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Glass in building — Tempered soda lime silicate safety glass

Verre dans la construction — Verre silico-sodo-calcique de sécurité trempé

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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).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by ISO/ TC 160, *Glass in building*, Subcommittee SC 1, *Product considerations*.

Introduction

Tempered soda lime silicate safety glass has a breakage behaviour that is different to annealed glass. This behaviour is a direct result of the high surface pre-stress.

Tempered soda lime silicate safety glass has a known behaviour under accident human impact together with known mechanical and thermal stress resistance.

NOTE 1 ISO/TC 160/SC 2 produces standards for the determination of the design strength of glass and is preparing a design method.

NOTE 2 In Europe, the term “thermally toughened” is used instead of “tempered”.

Glass in building — Tempered soda lime silicate safety glass

1 Scope

This document covers product definitions, product characteristics, i.e. tolerances, flatness, edgework, etc., fracture characteristics, including fragmentation, and the physical and mechanical characteristics of flat tempered soda lime silicate safety glass for use in buildings.

This document does not cover curved (bent) glass according to ISO 11485.

Other requirements, not specified in this document, can apply to thermally toughened soda lime silicate safety glass which is incorporated into assemblies, e.g. laminated glass or insulating glass units, or undergo an additional treatment, e.g. coating. The additional requirements are specified in the appropriate glass product standard. Thermally toughened soda lime silicate safety glass, in this case, does not lose its mechanical or thermal characteristics.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1288-3, *Glass in building — Determination of the bending strength of glass — Part 3: Test with specimen supported at two points (four point bending)*

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

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

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

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

ISO 29584, *Glass in building — Pendulum impact testing and classification of safety glass*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
flat tempered safety glass
tempered (thermally toughened) glass which has not been deliberately given a specific profile during manufacture

1) Under preparation.

3.2
enamelled tempered safety glass
tempered (thermally toughened) glass which has a ceramic frit fired into the surface during the tempering (toughening) process

Note 1 to entry: After tempering, the ceramic frit becomes an integral part of the glass.

Note 2 to entry: The application of the ceramic frit may be by a continuous application or discontinuous, e.g. screen printing.

3.3
horizontal process
process in which the glass is supported on horizontal rollers

3.4
air cushion process
process in which the glass is supported by an air cushion with or without additional rollers

Note 1 to entry: In this process, the glass will be between horizontal and 45° of horizontal.

3.5
vertical process
process in which the glass is suspended by tongs

3.6
edge deformation
deformation of the edge caused by the tong marks

3.7
edge lift
distortion produced in horizontally tempered safety glass, at the leading and trailing edge of the plate, as a result of the glass during the tempering (toughening) process not being supported by a roller

Note 1 to entry: This is a distortion produced by a deviation from surface flatness.

Note 2 to entry: Also referred to as edge dip.

3.8
perimeter deformation
distortion around the edge of tempered safety glass manufactured by air cushion process

3.9
local distortion
local deformation of vertically tempered safety glass underneath the tong marks

3.10
overall bow
deformation of the whole pane of tempered safety glass caused by the heating and cooling process

3.11
roller wave distortion
periodic distortion produced in horizontally tempered safety glass as a result of the glass during tempering process being in contact with the rollers

Note 1 to entry: This is a surface distortion produced by a reduction in surface flatness.

3.12
wave distortion
distortion in tempered safety glass manufactured by the air cushion process as a result of the tempering process

4 Glass products

Tempered safety glass is made from a monolithic glass generally corresponding to one of the following standards:

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

— float glass according to ISO 16293-2;

— patterned glass according to ISO 16293-5;

— coated glass according to ISO 11479-1.

NOTE For drawn sheet glass, an ISO standard is not available. Therefore, see EN 572–4 or national standards.

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

5 Fracture characteristics

5.1 General

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

Fragmentation in service may not correspond exactly to that described in Clause 8, due to restraint from fixing and external actions or due to the cause of fracture.

There can be different fragmentations if heat-strengthened glass is used in laminated glass.

5.2 Accidental human impact

5.2.1 When subjected to an accidental human impact, tempered safety glass will either not break or break in a manner that will reduce the risk of cutting and piercing injuries.

5.2.2 Tempered safety glass can be classified by the use of a pendulum impact test. When tested by this type of test, the safe breakage criteria employed for tempered safety glass is that the 10 largest crack free particles collected within 3 min after impact shall weigh no more than the mass equivalent of 6 500 mm^2 of the original test piece.

5.2.3 The quoted break criteria is taken from the standards given in Annex A. Annex A lists the test methods presently employed to classify this product.

NOTE The safe breakage criteria are different from the fragmentation criteria used to determine that the product complies with its definition.

5.3 Fragmentation

This test method is employed to demonstrate that the tempered safety glass breaks in the manner expected of this product. The fragmentation test (see Clause 8) details the minimum number of crack-free particles that shall be in a set area, i.e. 50 mm × 50 mm, and the dimension of the largest acceptable splinter.

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.

6 Dimensions and tolerances

6.1 Nominal thickness and thickness tolerances

The nominal thicknesses and thickness tolerances are those given in the relevant product standards (see Clause 4).

Table 1 — Nominal thicknesses and tolerances

Nominal thickness mm	Float glass tolerances mm	Patterned glass tolerances mm
2	±0,2	Not manufactured
3	±0,3	±0,5
4	±0,3	±0,5
5	±0,3	±0,5
6	±0,3	±0,5
8	±0,6	±0,8
10	±0,6	±1,0
12	±0,8	±1,5
15	±0,8	±1,5
19	±1,2	±1,5
22	±1,2	±2,0
25	±1,2	Not manufactured

The thickness of a pane shall be determined as for the basic product. The measurement shall be taken at the centre of the four sides, and away from the area of any tong marks (see Figure 2), which may be present.

6.2 Width and length (sizes)

6.2.1 General

When tempered safety glass dimensions are quoted for rectangular panes, the first dimension shall be the width, *B*, and the second dimension the length, *H*, as shown in Figure 1. It shall be made clear which dimension is the width, *B*, and which is the length, *H*, when related to its installed position.

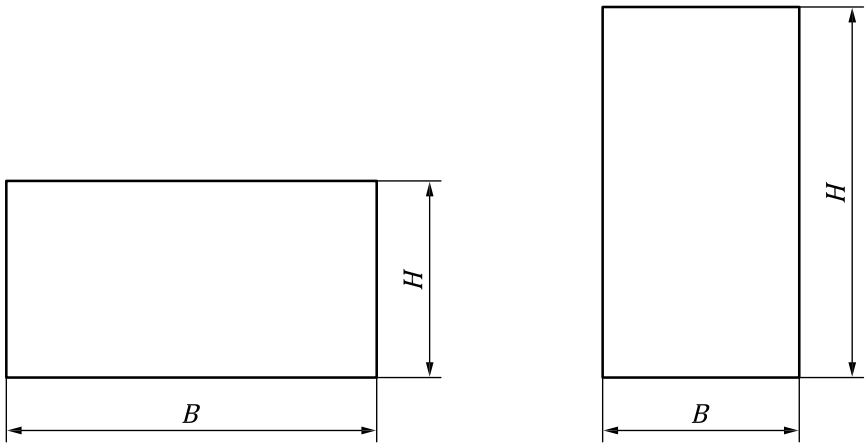


Figure 1 — Examples of width, *B*, and length, *H*, relative to the pane shape

For tempered safety glass manufactured from patterned glass, the direction of the pattern should be specified relative to one of the dimensions.

6.2.2 Maximum and minimum sizes

For maximum and minimum sizes, the manufacturer should be consulted.

6.2.3 Tolerances and squareness

The nominal dimensions for width and length being given, the finished pane shall not be larger than the nominal dimensions increased by the tolerance, *t*, or smaller than the nominal dimensions reduced by the tolerance, *t*. Limits are given in Table 2.

The squareness of rectangular glass panes is expressed by the difference between its diagonals. The difference between the two diagonal lengths of the pane of glass shall not be larger than the deviation limit, *v*, as specified in Table 3.

Table 2 — Tolerances, *t*, on width, *B*, and length, *H*

Dimensions in millimetres

Nominal dimension of side, *B* or *H*	**Nominal glass thickness**										
	2	3	4	5	6	8	10	12	15	19	25
≤ 1 000	±2						±3		±4	±5	
1 000 < *B* or *H* ≤ 2 000	±3								±4	±5	
2 000 < *B* or *H* ≤ 3 000	±4									±6	
3 000 < *B* or *H*	±4						±5			±6	

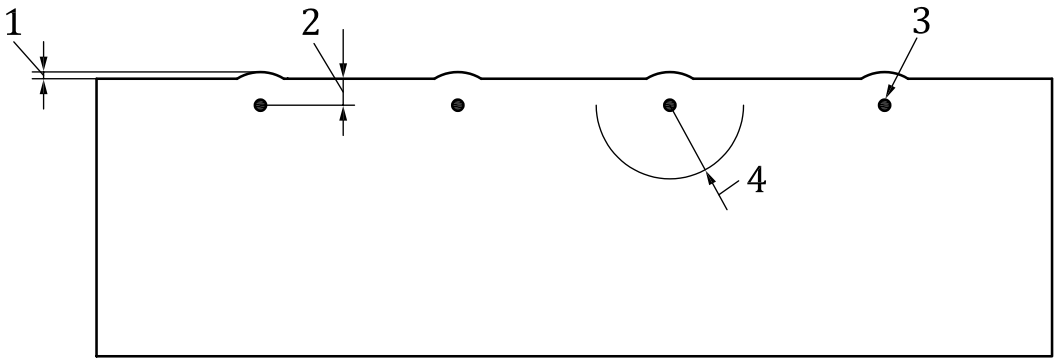
Table 3 — Limit deviations, *v*, for the difference between diagonals

Dimensions in millimetres

Nominal dimension of side, *B* or *H*	**Nominal glass thickness**										
	2	3	4	5	6	8	10	12	15	19	25
≤ 1 000	4						6		8	10	
1 000 < *B* or *H* ≤ 2 000	6								8	10	
2 000 < *B* or *H* ≤ 3 000	8									12	
3 000 < *B* or *H*	8						10			12	

6.2.4 Edge deformation produced by vertical tempering

The tongs used to suspend the glass during tempering result in surface depressions, known as “tong marks” (see Figure 2). The centres of the tong marks are situated up to a maximum of 20 mm from the edge. A deformation of the edge less than 2 mm can be produced in the region of the tong mark and there may also be an area of optical distortion.



Key

1 deformation in the tolerances of Table 2
2 up to 20 mm
3 tong mark
4 100 mm radius maximum area of optical distortion

Figure 2 — Tong mark deformation

6.3 Flatness

6.3.1 General

By the very nature of the tempering process, it is not possible to obtain a product as flat as annealed glass. This difference in flatness depends on the type of glass, e.g. coated, patterned, etc., glass dimensions, i.e. the nominal thickness, the dimensions, the ratio between the dimensions and the type of the tempering process employed.

There are six kinds of distortion:

a) overall bow (see Figure 3);

b) roller wave distortion (for horizontally tempered safety glass only) (see Figure 4);

c) edge lift (for horizontally tempered safety glass only) (see Figure 5);

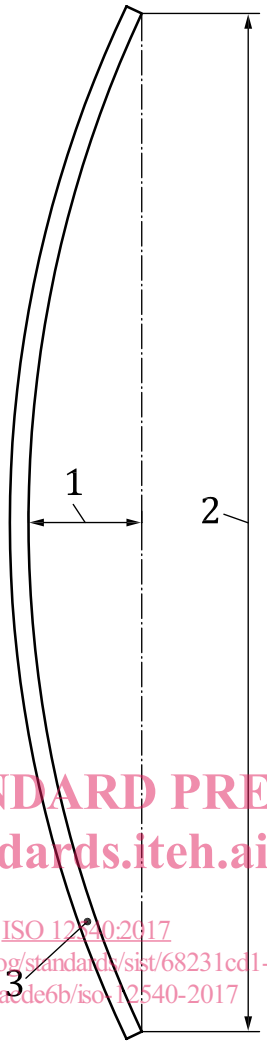
d) local distortion (for vertically tempered safety glass only) (see Figure 6).

Local distortion needs to be allowed for within the glazing materials and the weather seals. For special requirements, the manufacturers should be consulted.

e) wave distortion (for air cushion–tempered safety glass only) (see Figure 4);

f) perimeter deformation (for air cushion–tempered safety glass only) (see Figure 10).

NOTE Overall bow, roller wave, edge lift and perimeter deformation can, in general, be accommodated by the framing system.



Key

1 deformation for calculating overall bow
2 *B*, or *H*, or diagonal length
3 tempered safety glass

Figure 3 — Representation of overall bow

Key

1 roller wave distortion

Figure 4 — Representation of wave or roller wave distortion