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Glass in building — Destructive-windstorm-resistant security glazing — Test and classification

Verre dans la construction — Vitrages de sécurité résistant aux tempêtes destructrices — Essai et classification

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Contents

Page

Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 16932 was prepared by Technical Committee ISO/TC 160, *Glass in building*, Subcommittee SC 2, *Use considerations*.

Glass in building — Destructive-windstorm-resistant security glazing — Test and classification

1 Scope

1.1 This International Standard determines resistance of security glazing products to natural threats characterized by simulated destructive-windstorm events. Classification is intended as basis for judging the ability of glazing to remain without openings during a severe tropical cyclone with sustained wind speed of 50 m/s or greater. Impact by missile(s) and subsequent cyclic static-pressure differentials simulate conditions representative of windborne debris and pressures in a destructive windstorm. Glazing is tested in a standard frame. Classification is selected for a geographical location using the appropriate wind speed, pressure and level of protection.

1.2 The test method determines the performance of security glazing for use in fenestration assemblies under conditions representative of events that occur in severe, destructive-windstorm environments using simulated missile impact(s) followed by the application of cyclic static-pressure differentials.

1.3 A missile-propulsion device, an air pressure system and a test chamber are used to model some conditions that can be representative of windborne debris and pressures in a windstorm environment.

1.4 The performance determined by this test method relates to the ability of glazing in the building envelope to remain without openings during a windstorm.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
security glazing
glass-based fenestration glazing products, usually transparent or translucent, intended to protect property or people from natural threats

3.2
destructive windstorm
severe weather event with high sustained winds and turbulent gusts, such as hurricanes or typhoons (tropical cyclones), defined herein as having a basic wind speed equal to or greater than 50 m/s, capable of generating windborne debris

3.3
basic wind speed
V
wind speed as determined by the authority having jurisdiction

NOTE The basic wind speed is intended to represent the sustained-wind-speed design basis a local for a hurricane or typhoon (tropical cyclone), such as used to describe a 50-year recurrence period or annual 0,02 probability.

3.4
fenestration assembly
glazing system intended to be installed in a building

EXAMPLE Exterior windows and glazed doors.

3.5
air-pressure differential
P
specified maximum differential in static air pressure across the specimen, creating an inward or outward load

NOTE The air-pressure differential is expressed in pascal or its multiples.

3.6
missile
object that is propelled toward a test specimen

3.7
positive (or negative) cyclic test load
specified differential in static air pressure, creating an inward or outward load, to which the specimen is subjected in a series of cycles

3.8
test specimen
glazing materials and glazing unit assembled in a standard frame

See Annex B.

3.9
test-loading programme
entire sequence of air-pressure cycles applied to the test specimen

3.10
lumber missile
dressed piece of surface-dried, soft-wood, structural timber that impacts the glazing surface of the specimen

3.11
windborne debris
objects carried by the wind in windstorms

3.12
design pressure
uniform, static air-pressure difference, inward or outward, for which the test specimen is designed under service load conditions, using local conventional structural engineering specifications and concepts

NOTE This pressure is determined by either analytical or wind-tunnel procedures.

4 Principle and significance

4.1 General

This test method consists of mounting the test specimen and testing to an appropriate class, by impacting the test specimen with (a) missile(s) and then applying cyclic static-pressure differentials across the test specimen in accordance with a specified test-loading programme. The condition of the test specimen is observed and measured, and the results reported.

4.2 Purpose

The purpose of this International Standard is to determine the resistance of various glazing materials and glazing systems to threats characteristic of destructive windstorms. Qualification under this International Standard provides a basis for judgment of the ability of elements of the building envelope to remain without openings during a hurricane or typhoon (tropical cyclone). This minimizes the damaging effects of a destructive windstorm on the building interior and reduces the magnitude of internal pressurization.

4.3 Options

The user of this International Standard either

a) tests the glazing material to a specified and required “level of protection” for classification according to 9.3, or

b) tests the glazing material to other conditions without classification as requested by the authority having jurisdiction, in which case, the required information, as described in Annex A, shall be provided for the test procedure.

5 Apparatus

5.1 General

Any equipment capable of performing the test procedure within the allowable tolerances may be used.

5.2 Equipment

5.2.1 Mounting frame

This fixture supports the outer specimen test frame(s) described in Annex B in a vertical position during testing. The maximum mounting-frame deflection of the longest member (either during impact or at the maximum specified static air-pressure differential) shall not exceed $L/360$, where L denotes the longest unsupported length of a member of the mounting frame. Frame-deflection measurements shall be made normal to the plane of the specimen at the point of maximum deflection. The mounting frame shall be either integral with the test chamber or capable of being installed into the test chamber prior to or following missile impact(s). The mounting frame shall be anchored so it does not move when the specimen is impacted. The specifications for the inner and the outer specimen-support frame are shown in Annex B.

5.2.2 Air-pressure cycling test chamber

This consists of an enclosure or box with an opening against which the test specimen is installed. It shall be capable of withstanding the specified cyclic static-pressure differential. The chamber shall be deep enough to avoid contact with the test specimen during pressure cycling. Pressure taps shall be provided to facilitate measurement of the cyclic static-pressure differential. They shall be located such that the measurements are unaffected by the air supplied to or evacuated from the test chamber or by any other air movements.

5.2.3 Air-pressure system

A controllable blower, a compressed-air supply/vacuum system or other suitable system capable of providing the required maximum air-pressure differential (inward and outward acting) across the test specimen. Specified pressure differentials across the test specimen shall be imposed and controlled through any system that subjects the test specimen to the prescribed test-loading programme. Examples of suitable control systems include manually operated valves, electrically operated valves or computer-controlled servo-operated valves.

5.2.4 Air-pressure-measuring apparatus

Pressure differentials across the test specimen shall be measured by an air-pressure-measuring apparatus with an accuracy of ± 2 % of its maximum rated capacity, or ± 100 Pa, whichever is less, and with a response time of less than 50 ms.

EXAMPLE Acceptable apparatus are mechanical pressure gages and electronic pressure transducers.

5.2.5 Missile-propulsion device(s)

This is a device capable of propelling a missile at a specified speed and orientation towards a specified impact location; see Annex C. The missile shall not be accelerating upon impact due to the force of gravity along a line normal to the specimen.

5.2.6 Speed-measuring system

This is a system capable of measuring missile speeds within the tolerances defined in 7.3.2.

5.2.7 Missiles

5.2.7.1 General

Missiles shall be one or more of the following as appropriate to classification; see 9.2.

Any other representative missiles shall have mass, size, shape and impact speed determined by engineering analysis considering the design basic wind speed.

5.2.7.2 Small-ball missile

A solid steel ball weighing 2 g ± 5 %, with an 8 mm nominal diameter, and an impact speed between 0,40 and 0,80 of the basic wind speed; see Table 4.

5.2.7.3 Lumber missile

The lumber missiles, typically, have a relative density of 0,48; a hardness of 2 600 N, as measured by a modified Janka hardness test[8]; and cross-section dimensions of 38 mm × 89 mm, with a linear density of between 1,61 kg/m and 1,79 kg/m. The timber, generally called “2 × 4s” in reference to its nominal dimensions of 2 in by 4 in, shall have a mass and an impact speed as shown in Table 1. The missile shall have no defects, such as knots, splits, checks, shakes or wane, within 30 cm of the impact end. The impact end shall be trimmed square. If required for propulsion, a circular sabot having a mass of no more than 0,2 kg may be applied to the trailing edge of a large missile. The mass of the large missile includes the mass of the sabot.

5.3 Calibration

5.3.1 Speed-measuring system

The speed-measuring system shall be calibrated to an accuracy of ± 2 % of the elapsed time required to measure the speed of the specified missile. Calibration shall be performed at the manufacturer's recommended frequency, but in any event, not more than six months prior to the test date. The speed-measuring system shall be calibrated by at least one of the following methods:

— photographically, using a stroboscope and a still camera;

— photographically, using a high-speed motion-picture or video camera with a frame rate exceeding 500 frames per second capable of producing a clear image and a device that allows single-frame viewing;

— using gravity to accelerate a free-falling object having negligible air drag through the timing system and comparing measured and theoretical elapsed times;

— using any independently calibrated speed-measuring system with an accuracy of ± 1 %.

5.3.2 Pressure transducers

Electronic pressure transducers shall be calibrated at six-month intervals using a standardized calibrating system or a manometer readable to 10 Pa (1 mm of water).

5.3.3 Manometers

The calibration of manometers is normally not required, provided that the instruments are used at a temperature near their design temperature.

6 Test specimens

6.1 General

The test specimens shall consist of the glazing panel mounted in a test frame.

Entire fenestration assemblies may be tested in a similar way.

6.2 Glazing material

The glazing material tested shall be nominally (1 100 ± 5) mm × (900 ± 5) mm and shall be representative of the commercial production.

6.3 Number of samples

Three test specimens shall be submitted for the lumber-missile or small-ball-missile test.

6.4 Order of testing

Test specimens passing the acceptance criteria of the lumber-missile or small-ball-missile impact test shall be submitted for the air-pressure-cycle test.

7 Test procedure

7.1 General

Glazing materials shall be tested to a class appropriate to its use, as described in Clause 9. Basic wind speed and level of protection is specified by the authority having jurisdiction or as directed by the test client. If the intent is to classify the glazing, the following test information shall be provided:

a) basic wind speed;

b) level of protection;

c) maximum specified air-pressure differential (if different from Table 4).

If the glazing material is tested at other conditions required by the authority having jurisdiction, then the required information shall be provided, as described in Annex A.

7.2 Preparation

7.2.1 Installation

Support and secure the test specimen into the standard mounting frame in a vertical position. The test specimen shall not be removed from the mounting frame at any time during the test sequence.

7.2.2 Conditioning

Unless otherwise specified, condition the specimens separately for at least 4 h within a temperature range of 18 °C to 28 °C.

7.2.3 Missile impact

Take the following steps to prepare the specimen for missile impact.

— Secure the specimen and mounting frame such that the missile (lumber missile or small-ball missile) impacts the exterior side of the specimen as installed.

— Locate the end of the propulsion device from which the missile exits at least 1,5 times the length of the missile from the specimen. This distance shall be no less than 1,80 m.

— Set up appropriate signal/warning devices to prevent test and/or other personnel from coming between the propulsion device and the test specimen during testing.

— Weigh each missile prior to starting the test.

— Load the missile into the propulsion device.

— Reset the speed-measuring system.

— Align the missile-propulsion device such that the specified missile impacts the test specimen at the specified location.

7.3 Missile impact test

7.3.1 Projectile descriptions

Propel the small ball or proper lumber missile at the impact speed specified in Table 1. For classification, refer to Table 3.

Table 1 — Applicable missiles

Missile type	Missile	Impact speed m/s
A	(2 ± 0,1) g (small steel ball)	39,7
B	(2,05 ± 0,1) kg (small lumber)	12,2
C	(4,1 ± 0,1) kg (medium lumber)	15,3
D	(4,1 ± 0,1) kg (medium lumber)	24,4
E	(6,8 ± 0,1) kg (large lumber)	22,4

7.3.2 Impact-speed tolerance

Tolerances for the measured missile speed at any point after the missile acceleration caused by the propulsion device equals zero are as follows:

— ± 2 % when the specified speed is ≤ 23 m/s;

— ± 1 % when the specified speed > 23 m/s.

7.3.3 Impact angle

Upon impact, the longitudinal axis of missiles having a longitudinal axis, shall not deviate more than 5° from a line normal to the specimen at the specified impact point.

NOTE To ensure that the expected missile rotation prior to impact is less than 5° from a horizontal datum, measure the vertical height to the centre of the exit end of the propulsion device (if it is horizontal), h_B, and the vertical height to the centre of the missile impact point on the specimen, h_I, then:

$$5° \leqslant \tan^{-1}\left|\frac{h_B - h_I}{d}\right|$$

where d denotes the horizontal distance from the exit end of the propulsion device to the specimen.

7.3.4 Impact location

7.3.4.1 Lumber-missile test

Impact each glazing test specimen once, as shown in Figure 1 a).

a) Impact one specimen with the missile within a 65 mm radius circle at the centre of specimen.

b) Impact a different specimen with the missile within a 65 mm radius circle with the centre located 150 mm from supporting members at a corner.

c) Impact the remaining specimen with the missile within a 65 mm radius circle having its centre located 150 mm from supporting members at a diagonally opposite corner.