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ISO 11485-3

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Glass in building — Curved glass —

Part 3: Requirements for curved tempered and curved laminated safety glass

Verre dans la construction — Verre bombé —

Partie 3: Exigences pour le verre de sécurité bombé trempé et bombé feuilleté

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 160, *Glass in building*, Subcommittee SC 1, *Product considerations*.

ISO 11485 consists of the following parts, under the general title *Glass in building — Curved glass*:

— *Part 1: Terminology and definitions*

— *Part 2: Quality requirements*

— *Part 3: Requirements for curved tempered and curved laminated safety glass*

Introduction

Curved tempered safety glass has a breakage behaviour that is different to annealed glass. This behaviour is a direct result of the high surface prestress and the stress profile within the glass.

Curved tempered safety glass has a known behaviour under accident human impact.

Curved laminated safety glass has safety properties that are different to annealed glass. This behaviour is a direct result of the assembly of two or more glass panes with one or more interlayers.

Curved laminated safety glass has a known behaviour under accidental human impact.

Glass in building — Curved glass —

Part 3: Requirements for curved tempered and curved laminated safety glass

1 Scope

This part of ISO 11485 defines the conditions to classify a curved glass product as a curved safety glass.

This part of ISO 11485 classifies curved tempered glass and curved laminated glass as safety glasses 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 part of ISO 11485 relates to increasing personal safety by

— the reduction of cutting and piercing injuries to persons, and

— the containment characteristics of the material.

This part of ISO 11485 covers fracture characteristics, including fragmentation test and the physical and mechanical characteristics of curved tempered safety glass for use in buildings.

2 Normative references

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

ISO 11479-1, *Glass in building — Coated glass — Part 1: Physical defects*

ISO 11485-1, *Glass in building — Curved glass — Part 1: Terminology and definitions*

ISO 11485-2, *Glass in building — Curved glass — Part 2: Quality requirements*

ISO 12543-1, *Glass in building — Laminated glass and laminated safety glass — Part 1: Definitions and description of component parts*

ISO 16293-1, *Glass in building — Basic soda lime silicate glass products — Part 1: Definitions and general physical and mechanical properties*

ISO 16293-2, *Glass in building — Basic soda lime silicate glass products — Part 2: Float glass*[1)]

ISO 16293-5, *Glass in building — Basic soda lime silicate glass products — Part 5: Patterned glass* [1)]

ISO/TS 29584, *Glass in building — Pendulum impact testing and classification of safety glass for use in buildings* [1)]

EN 572-4, *Glass in building — Basic soda lime silicate glass products — Drawn sheet glass*

1) To be published.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11485-1 and the following apply.

3.1
equivalent flat glass
flat glass of the same nature, thickness, and composition, produced on the same equipment and under the same process conditions as the production of curved safety glass, but with a radius equal or near to the infinite for the purpose of pendulum impact testing

3.2
curved tempered safety glass
curved tempered glass that is distinguished by a fragmentation test as per Clause 5 and by an impact test as per Clause 8, and their requirements

3.3
curved heat-soaked tempered safety glass
curved heat-soaked tempered glass that is distinguished by a fragmentation test as per Clause 5 and by an impact test as per Clause 8, and their requirements

3.4
curved laminated safety glass
curved laminated glass that is distinguished by an impact test as per Clause 8, and its requirements

4 Glass products

4.1 Curved tempered safety glass

Curved tempered safety glass is made from a monolithic flat glass generally corresponding to one of the following International Standards:

— soda lime silicate glass according to ISO 16293-1;

— float glass according to ISO 16293-2;

— drawn sheet glass according to EN 572-4;

— patterned glass according to ISO 16293-5;

— coated glass according to ISO 11479-1.

Other nominal thicknesses of glass than those covered in the above standards are possible.

4.2 Curved laminated safety glass

Curved laminated safety glass is made of at least 2 monolithic curved glasses corresponding to the following International Standard:

— Curved glass according to ISO 11485-1

NOTE The curved glasses used to make the laminated glass can be annealed, tempered, heat-strengthened, or chemically strengthened.

5 Fragmentation test for curved tempered safety glass

5.1 General

In the event of breakage, curved tempered safety glass fractures into numerous small pieces, the edges of which are generally blunt.

The fragmentation test determines whether the glass breaks in the manner prescribed for a curved tempered safety glass. This fragmentation test shows the behaviour of breakage of a curved tempered safety glass without any stress of external action, only by the pre-stress.

The fragmentation in service might not always correspond to that determined during the fragmentation test due to the imposition of other stresses, i.e. from fixing or from reprocessing (e.g. laminating).

This fragmentation behaviour ignores any influence of support conditions and is a representation of the effect of the surface pre-stress.

These properties are not size dependent.

5.2 Dimensions and number of test specimens

The dimensions of the test specimens shall have a length of 360 mm and a chord of 1 100 mm, without holes, notches, or cut-outs.

NOTE With some equipment, the dimension of 360 mm can be difficult to temper. In that case, a sample with a length of 500 mm and a chord of 1 100 mm can be used.

Two radiuses will be tested:

— The minimum possible radius that can be given to a glass of that dimensions, with the equipment used;

— A radius of (5 000 ± 500) mm.

NOTE The girth should be calculated for the specific radius, in order to have a chord equal to 1100 mm,

Samples should be representative of production. Test specimen shall be manufactured under the conditions that are applicable for the production of that type/thickness of product.

Five specimens shall be tested for each radius.

5.3 Test procedure

An adhesive film can be applied on the convex side of the test specimen, on the whole surface.

The test specimen will be placed on a flexible plate, e.g. plywood, with the concave side up. This flexible plate will be fixed in its centre on a support piece, to avoid movement of the whole during impact.

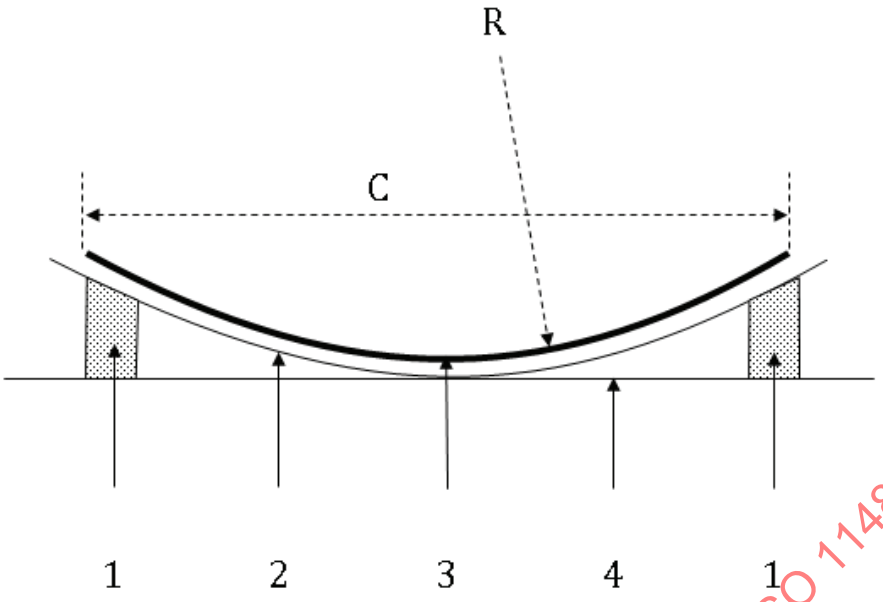
Support blocks (polystyrene, wood) will be placed on the straight edges to accommodate the curvature of the glass (see Figure 1).

Each test specimen shall be impacted, using a pointed steel tool, at a position 20 mm in from the longest edge of the test specimen at the mid-point of that edge, until breakage occurs (see Figure 2).

For curved tempered glass manufactured by vertical tempering, the impact point shall not be on the tong mark edge.

NOTE The fragmentation characteristics of glass are unaffected by temperatures between –50 °C and +100 °C.

Examples of steel tools are a hammer of about 75 g mass, a spring loaded centre punch, or other similar appliance with a hardened point. The radius of curvature of the point should be approximately 0,2 mm.

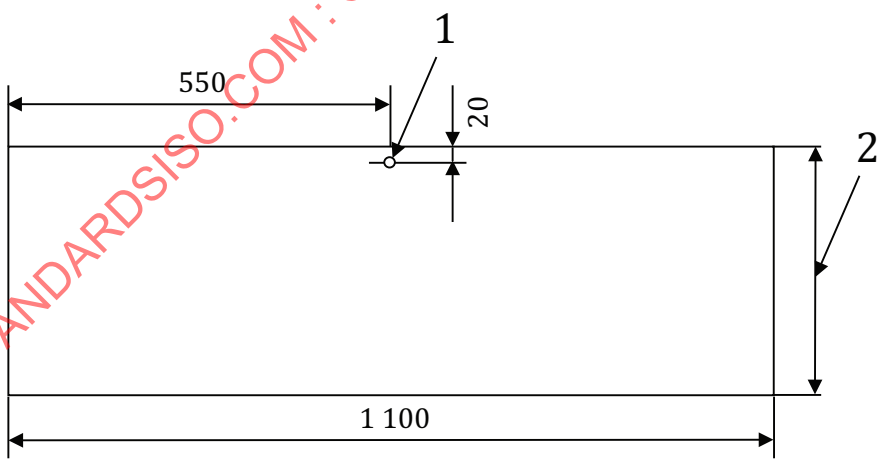


Key

C chord = 1 100 mm
R radius = 1 000 mm
1 support blocks
2 plywood flexible plate
3 glass sample
4 horizontal support

Figure 1 — Installation for fragmentation test – Example for R = 1000 mm

Dimensions in millimetres



Key

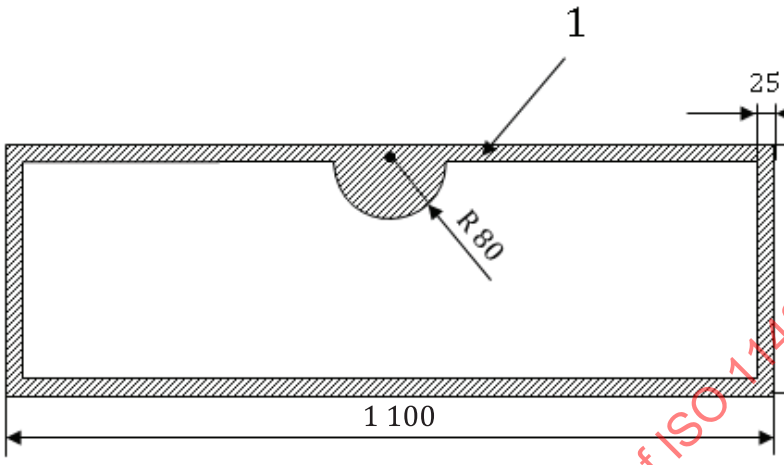
1 impact point
2 width = 360 mm or 500 mm

Figure 2 — Position of impact point

5.4 Assessment of fragmentation

An area of radius 80 mm, centred on the impact point, and a border of 25 mm, round the edge of the test specimen (see Figure 3), shall be excluded from the assessment.

Dimensions in millimetres



Key

1 excluded area

2 width = 360 mm or 500 mm

Figure 3 — Area to be excluded from the particle count determination and largest particle measurement

The particle count shall be made in the region of coarsest fracture (the aim being to obtain the minimum value).

The particle count shall be made by placing a mask of (150 ± 1) mm × (150 ± 1) mm on the test piece (see Annex B), on the concave side of the curved glass, in the zone where the biggest fragments are located.

Wait 3 min after breakage before starting to count, and count up to 10 min after breakage. The number of crack-free particles within the mask shall be counted. A particle is "crack-free" if it does not contain any cracks which run from one edge to another (see Figure 4).

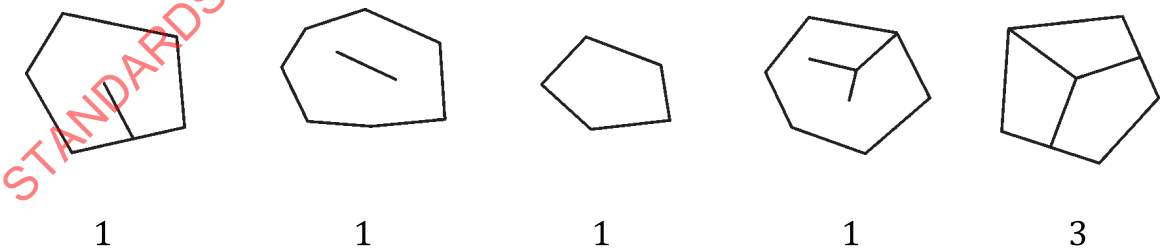


Figure 4 — Examples of crack-free particles and the assessment regarding the number

In the particle count, all particles wholly contained within the area of the mask shall be counted as one particle each and all the particles which are partially within the mask shall be counted as 1/2 particle each (see Annex B).

5.5 Minimum values from the particle count

In order to classify a glass as a tempered curved tempered safety glass, the particle count of each test specimen shall not be less than the values given in Table 1.

Table 1 — Minimum particle count values

Glass type	Nominal thickness, d mm	Minimum particle count
All glass types	3	270
	4 to 12	360
	15 to 25	270

5.6 Selection of the longest particle

The longest particle shall be chosen from the body of the test specimen.

It shall not be measured in the excluded area. If the splinter is in both areas, the length of the splinter in the counting area is measured.

5.7 Maximum length of longest particle

In order to classify the glass as curved tempered safety glass, the length of the longest particle shall not exceed 100 mm.

5.8 Test Report

The test report shall include the following information:

— Identification of the specimen;

— Radius of the specimen;

— Particle count of the fractured test specimen;

— Longest particle length;

— Date and time of the test;

— Names, positions of personnel carrying out or supervising the test.

Each page of the report shall be signed and dated by the person responsible for the test.

6 Other physical characteristics

6.1 Thermal durability

The mechanical properties of curved tempered safety glass are unchanged for continuous service up to 250 °C and are unaffected by sub-zero temperatures. Curved tempered safety glass is capable of resisting both sudden temperature changes and temperature differentials.

NOTE The resistance against temperature difference is sufficient to withstand the temperature differential which occurs in glazing exposed to solar radiation, usually below 100°K.

6.2 Mechanical strength

There is currently no standardized method of evaluation/measurement of the mechanical strength of curved tempered glass.

7 Marking

Curved tempered safety glass conforming to this part of ISO 11485 shall be permanently marked. The marking shall give the following information:

— name or trademark of manufacturer;

— number of this International Standard (i.e. ISO 11485-3).

8 Pendulum impact performance of safety glass

8.1 General

The purpose of this test is to evaluate, by means of soft body impactors, safe breakage characteristics of glazing products intended to reduce cutting and piercing injuries to persons through accidental impact.

There is, at present, no ISO test method available for the classification of the impact performance of curved tempered safety glass under accidental human impact. Work is on-going in ISO TC 160 SC 2 WG 6. Until a standard is agreed, national standards should continue to be used.

NOTE 1 Annex A lists the test methods presently employed to classify this product.

NOTE 2 ISO/TS 29584, to be published, will cover applicable pendulum impact test methods, i.e. twin tyre and lead shot-filled punch bag.

8.2 Problem specific to curved safety glass

Curved glass is excluded from the scope of most of national standards.

The problems to perform test on curved glass are the following:

— Test rig should be adapted to each radius tested;

— The impactor may be deviated by the curvature, leading to a lower energy level transmitted to the glass;

— Decision should be made whether the concave or the convex side will be impacted.

In order to simplify the procedure and to give comparative test results, the test is performed on an equivalent flat glass, see 3.1.

8.3 Test method

The equivalent flat glass is tested according to ISO/TS 29584.

Other national standards, as listed in Annex A can also be used.

Annex A
(normative)

Pendulum impact test methods

A.1 ISO technical specification

ISO/TS 29584, *Glass in building – Technical Specification – Pendulum impact testing and classification of safety glass for use in buildings*

A.2 Pendulum test methods employed around the world for the classification of tempered safety glass against accidental human impact

A.2.1 Japan

Lead shot-filled leather shot bag, weight (45 ± 0,1) kg as per JIS R 3206

A.2.2 Australia, New Zealand

Lead shot-filled leather shot bag, weight (46 ± 0,1) kg as per AS/NZ 2208

A.2.3 United States of America

Lead shot-filled leather shot bag, weight (45,4 ± 0,2) kg as per ANSI Z97.1.

NOTE Federal regulation CPSC 16 CFR 1201 also details a pendulum test method similar to ANSI Z97.1.

A.2.4 Canada

Lead shot-filled leather shot bag, weight (45,4 ± 0,1) kg as per CAN-CGSB/12.1-M 90.

A.2.5 Europe

Twin tyre impactor, weight (50 ± 0,1) kg as per EN 12600.

A.2.6 China

Lead shot-filled leather shot bag, weight (45 ± 0,1) kg as per GB 15763.3

A.2.7 Russian Federation

Lead shot-filled leather shot bag, weight (45 ± 1) kg as per GOST R 54171.