Designation: E2353 – 21

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 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard. 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.10 *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]

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

E631 Terminology of Building Constructions

[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.

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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.

E699 Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured 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
E2358 Specification for Performance of Glazing in Permanent Railing Systems, Guards, and Balustrades

2.2 *Other Standards:*
16 CFR Part 1201 CPSC Safety Standard for Architectural Glazing Materials[3]
ANSI Z97.1 Standard Glazing Materials Used in Buildings[4]

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.

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 5.1.6 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

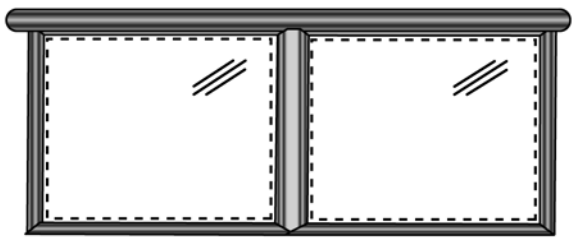

FIG. 1 Type I: Four-Side Support—Glazing as Infill

[3] Available from U.S. Consumer Product Safety Commission (CPSC), 4330 East West Hwy., Bethesda, MD 20814, http://www.cpsc.gov.
[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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

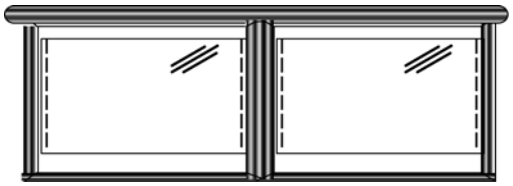

FIG. 2 b Type II: Two-Side Support—Single Lite Glazing as Infill *(continued)*

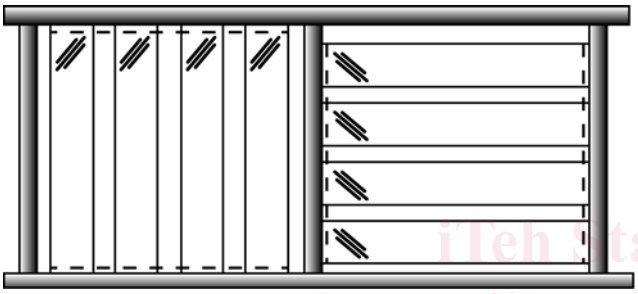

FIG. 2 c Type II: Two-Side Support—Multiple Lite Glazing as Infill *(continued)*

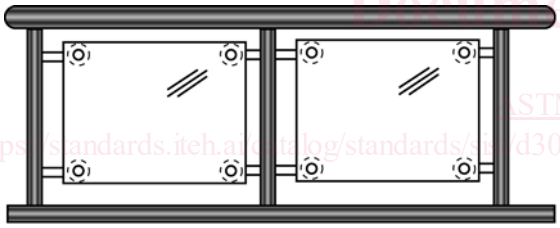

FIG. 3 a Type III: Point Fixed Glazing System—Glazing as Infill

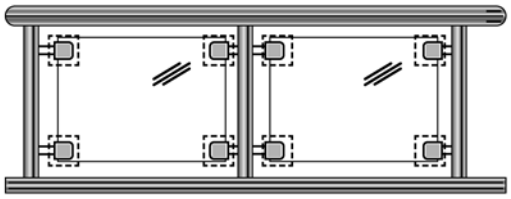

FIG. 3 b Type III: Edge Clamping Glazing System—Glazing as Infill *(continued)*

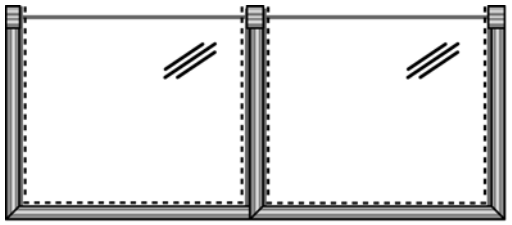

FIG. 4 Type IV: Three-Side Support—Glazing as Structural Member

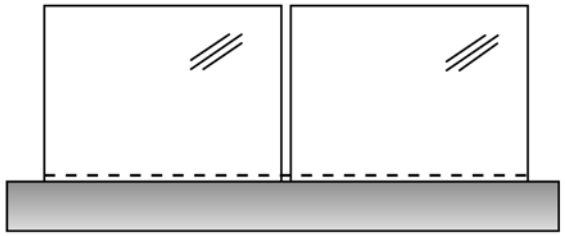

FIG. 5 a Type V: One-Side Support—Glazing as Structural Member

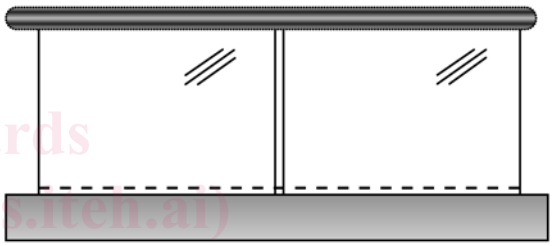

FIG. 5 b Type V: One-Side Support with Protective Top Rail—Glazing as Structural Member *(continued)*

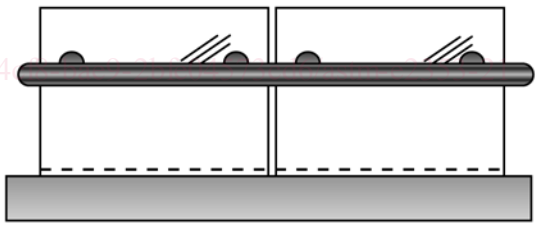

FIG. 5 c Type V: One-Side Support with Surface Attached / Bolted Handrail—Glazing as Structural Member *(continued)*

attached to the glass (Fig. 5c), but does not offer structural support to the system.

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. 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.

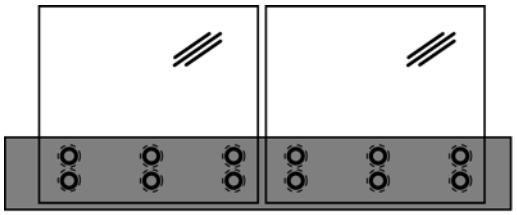

FIG. 6 Type VI: Point Supported Only—Glazing as Structural Member

TABLE 1 Test Summary

Type	Test 1: Frame[A]	Test 2: Glazing Infill Impact 1[B]	Test 3: Glazing Infill Impact 2[C]
	Section 12	Shot Bag (Soft Body) Pendulum	Steel (Hard Body) Pendulum
I through IV	12.2.4, 12.2.5, and 12.2.6	13.3 Center	13.4
V and VI	12.2.4, 12.2.5, and 12.2.6	13.3 Top Edge	13.4

[A] Tests performed as outlined in Section 12.
[B] Tests performed as described in ANSI Z97.1 and 13.3 of this test method.
[C] Tests performed as using impactor described in 7.4.

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 %.

7.2 *Assembly Support Fixture,* an assembly support fixture shall supply the rigidity normally provided to an assembly in a building by the ceiling, floor, and walls. The support fixture for the specimen shall consist of a vertical wall section constructed from nominal steel or 2 by 4 wood studs, 406 mm (16 in.) on center, with a rough opening of sufficient size to support the test specimen in accordance with the manufacturer specifications. The limiting deflection of the wall shall be L/175 (based on the anticipated loads).

7.3 *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.

7.4 *Shot Bag, Traction and Release System:*

7.4.1 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.

7.4.2 The impactor shall consist of the leather bag described in Fig. 7, a commercial punching bag[5] 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 mm ± 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,[6] 12 mm to 15 mm (0.5 in. 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 kg ± 0.1 kg (100 lb ± 4 oz), excluding traction system attachments.

7.4.3 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.

7.5 *Pendulum Impactor:*

7.5.1 Apparatus having a variable mass moving carriage (impact ram), supported by a suspension system of four cables, shall be used to supply the specified level of impact energy with the specifications noted in 7.6 and 7.7.

7.5.2 The impact device shall be a pendulum system with an impact ram capable of delivering the specified horizontal impact energy.

7.5.3 The mass of the (movable) suspension system shall not exceed 5 % of the mass of the impact ram, including impact ram nose, and shall not be included as part of the specified impact mass.

7.5.4 Care shall be taken to prevent impact ram wobble and to ensure that the impact ram is level and perpendicular to the specimen at impact. No slack in the supporting cables is allowed when retracting the impact ram to the specified drop

[5] 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.

[6] 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.

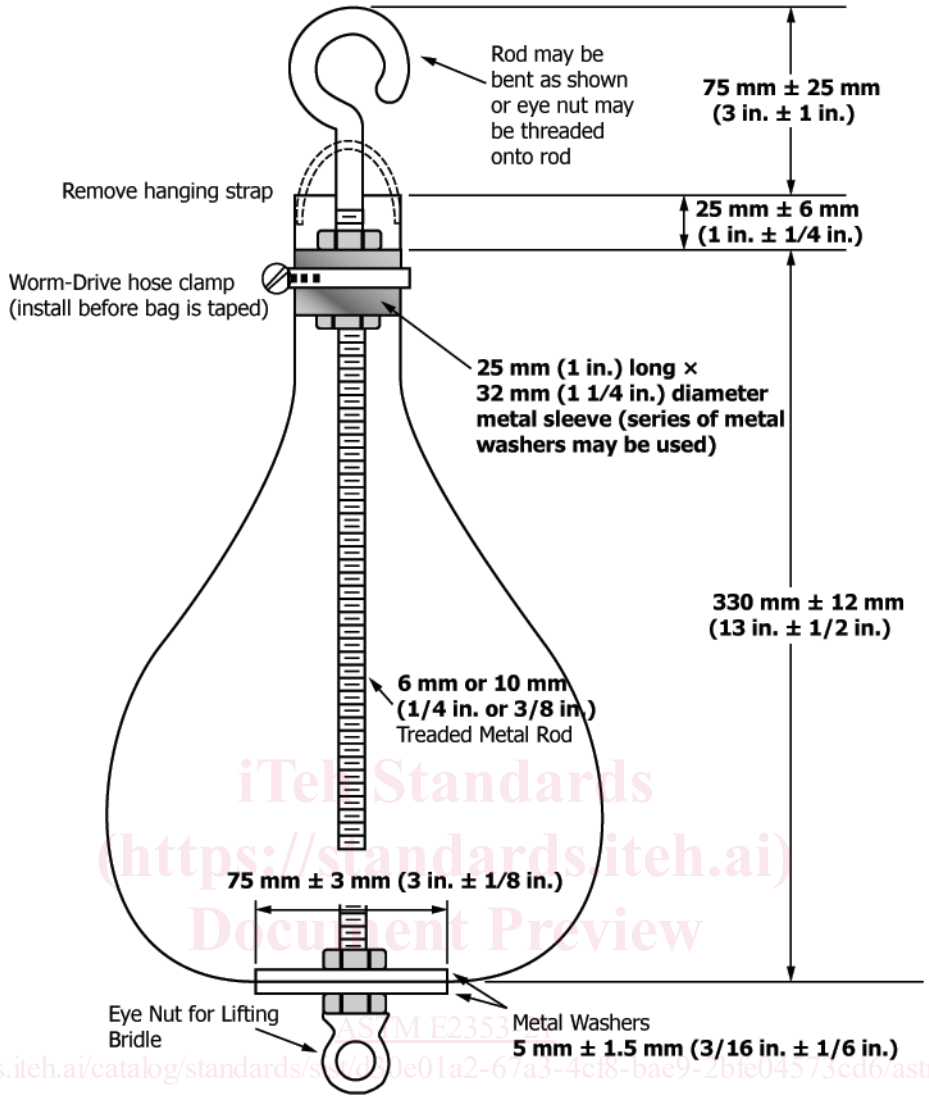

FIG. 7 Shot Bag Impactor

height. The length of the cables in the suspension system defines the allowable drop height for that system. To prevent impact ram wobble, it is necessary to use two pairs of cables of sufficient separation that, hanging unrestrained, are parallel to each other when viewed perpendicular to the long axis of the impact ram.

7.5.5 Use a quick release mechanism that is capable of holding the impact ram and releasing it in uniform manner without imparting any forward motion or acceleration. Provide a means to ensure that the impact ram does not unintentionally strike the specimen after the initial impact, that is, rebound and strike the specimen again.

7.6 *Impactor:*

7.6.1 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.

7.7 *Impact Nose:*

7.7.1 The impact nose shall be 63 mm ± 5 mm (2.5 in. ± 0.2 in.) in diameter and the radial tolerance shall be within 3.2 mm (0.125 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.

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 °C and 30 °C (65 °F 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.

12.2 Structural evaluation test methods shall be performed at loads designated by the specifying authority.

12.2.1 *Selection of Test Methods*—The user may select one or more of the test methods described in 12.2.4, 12.2.5, and 12.2.6, as determined by the performance specification or the purposes of the test.

12.2.2 *Sequence of Test Methods*—Specimens tested for two or more of the loading conditions shall be subjected first to the in-fill load test, followed by the uniform load test, and last, the concentrated load test, in that order unless specified otherwise by the performance specification.

12.2.3 *Replacement of Failed Components*—If the test is conducted for research, design, or product development purposes, if a component(s) or connection(s) fails in any of the tests, testing may continue after the failed component or connection is removed and replaced. The failure must be recorded. If testing is conducted for purposes of determining compliance with a performance standard or to determine performance of the complete railing system or any element of the railing system, the failed component or connection may not be replaced. The test series continues as defined in 12.2.1.

12.2.4 *In-Fill Load Test*—The test specimen shall be capable of satisfactorily resisting the required test load applied over a 0.09 m^2 (1 ft^2) area normal to the in-fill. The test load shall be applied at the intersection of the horizontal and vertical center lines of the in-fill, unless specified otherwise by the performance specification or the purposes of the test. If it is determined that another location will yield lesser results, that position should be used instead of the indicated intersection point of the center lines. Record deflection of the in-fill at the point of maximum deflection of the in-fill.

12.2.5 *Uniform Load Test*—Subject the top rail or other rail of the test specimen to the required maximum uniform test load applied vertically and horizontally, as required by the performance specification. Required vertical and horizontal test loads shall be applied separately and sequentially, unless otherwise required by the performance specification or to meet the purpose of the test. Record the deflection at mid-span during each test.

12.2.6 *Concentrated Load Test*—The top rail or other subject rail of the test specimen shall be subjected to the concentrated test load applied vertically and horizontally, as required by the performance specification. Apply required vertical and horizontal test separately and sequentially, unless otherwise required by the performance specification or to meet the purpose of the test. The required concentrated test load shall be applied at the following three critical locations: rail midspan between posts, top rail adjacent to a post (maximum 3 in. from post), top of a single post. Test loads are to be applied and deflection recorded sequentially, one location at a time. The load applied on the rail adjacent to the post can be applied to the opposite post from which the top-of-post test was performed. In the case of swing gates, if the structure of the gate requires locating the test load more than 3 in. from a post due to hinge or latch construction, the load should be located as

close to the 3 in. maximum distance from the post as is possible. Record the deflection at the point of application of the load.

12.3 *Load Application:*

12.3.1 *Rate of Loading*—The rate of loading shall be such that the maximum specified load is achieved in no less than 10 s and no more than 5 min.

12.3.2 *Load Duration*—Maintain the maximum specified load for 1 min before releasing. (**Warning—**Possible injury to personnel and damage to the test equipment and instrumentation prior to, during, and after load application by any unexpected release of potential strain energy accumulated during testing can occur and must be given consideration. (**Warning—**If tests are conducted in a structure and not in a testing laboratory, exercise caution against unwanted damage to the building, its components, and its finish.)

12.3.3 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).

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

12.3.5 Perform only one test per glazing in-fill type on each of the three specimens at the most critical point of the system.

12.4 *Shot Bag Impact Test:*

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

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

12.5 *Pendulum Impact Test:*

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

12.5.2 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 12.1 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 mm, 1220 mm, or 1525 mm (18 in., 48 in., 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 of this test method with mounting in accordance with manufacturer's instructions.

13.4.1.1 Set up the impact ram so that it has a horizontal axis and is perpendicular to the specimen.

13.4.1.2 Impactor nose, when hanging unrestrained, is within 6 mm (0.25 in.) of the front surface of the specimen at a point defined by the intersection of the vertical and horizontal center line of the glazing surface to be impacted.

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