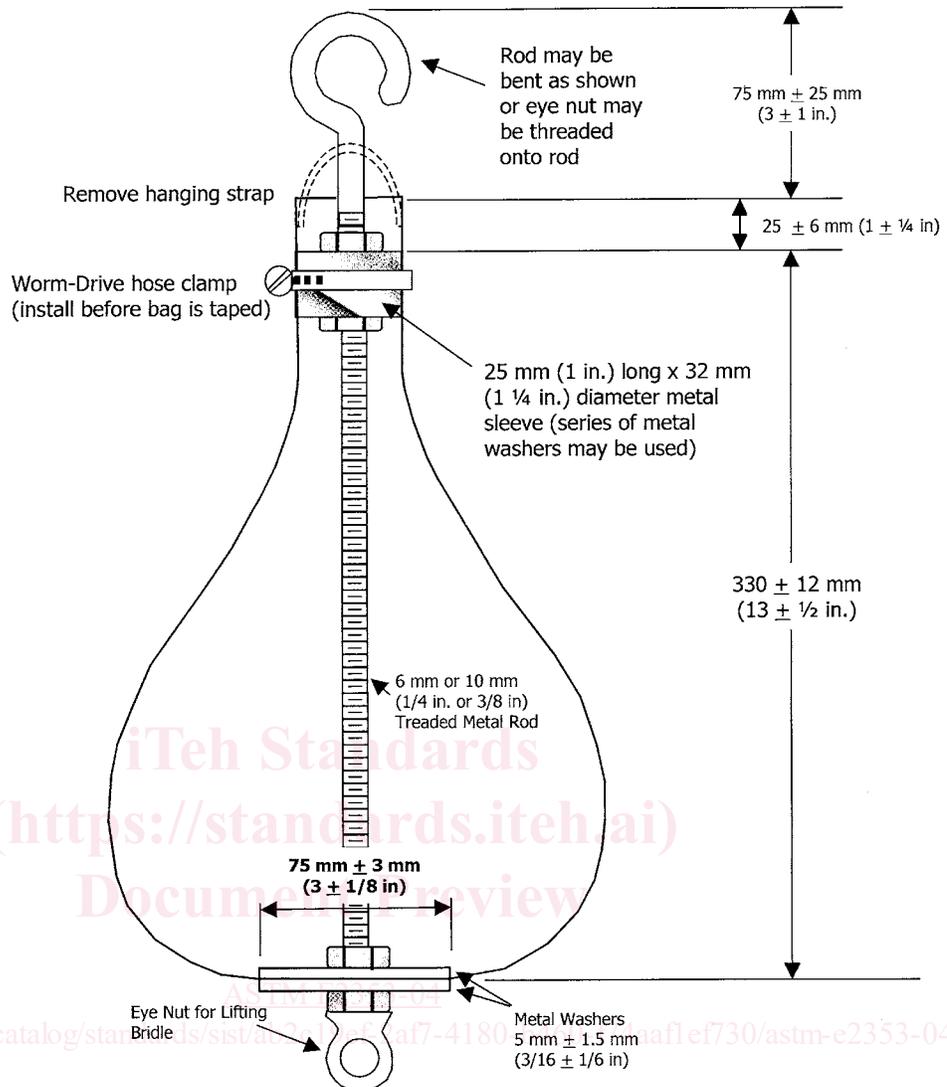


FIG. 9 Shot Bag Impactor

9. Test Selection, Sampling, Test Specimens, and Installation

9.1 Test Selection:

9.1.1 The only tests that need to be performed are those that are considered necessary to provide information required by the requesting party, testing agency and regulatory body involved.

9.2 Sampling:

9.2.1 Test a minimum of three representative replicate specimens of each type of system.

9.2.2 Sequential testing of the same specimen is permissible provided no breakage of any component occurs during the previously performed tests.

9.3 Test Specimens:

9.3.1 The specimen installation, including the post spacing, shall be the same as the actual field installation. The specimen

shall have a minimum of three posts or have a minimum linear length of 3 m (10 ft). Each unique attachment scenario is to be tested.

9.3.2 Multiple types of infill panels can be qualified within one test provided each panel is individually glazed into the system prior to the start of the test. No substitution of infill product is permitted once testing has commenced.

9.4 Installation:

9.4.1 Install the glass rail, guard, or balustrade system being tested in accordance with the manufacturers or designers specifications.

10. Preparation of Apparatus

10.1 Mount the glass rail, guard, or balustrade assembly in accordance with the manufacturers written installation instructions or as to be constructed.