
**Steklo v stavbah – Preskus z nihalom – Preskusna metoda z udarcem in
klasifikacija ravnega stekla**

Glass in building - Pendulum test - Impact test method and classification for flat glass

Glas im Bauwesen - Pendelschlagversuch - Verfahren für die Stoßprüfung und die
Klassifizierung von Flachglas

Verre dans la construction - Essai au pendule - Méthode d'essai d'impact et classification
du verre plat

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This European Standard was approved by CEN on 10 August 2002.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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Foreword

This document (EN 12600:2002) has been prepared by Technical Committee CEN/TC 129 "Glass in building", the secretariat of which is held by IBN/BIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2003, and conflicting national standards shall be withdrawn at the latest by May 2003.

In this European Standard the annexes A, B and C are normative and the annex D is informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

This European Standard is a test method standard, which is intended to classify flat glass products used in buildings, by performance under impact and by mode of breakage. The classification by drop height corresponds to graded values of energy transmitted by the impact of a person.

The classification system in this European Standard relates to increasing personal safety by:

- the reduction of cutting and piercing injuries to persons;
- the containment characteristics of the material.

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1 Scope

This European Standard specifies a pendulum impact test method for single flat panes of glass for use in buildings. The test is intended to classify flat glass products in three principal classes by performance under impact and by mode of breakage.

This standard does not specify requirements for applications, nor does it specify requirements for durability.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. Normative references are cited at the appropriate place in the text, and the publications are listed below. For dated references, subsequent amendments to or revisions of this publication apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 572-1, *Glass in building – Basic soda lime silicate glass products – Part 1: Definitions and general physical and mechanical properties.*

EN 572-2, *Glass in building – Basic soda lime silicate glass products – Part 2: Float glass.*

EN 572-3, *Glass in building – Basic soda lime silicate glass products – Part 3: Polished wired glass.*

EN 1863-1, *Glass in building – Heat strengthened soda lime silicate glass – Part 1: Definition and description.*

EN 12150-1:2000, *Glass in building – Thermally toughened soda lime silicate safety glass – Part 1: Definition and description.*

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EN 12337-1, *Glass in building – Chemically strengthened soda lime silicate glass – Part 1: Definition and description.*

EN ISO 12543-1, *Glass in building – Laminated glass and laminated safety glass – Part 1: Definitions and description of component parts (ISO 12543-1:1998).*

ISO 48:1994, *Rubber, vulcanized or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD).*

ISO 2408, *Steel wire ropes for general purposes – Characteristics.*

ISO 4251-1, *Tyres (ply rating marked series) and rims for agricultural tractors and machines – Part 1: Tyre designation and dimensions, and improved rim contours.*

3 Terms and definitions

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

3.1

asymmetric material

product in which, from both outer surfaces, the sequence of glass panes, plastic glazing sheet material and interlayer(s) by type, thickness, finish and/or general characteristics is different; or

a monolithic glass pane with differing surface finish, e.g. patterned glass

EN 12600:2002 (E)**3.2****drop height**

vertical height from the horizontal centre line of the impactor at the point of release to the horizontal centreline of the impactor when it is at rest vertically

3.3**masking**

temporary protective covering applied to the test piece for ease of transportation.

NOTE This does not include protective edge tapes.

3.4**crack-free particle**

particle of toughened glass which does not contain any cracks which run from one edge to another

[EN 12150-1:2000, 8.4]

4 Test requirements

When tested by the method given in clause 5 each test piece shall either not break or shall break as defined in one of the following ways:

- a) numerous cracks appear, but no shear or opening is allowed within the test piece through which a 76 mm diameter sphere can pass when a maximum force of 25 N is applied (in accordance with annex A). Additionally, if particles are detached from the test piece up to 3 min after impact, they shall, in total, weigh no more than a mass equivalent to 10 000 mm² of the original test piece. The largest single particle shall weigh less than the mass equivalent to 4 400 mm² of the original test piece;
- b) disintegration occurs and the 10 largest crack-free particles collected within 3 min after impact and weighed, all together, within 5 min of impact shall weigh no more than the mass equivalent to 6 500 mm² of the original test piece. The particles shall be selected only from the portion of the original test piece exposed in the test frame. Only the exposed area of any particle retained in the test frame shall be taken into account in determining the mass equivalent.

5 Test method**5.1 Test apparatus****5.1.1 Description of test apparatus****5.1.1.1 General**

The test apparatus shall comprise:

a stable main frame;

a clamping frame which is fitted onto the main frame and is used to hold the test piece in position for the duration of the test;

a dual tyre impactor with a suspension device and release mechanism.

5.1.1.2 Main frame (see Figures 1, 2 and 3)

This shall be constructed from welded, or bolted, hot rolled steel channel sections with rounded edges, designed to present a rigid and flat surface to the sub-frame. The lower cross members shall be securely fixed to a concrete floor.

NOTE Additional support to the frame can be provided, if required, by means of horizontal steel sections fixed to an adjacent rigid wall (see Figure 2, F_2).

The dimensions of the main frame (see Figure 3) shall be:

- internal width: (847 ± 5) mm;
- internal height: $(1\,910 \pm 5)$ mm

5.1.1.3 Clamping frame (see Figure 4)

Clamping frame, used to hold the test piece in the apparatus, consisting of two rectangular parts which clamp the test piece along its perimeter. The inner part of the clamping frame is attached to the main frame.

The assembly is held together by a clamping device. The clamping frame shall be suitably rigid to withstand the pressure exerted by the clamping device.

The dimensions of the clamping frame shall be:

- internal width: (847 ± 5) mm;
- internal height: $(1\,910 \pm 5)$ mm

Each part of the clamping frame shall be fitted with a strip of rubber. The rubber strips shall be the only element in contact with the test piece and shall be (20 ± 2) mm wide and (10 ± 1) mm thick and have a hardness of (60 ± 5) IRHD in accordance with ISO 48.

NOTE It is recommended to use polychloroprene or a similar material.

5.1.1.4 Impactor (see Figures 5 and 6)

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Impactor consisting of two pneumatic tyres, Tyre 3.50-R8 4PR¹⁾ in accordance with ISO 4251-1, with round section and flat longitudinal tread. The tyres shall be fitted to the rims of the wheels that carry two steel weights of equal mass. The weights shall be dimensioned so that the total mass of the impactor is $(50 \pm 0,1)$ kg.

NOTE An example of the impactor, using steel with a density of $7\,830 \text{ kg/m}^3$, is shown in Figure 5.

5.1.1.5 Suspension system (see Figure 2)

The impactor shall be suspended by means of a steel cable of 5 mm in diameter conforming to ISO 2408, from a bracket attached above the head of the main frame. The bracket shall be rigid to ensure that the point of suspension remains stationary during the test and shall be positioned to permit the impactor to strike the centre of the test piece.

At the highest drop height the angle between the taut suspension cable and the bracket shall not be less than 14° from the horizontal.

When the impactor is hanging freely, at rest, the distance between the fully inflated tyres and the surface of the test piece shall not exceed 15 mm and shall not be less than 5 mm (see Figure 2; D) and the centre line of the impactor shall be within 50 mm radially from the centre of the test piece.

¹⁾ Tyre 3.50-R8 4PR manufactured by Vredestein can be used for the pendulum test. It can be obtained from Vredestein BV, Ingenieur Schiffstraat 370, NL - 7547 RD Enschede, Nederland or Vredestein GmbH, August-Horch-Strasse 7, D - 56070 Koblenz, Deutschland.

The above tyre does not mean that CEN is recommending the use of this particular tyre. Equivalent tyres may be used as long as it is demonstrated that equivalent results will be obtained.

EN 12600:2002 (E)**5.1.1.6 Impact release mechanism (see Figure 2)**

The impactor release mechanism enables the impactor to be raised and positioned at each of the specified drop height positions and then to be released so that it swings freely and impacts the test piece. The release cable shall be connected to the top and bottom ends of the impactor by suitable links so that the raising force is applied at right angles to the axis of the impactor. The release mechanism shall ensure that the release cable is maintained at the correct orientation at each of the drop heights.

5.1.2 Calibration

The test apparatus shall be calibrated in accordance with annex B in order to ensure that the energy transferred to the test piece by the impactor during the test carried out on different apparatus is consistent.

5.2 Test pieces**5.2.1 General**

Each test piece shall comprise a single pane of glass product and be representative of the normal production of the type of product submitted for test.

5.2.2 Dimensions of the test pieces

The test pieces shall have the following dimensions:

- width (876 ± 2) mm;

- height $(1\,938 \pm 2)$ mm

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Results obtained with test pieces of these dimensions are valid for classification purposes of the glass product whatever the service dimensions.

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5.2.3 Number of test pieces

The test shall be carried out at each drop height on four pieces of identical structure and the same nominal thickness.

If the test pieces are of an asymmetric material, their number shall be doubled unless they are intended solely for installation in situations where the risk of impact is from one side only.

5.2.4 Preparation of the test pieces

Remove all masking and protection material from the test pieces and condition for a minimum of 12 h at (20 ± 5) °C.

5.3 Impact test procedure

5.3.1 Testing shall start at the lowest drop height (see Table 1) and increase up to the drop height appropriate to the class for which the material is intended (see 6.2).

5.3.2 The test shall be carried out at (20 ± 5) °C.

5.3.3 Place each test piece in the clamping frame so that its edges are encased in the rubber to a minimum depth of 10mm. When clamped, the rubber shall be compressed by not more than 20 % of its thickness.

Inflate both impactor tyres to a pressure of $(0,35 \pm 0,02)$ MPa. Pressure shall be checked before each drop height.

Raise the impactor to the lowest drop height (see Table 1) and stabilize. At the drop height the suspension cable shall be taut, and the axis of the impactor and cable shall be in line (see Figure 2).

Table 1 — Impact levels

Classification	Drop height mm
3	190
2	450
1	1 200

5.3.4 Release the impactor so that it falls with a pendulum movement and without initial velocity. The direction of impact on the centre of the test piece shall be normal to the surface. If the impactor strikes the test piece more than once the test shall be deemed to be invalid.

The weights shall not make contact with the test piece during the impact.

5.3.5 For asymmetric materials that are intended for installation where the risk of impact is from both sides, carry out the test on both sides.

For asymmetric materials where the required classification is for one face only (see 5.2.3) then only the designated face shall be tested and this shall be reported in the test report.

5.3.6 Inspect the test piece after impact and note whether:

it remains unbroken; or

it broke in accordance with either the requirements a) or b) of clause 4; or

it broke and failed to conform to the requirements of clause 4.

5.3.7 If any of the initial four test pieces fails to conform to the requirements of clause 4, terminate the procedure. If all four test pieces either do not break or else break according to the criteria given in clause 4, and it is required to test the material to a higher impact level, increase the drop height to the next level (see Table 1). Repeat the test on four more samples of the same material.

NOTE If the material remained unbroken, the same sample(s) may be used.

5.3.8 Report all test results as required by clause 7.

6 Classification

6.1 General

Glazing conforming to this European Standard is classified as follows:

- its performance under the impact test;
- the drop height at which breakage occurred;
- the drop height at which the product passed in accordance with a) of clause 4;
- the drop height at which the product passed in accordance with b) of clause 4;

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- the mode of breakage of the material if it remains unbroken after the impact test.

6.2 Drop height class

Glazing shall be classified as follows:

Class 3 – material that conforms to the requirements of clause 4 when tested by the method given in clause 5 at a drop height of 190 mm;

Class 2 - material that conforms to the requirements of clause 4 when tested by the method given in clause 5 at drop heights of 190 mm and 450 mm;

Class 1 - material that conforms to the requirements of clause 4 when tested by the method given in clause 5 at drop heights of 190 mm, 450 mm and 1 200 mm.

6.3 Mode of breakage

If all test pieces remain unbroken at the drop height appropriate to its intended drop height class, the mode of breakage shall be determined as per Annex C. The mode of breakage shall be described as follows:

Type A – numerous cracks appear forming separate fragments with sharp edges, some of which are large;

Type B – numerous cracks appear, but the fragments hold together and do not separate;

Type C – disintegration occurs, leading to a large number of small particles that are relatively harmless.

NOTE The descriptions of the mode of breakage are intended to convey the following information (see annex C).

Type A – mode of breakage typical of annealed glass;

Type B – mode of breakage typical of laminated glass;

Type C – mode of breakage typical of toughened glass.

Performance classification

The performance classification of a glass product shall be given as follows:

α (β) Φ

where

α is the highest drop height class at which the product either did not break or broke in accordance with a) or b) of clause 4;

β is the mode of breakage;

Φ is the highest drop height class at which the product either did not break or when broke, broke in accordance with a) clause.

When a glass product breaks at a drop height of 190 mm and the breakage is not in accordance with a) of clause 4 then the value of Φ quoted shall be zero.

EXAMPLES

A set of laminated glass test specimens were impacted with the following results:

Classification 2 (B) 2

- at 190 mm: 3 specimens did not break and 1 specimen broke in accordance with a) of clause 4;
- at 450 mm: all 4 specimens broke in accordance with a) of clause 4;
- at 1 200 mm: all 4 specimens broke and failed to comply with b) clause 4.

Classification 1 (C) 3

A set of thermally toughened soda lime silicate glass test specimens were impacted with the following results:

- at 190 mm: all 4 specimens did not break;
- at 450 mm: all 4 specimens broke in accordance with b) of clause 4;
- at 1 200 mm: all 4 specimens broke in accordance with b) of clause 4.

Classification 1 (C) 0

A set of thermally toughened soda lime silicate glass test specimens were impacted with the following results:

- at 190 mm: 2 specimens did not break and 2 specimens broke in accordance with b) of clause 4;
- at 450 mm: all 4 specimens broke in accordance with b) of clause 4;
- at 1 200 mm: all 4 specimens broke in accordance with b) of clause 4.

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7 Test report

The test report shall give the following details: [SIST EN 12600:2004](https://standards.iteh.ai/catalog/standards/sist/ddc38a5e-daa3-43d9-9666-60dd162a1d2a/sist-en-12600-2004)

- a) type and nominal thickness of glass product;
- b) dimensions of test pieces;
- c) behaviour at each drop height for each test piece. This shall include whether or not the test piece broke. If the test piece broke, the mode of breakage shall be stated, and whether or not it was in accordance with the criteria given in clause 4 and state the particular criteria, i.e. a) or b) of clause 4. If the test piece remained unbroken, the mode of breakage shall be determined from 6.3;
- d) performance classification;
- e) date of the last calibration of the test rig according to annex B;
- f) in case of applied films, reference should be made as to whether or not the film was clamped in the frame;
- g) the name and the address of the testing laboratory;
- h) laboratory test identification number to enable test data to be traced;
- i) date of test report;
- j) name of manufacturer/processor and/or supplier of the test material;
- k) declared description of the material tested (including product type, trade name or other means of identification);
- l) in the case of asymmetric materials, the test report shall state the classification of both surfaces unless only one impact side has been tested (see 5.3.5). In the latter case the classification and the surface which was impacted shall be reported.