Designation: E2353 – 16

Standard Test Methods for Performance of Glazing in Permanent Railing Systems, Guards, and Balustrades[1]

This standard is issued under the fixed designation E2353; 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 cover procedures to be followed in testing the performance of glazing in permanent railing systems, guards and balustrades including components such as rails and swing gates or other forms of required guardrail opening protection installed in and for assembly, commercial, educational, industrial, institutional, stadiums, recreational, and residential buildings and other structures such as towers or elevated platforms.

1.2 These test methods are applicable to such railing, guard, and balustrade systems having glass or other glazing materials as the major structural component or the infill panel including swing gates and other forms of guardrail protection.

1.3 These test methods can be used to determine whether permanent rails, guards and balustrades including components, having glass or other glazing material comply with requirements of performance specifications, codes, norms, and standards.

1.4 Specifically, these test methods cover procedures for determining the static strength, impact performance, and post-breakage characteristics of railing systems, guards, and balustrades, including a component with glass or other glazing material installed in one, two, three and four-side support systems fastened to concrete, masonry, wood, metal, and 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 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, norms, 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 or other glazing material supported by rails, guards, or balustrades, or both, 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 glazing breakage. These test methods do not address structural limitation of glazed or 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]

E329 Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

E631 Terminology of Building Constructions

E699 Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components

E935 Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings

E1481 Terminology of Railing Systems and Rails for Buildings

[1] These test methods are 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 Glass for Floors and Stairs.

Current edition approved Feb. 15, 2016. Published March 2016. Originally approved in 2004. Last previous edition approved in 2014 as E2353 – 14. DOI: 10.1520/E2353-16.

[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.

E2025 Test Method for Evaluating Fenestration Components and Assemblies for Resistance to Impact Energies (Withdrawn 2015)[3]

E2358 Specification for the Performance of Glass in Permanent Glass Railing Systems, Guards, and Balustrades

2.2 *Other Standards:*

16 CFR Part 1201 CPSC Safety Standard for Architectural Glazing Materials[4]

ANSI Z97.1 Standard Glazing Materials Used in Buildings[5]

3. Terminology

3.1 *Definitions*—General terms used in this test method are defined in Terminologies E631 and E1481. Terms common to this 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, n*—the loss of load carrying capacity or the inability to meet the required load carrying capacity specified in the applicable performance standard, depending on the purpose of the test.

3.2.2 *glazing retention, v*—the property of maintaining the glass or other glazing material, post breakage, in a system, such that the glass or other glazing material must be held in the framing system with no opening sufficient to pass a 76 mm (3 in.) solid steel sphere through the original plane of the glazing system within a ±15 degree slope using a horizontally applied force of 18 N (4.0 lb).

3.2.3 *glazing shard containment, n*—the property of maintaining the broken glass or glazing material in essentially one piece with no more than the equivalent weight of 6452 mm^2 (10 $in.^2$) of the original specimen detaching from the specimen.

3.2.4 *guardrail opening protection, n*—swing gates or other form of barrier to prevent unintended egress or fall through guardrail openings.

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

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

3.2.7 *specifying authority, n*—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.

3.2.8 *stile, n*—one of the upright structural members of a frame or a framework of bars.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from U.S. Consumer Product Safety Commission (CPSC), 4330 East West Hwy., Bethesda, MD 20814, http://www.cpsc.gov.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

4. Significance and Use

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

4.2 Specification E329 and Practice E699 are standards that assist the user of these test methods to apply appropriate procedures and methods to ensure a quality result is provided.

4.3 These test methods determine whether railing systems comply with requirements of the applicable performance specifications.

4.4 These test methods are intended for use in the buying and selling of railing systems and components according to performance specifications, for use in product development research, for use in quality assurance and manufacturing process control, for use in developing performance standards, and for use in field and laboratory compliance determination.

5. Types

5.1 For purposes of these test methods, rail, guard, and balustrade assemblies that incorporate glazing are classified as types and are described in 5.1.1 through 5.1.5 and as shown in Figs. 1-6. Each supported edge is indicated by a dashed line (---).

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

5.1.2 *Type II*—A glazed 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).

5.1.3 *Type III*—A glazed 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, edge clamping or other non-continuous brace along a portion of the glazing.

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

5.1.5 *Type V*—A glazed rail, guard, or balustrade assembly with a single full view glazing material that is fully captured on only one side (that is, single side support). A decorative or protective top rail (Fig. 5b), or a handrail may or may not be attached to the glass (Fig. 5c), but does not offer structural support to the system.

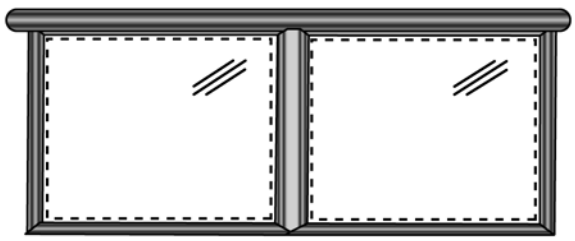


FIG. 1 Type I: Four-Side Support—Glazing as Infill

FIG. 2 a Type II: Two-Side Support—Single Lite Glazing as Infill

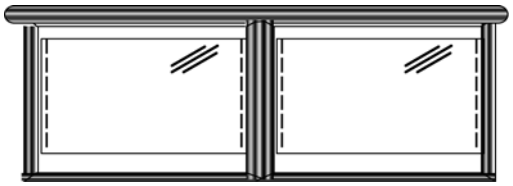


FIG. 2 b Type II: Two-Side Support—Single Lite Glazing as Infill *(continued)*

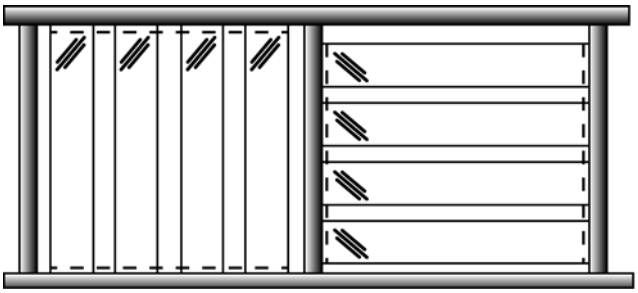


FIG. 2 c Type II: Two-Side Support—Multiple Lite Glazing as Infill *(continued)*

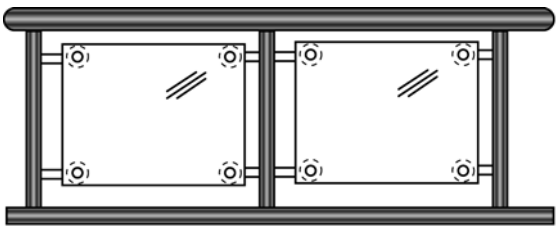


FIG. 3 a Type III: Point Fixed Glazing System—Glazing as Infill

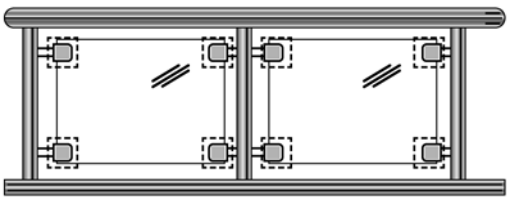


FIG. 3 b Type III: Edge Clamping Glazing System—Glazing as Infill *(continued)*

5.1.6 *Type VI*—A glass rail, guard, or balustrade assembly with a single full view glazing material that is point supported only (Fig. 6). A decorative or protective top rail may or may not be attached to the glass, but does not offer structural support to the system.

6. Summary of Test Method

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

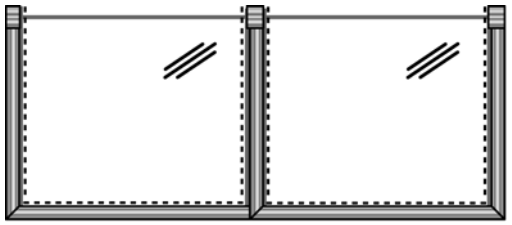


FIG. 4 Type IV: Three-Side Support—Glazing as Structural Member

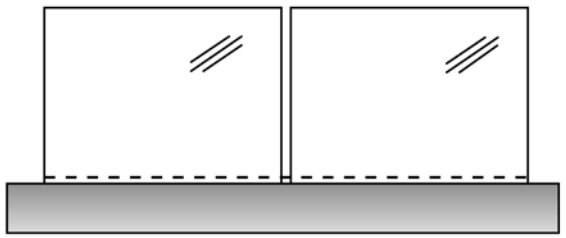


FIG. 5 a Type V: One-Side Support—Glazing as Structural Member

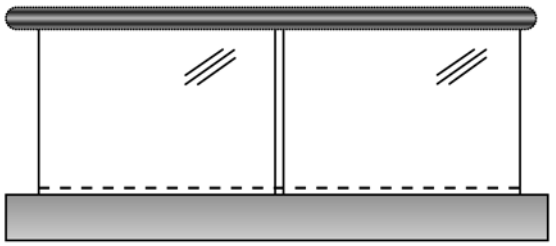


FIG. 5 b Type V: One-Side Support with Protective Top Rail—Glazing as Structural Member *(continued)*

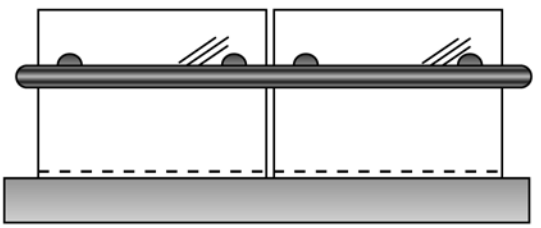


FIG. 5 c Type V: One-Side Support with Surface Attached / Bolted Handrail—Glazing as Structural Member *(continued)*

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.

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

7. Apparatus

7.1 *Instrumentation,* load and time-measuring devices with an accuracy of ±2 % of 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 ±5 %.

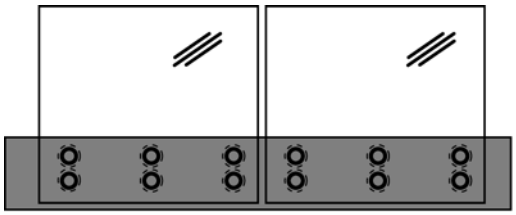


FIG. 6 Type VI: Point Supported Only—Glazing as Structural Member

TABLE 1 Test Summary

Type	Test 1: Frame[A]	Test 2: Glazing Infill Impact 1[B]	Test 3: Glazing Infill Impact 2[C]
	E935 Section	Shot Bag (Soft Body) Pendulum	Steel (Hard Body) Pendulum
I through IV	10.1, 10.5, & 10.6	13.3 Center	13.4
V and VI	10.1, 10.5, & 10.6	13.3 Top Edge	13.4

[A] Tests performed as outlined in Test Methods E935.
[B] Tests performed as described in ANSI Z97.1 and 13.3 of this test method.
[C] Tests performed as described in Test Method E2025 and 13.4 of this test method.

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. 7, a commercial punching bag[6] 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. 71/2 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,[7] 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 shall be 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 E2025 with the specifications noted in 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 (⅛ 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.

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

9.1 *Test Selection:*

9.1.1 Load test methods described in Section 12 for the uniform load test and the concentrated load test are selected based on the performance specification, testing agency and regulatory body involved. Glazing impact shall be conducted on all systems in accordance with Section 13. Selection of necessary tests are based on the performance level required as outlined in Specification E2358 Section 6 or the specifying authority.

9.2 *Sequence of Test Methods:*

9.2.1 Specimens tested for two or more of the loading conditions are subjected first to the in-fill load test, followed by the uniform load test, and then the concentrated load test and shot bag glazing impact test, sphere penetration evaluation, steel nose pendulum impact, and sphere penetration evaluation, in that order, unless directed otherwise by the performance specification.

9.3 *Sampling:*

9.3.1 A minimum of three representative replicate specimens of each type of system shall be tested.

[6] 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. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[7] Such as 3M No. 898 (a tradename), or equal. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

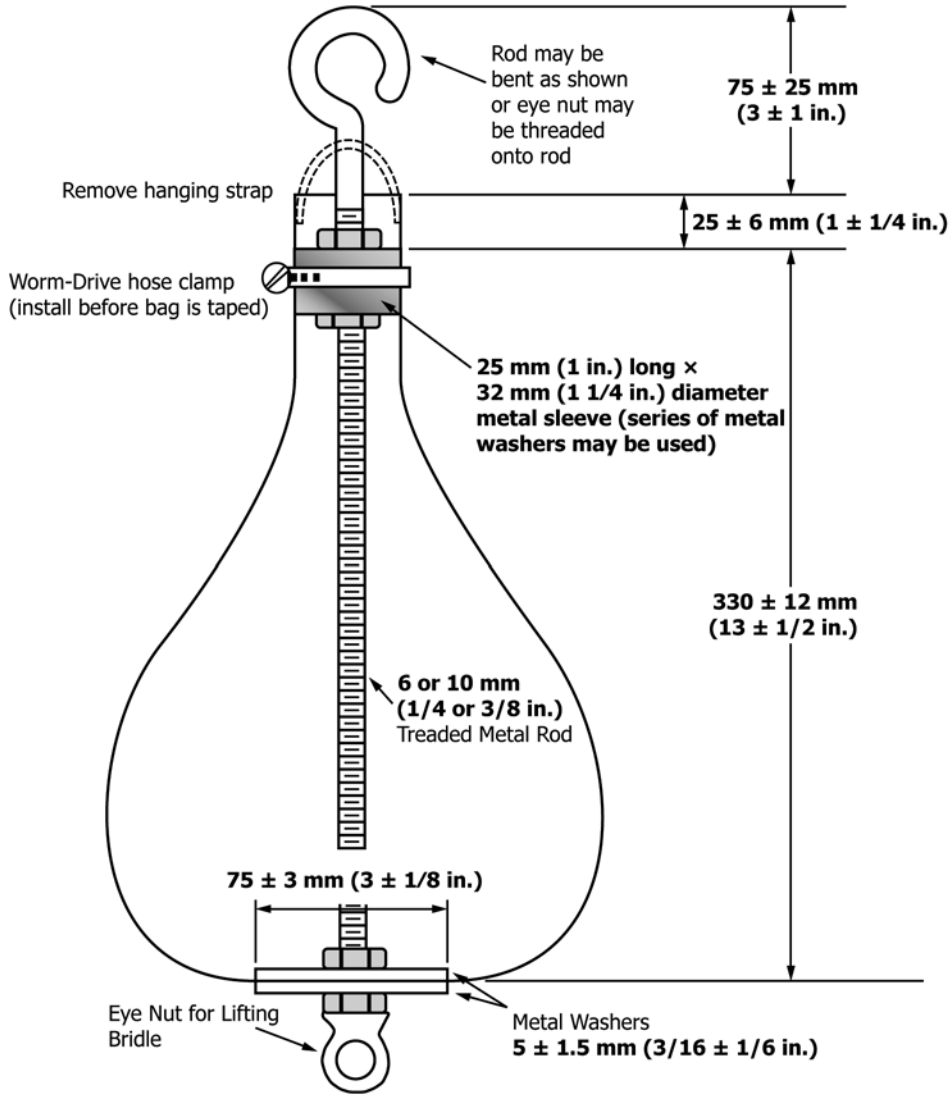


FIG. 7 Shot Bag Impactor

9.3.2 Sequential testing of the same specimen shall be permissible provided no breakage of any component occurs during the previously performed tests.

9.4 *Test Specimens:*

9.4.1 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 shall be tested.

9.4.2 Multiple types of infill panels shall 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 shall be permitted once testing has commenced.

9.5 *Installation:*

9.5.1 The glass rail, guard, or balustrade system being tested shall be installed in accordance with the manufacturers or designers specifications.

10. Preparation of Apparatus

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

10.2 Glazing shall be mounted so as to apply impact from the side of the upper floor level.

11. Conditioning

11.1 The specimens shall be conditioned to a uniform test temperature between 18 and 30°C (65 and 85°F) for at least 4 h with separation to permit free air circulation.

12. Procedure

12.1 *Glazing Evaluation:*

12.1.1 *Static Load Testing:*

12.1.1.1 Test loads shall be applied in both directions.

12.1.1.2 *Load Removal*—At the conclusion of each test, remove all loads before starting the next test.

12.1.1.3 Structural evaluation Test Methods E935 Sections 10 and 11 shall be performed at loads designated by the specifying authority.

12.1.1.4 For in-fill testing, use a bearing plate with appropriate cushioning between the plate and the glazing. The bearing plate should be 0.9 m^2 (1 ft^2).

12.1.1.5 Each load test to be performed on a new specimen or the undamaged specimen from the previously applied test.

12.1.1.6 Perform only one test per glazing infill type on each of the three specimens at the most critical point of the system.

12.2 *Shot Bag Impact Test:*

12.2.1 The Shot Bag Impact Test (see 13.3) shall be performed on a new specimen, or the same undamaged specimen from tests 12.1.

12.2.2 After shot bag impact and breakage, penetration of the solid sphere is to be determined (3.2.2).

12.3 *Pendulum Impact Test:*

12.3.1 The Pendulum Impact Test (see 13.4) shall be performed on a new specimen, or the same undamaged specimen from 12.1.

12.3.2 After pendulum impact, penetration of the solid sphere is to be determined (3.2.2).

13. Test Methods

13.1 *Static Loads*—Static loads shall be applied in accordance with Test Methods E935 as appropriate and unless specified differently in this test method.

13.2 For multiple balusters between stiles (posts) (see Fig. 2c, Type II); the specimen shall be impacted two times with the shot bag. The first impact shall be targeted to impact at the center of a baluster and the second impact shall be targeted to impact between two balusters.

13.3 *Shot Bag Impact Test:*

13.3.1 Any protective masking or decorative components shall be removed from the glazing material.

13.3.2 To position the impactor at the selected drop height, a traction force shall be applied to raise the impactor such that the axis of the impactor shall be aligned with the suspension cable, with the cable remaining taut. To ensure this, the top and bottom ends of the impactor shall be connected to the release device by a suitable link.

13.3.3 To reduce bag deformation during testing, the bag shall be rotated about the axis of its suspension device before each specimen or sample set, by no less than 30 degrees, and by no more than 90 degrees.

13.3.4 To reduce bag damage during testing, a thin homogeneous or non-woven plastic film no more than 0.13 mm (0.005 in.) thick or a loosely draped woven cloth towel weighing no more than 0.05 g/cm^2 (0.0113 $oz./in.^2$) shall be permitted to be suspended vertically from its top edge directly in front of the surface of the specimen at a distance no more than 10 mm (0.4 in.).

13.3.5 The impactor shall be suspended from an overhead support, located so when at rest it will, at its maximum diameter, be located no more than 12 mm (0.5 in.) from the surface of the specimen and no more than 50 mm (2 in.) from the impact location of the glazing infill specimen.

13.3.5.1 Raise the impactor to the required height (460, 1220, or 1525 mm (18, 48, or 60 in.)) and stabilize it. The suspension device shall be taut and the axes of the impactor and cable shall be aligned.

13.3.5.2 The impactor, stabilized in the launch position in a vertical plane normal to the test specimen, shall be released and falls without initial velocity or axial rotation.

13.3.5.3 If the glazing does not break, the impactor is to be raised to the next designated height and glazing impacted from the new height to obtain breakage. If breakage does not occur at the 1525 mm height, glass shall be broken with a center-punch in accordance to ANSI Z97.1. Glazings unable to be broken with a center punch and remaining completely in the frame after impact shall be recorded as intact.

13.3.6 *Impact Locations and Drop Heights:*

13.3.6.1 Type I, II, III and IV systems shall be impacted at the geometric center ±50 mm (2 in.) of the glazing infill. The impact drop heights progress from 460 mm to 1220 mm to 1525 mm.

13.3.6.2 Type V and VI shall be impacted at ±50 mm (2 in.) of the centerline of the specimen, no more than 200 mm (8 in.) from the top edge. Test specimens shall be impacted from a drop height of 1525 mm.

13.3.7 Each test specimen shall be inspected after each impact and report condition of specimen.

13.4 *Pendulum Impactor Test:*

13.4.1 Impact testing shall be performed using outlined apparatus in Section 7.4 of this test method with mounting and testing procedures as outlined in Test Method E2025 Sections 8 and 11 respectively.

13.4.2 Raise the impactor to the required height to deliver a 100 J (74 ft-lbf) impact at each designated location.

13.4.3 *Impact Location:*

13.4.3.1 For a continuous lite between support stiles, a total of three impacts shall be performed on the same lite of glass, impacting at the geometric center of the glazing and within 150 mm (6 in.) of adjacent corners as shown in Fig. 8.

13.4.3.2 If multiple balusters are used between support stiles made of a material other than glass, the pendulum impact shall be adjusted so as to impact the first baluster, the nearest point to geometric center staying within 76 mm (3 in.) of an edge, and last baluster between the stiles at the center of the middle baluster and within 150 mm (6 in.) of adjacent corners as shown in Fig. 9. Multiple impacts to a single baluster shall be permitted.

13.4.3.3 If infill balusters are single or multiple units installed in a manner in which they are at an angle to the top rail, glazing infill non-parallel to adjacent lites (Fig. 10), the pendulum impactor nose shall be positioned to impact the innermost location (furthest from the impactor) of the baluster. The impactor shall be positioned so the nose, at rest, is closest to the innermost point of the baluster without contacting any portion of the baluster itself. The impact locations shall be as described in 13.4.2 of this test method as appropriate for the glazing type.

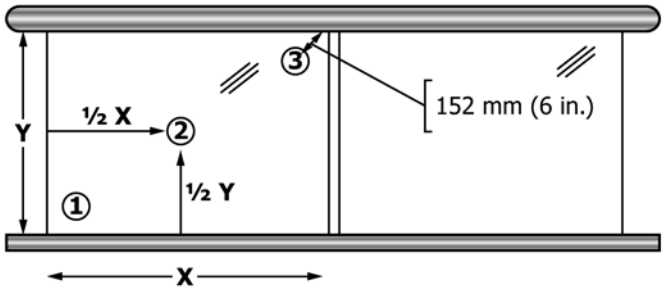


FIG. 8 Locations for Pendulum Impacts Single Lite Baluster

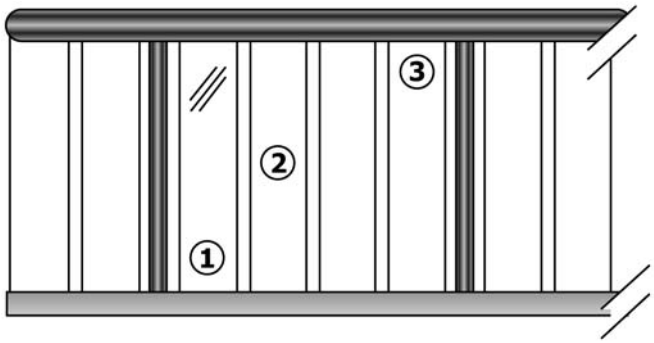


FIG. 9 Locations for Pendulum Impacts Multiple Balusters

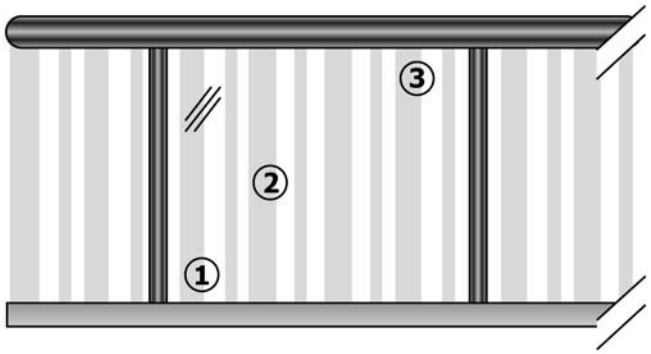


FIG. 10 Locations from Pendulum Impacts Multiple Balusters Non-parallel

14. Calculation or Interpretation of Results

14.1 Load deformation data for tests cited in 12.1.1.3 and 12.1.1.4 of this test method shall be calculated according to Section 12 of Test Methods E935.

14.2 Any glass fracture associated with tests performed under 12.1.1.3 and 12.1.1.4 shall constitute a failure.

14.3 Performance after impact as tested in 12.2 shall be classified in accordance with Table 2.

14.3.1 Retention of the product in the frame is based on the definition of glazing retention in 3.2.2 of this test method.

14.3.2 Containment of glazing shards is based on the definition of glazing shard retention in 3.2.2 of this test method.

14.3.3 Classification is assigned after loads have been released, impacts completed and sphere evaluation determined.

14.3.3.1 Sphere passing the original plane of the glazing more than ±15 degrees slope after shot bag or pendulum impact is to be classified as (3).

14.3.3.2 Glazing with separated shards greater than 6452 mm^2 (10 $in.^2$) when the sphere does not penetrate the original plane of the glazing ±15 degrees slope is to be classified as (3).

15. Report

15.1 The report shall contain a description of the results of the test(s) performed in accordance with these test methods.

15.2 The report shall also include at least the following:

15.2.1 Identification of the glass rail, guard, or balustrade assembly;

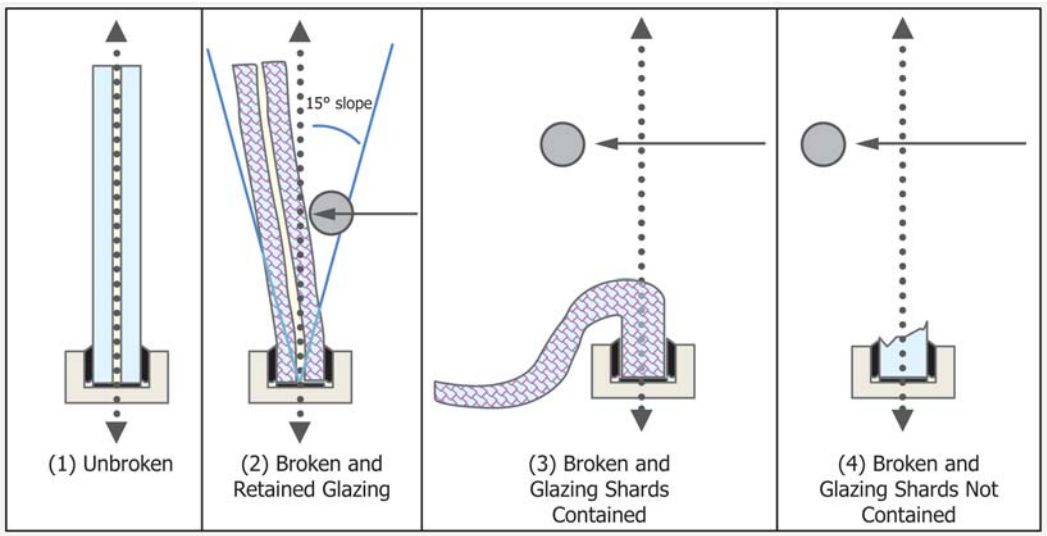
15.2.2 Detailed description of glazing materials including glass type, glass treatment, glass thickness, and component manufacturers and copy of the report certifying glazing test results in accordance with the test requirements of 14.1 and 14.2;

15.2.3 Bill of materials;

15.2.4 Assembly drawing with glazing details;

TABLE 2 Post Impact Classification

Classification Number	Description	Requirements
1	Glazing unbroken	Glazing completely retained in system and unbroken
2	Glazing broken and retained	No passage of 0.76 mm (3 in.) solid sphere
3	Glazing broken and shards contained	Glazing shards separated from system not greater than 6452 mm^2 (10 $in.^2$) of equivalent weight of original glazing specimen
4	Glazing broken and shards not contained	Glazing shards separated from system are greater than 6452 mm^2 (10 $in.^2$) of equivalent weight of original glazing specimen



Graphical Depiction of Glazing Classification

15.2.5 Performance level and load used;

15.2.6 Shot bag drop heights and location of impact;

15.2.7 Sphere penetration evaluation after shot bag impacts;

15.2.8 Pendulum impact location;

15.2.9 Sphere penetration evaluation after pendulum impacts;

15.2.10 Classification of post breakage performance;

15.2.11 A statement by test method as to the performance of the glass rail, guard or balustrade specimen(s);

15.2.12 A description of the method of installation or installation fastening; and

15.2.13 A description of the test methods used.

16. Precision and Bias

16.1 These test methods do not generate numerical values. They establish a pass/fail condition that cannot generate numerical values for precision and bias.

17. Keywords

17.1 balcony; balustrades; fall-out; flat glass; glass; glazing; guards; impact; laminated glass; rails; retention; safety; safety glazing; tempered glass

APPENDIX

(Nonmandatory Information)

X1. PERFORMANCE LEVELS

X1.1 The products evaluated by these test methods are potentially subjected to a wide variety of forces and impacts that could cause breakage and lead to the potential fall-out if the glazing vacates the frame. These test methods outline a test methodology that takes into account the various impacts from a sharp blow of a knee, a blunt object impact or a full body impact. Although not every form of impact and force can be accounted for in a test method, these test methods provide a means of establishing a level of retention and glazing shard containment that may help glazing in rails; guards and balustrades perform their intended function of protection and fall-out prevention.