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Glass in building — Heat strengthened soda lime silicate glass

Verre dans la construction — Verre de silicate sodo-calcique durci thermiquement

Reference number
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Foreword

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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 of 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 www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Heat strengthened soda lime silicate glass has a higher resistance to thermal stress and an enhanced mechanical strength when compared to annealed soda lime silicate glass.

Glass in building — Heat strengthened soda lime silicate glass

1 Scope

This document specifies product definitions, product characteristics (i.e. tolerances, flatness, edgework), fracture characteristics, including fragmentation, and the physical and mechanical characteristics of flat heat strengthened soda lime silicate glass for use in buildings.

This document does not cover surface finished glasses (e.g. sandblasted, acid etched) after heat strengthening.

This document does not cover curved (bent) glass.

Other requirements, not specified in this document, can apply to heat strengthened soda lime silicate glass which is incorporated into assemblies (e.g. laminated glass or insulating glass units), or undergoes an additional treatment (e.g. coating). The additional requirements are specified in the appropriate glass product standard. Heat strengthened soda lime silicate 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, *Glass in building — Basic soda lime silicate glass products — Part 2: Float glass*

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

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

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

3.1
heat strengthened soda lime silicate glass
heat strengthened glass
glass within which a permanent surface compressive stress, additionally to the basic mechanical strength, has been induced by a controlled heating and cooling process in order to give it increased resistance to mechanical and thermal stress and prescribed fragmentation characteristics

Note 1 to entry: Thermal durability and mechanical strength are generated by the level of surface compression. These properties are not size dependent.

3.2
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 is between horizontal and 45° of horizontal.

3.3
edge deformation
deformation of the edge caused by the tong marks

3.4
edge lift
edge dip
distortion produced in horizontally *heat strengthened glass* (3.1), at the leading and trailing edge of the plate, as a result of the glass not being supported by a roller during the heat strengthening process

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

3.5
perimeter deformation
distortion around the edge of *heat strengthened glass* (3.1) manufactured by *air cushion process* (3.2)

3.6
local distortion
local deformation of vertically *heat strengthened glass* (3.1) underneath the tong marks

3.7
overall bow
deformation of the whole pane of *heat strengthened glass* (3.1) caused by the heating and cooling process

3.8
roller wave distortion
periodic deformation produced in horizontally *heat strengthened glass* (3.1) as a result of the glass during heat strengthening process being in contact with the rollers

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

3.9
wave distortion
distortion in *heat strengthened glass* (3.1) manufactured by the *air cushion process* (3.2) as a result of the heat strengthening process

4 Glass products

Heat strengthened glass shall be made from a monolithic glass corresponding to ISO 16293-1:

— when float glass is used it shall be in accordance to ISO 16293-2;

— when patterned glass is used it shall be according to ISO 16293-5;

— when coated glass is used it shall be according to ISO 11479-1.

NOTE There is no international standard for drawn sheet glass. Therefore, see EN 572-4 or national standards.

Glass nominal thicknesses other than those covered in the above international standards are possible.

5 Fracture characteristics

5.1 General

In the event of breakage, heat strengthened glass fractures in a manner similar to annealed glass (see Clause 8).

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.

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

5.2 Fragmentation

This test method is employed to demonstrate that heat strengthened glass breaks in the manner expected for this product. The fragmentation test (see Clause 8) details the fracture pattern, especially the maximum surface area of "islands".

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

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), some of which are reproduced in Table 1.

Table 1 — Nominal thicknesses and tolerances

Nominal thickness mm	Float glass tolerances mm	Patterned glass tolerances mm
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[a]	±0,8	±1,5

[a] This thickness is only produced by some manufacturers. Therefore, consult the manufacturer for availability.

The thickness of a pane shall be determined as for the basic product. The measurement shall be taken at the centres 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 heat strengthened 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. For heat strengthened glass manufactured from patterned glass, the direction of the pattern should be specified relative to one of the dimensions.

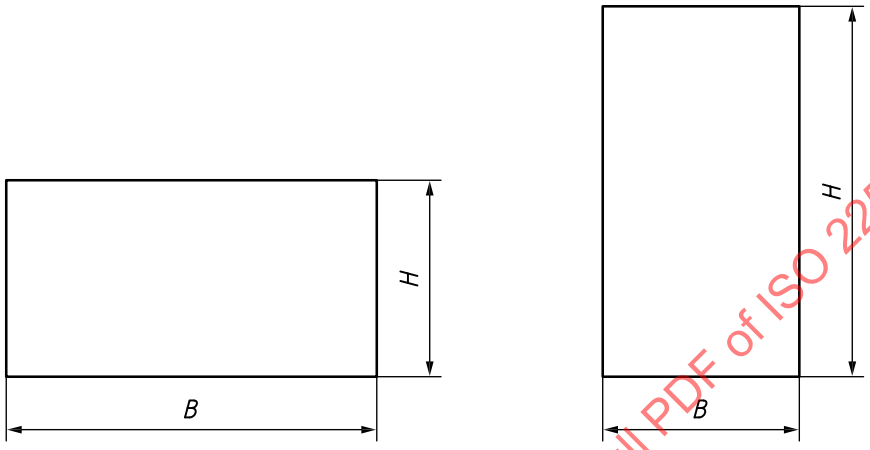


Figure 1 — Examples of width, *B*, and length, *H*, relative to the pane shape

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*	**Tolerance**, *t*	
	Nominal glass thickness, $d \leq 8$	**Nominal glass thickness**, $d > 8$
≤1 000	±2	±3
1 000 < *B* or *H* ≤ 2 000	±3	±3
2 000 < *B* or *H* ≤ 3 000	±4	±4
>3 000	±4	±5

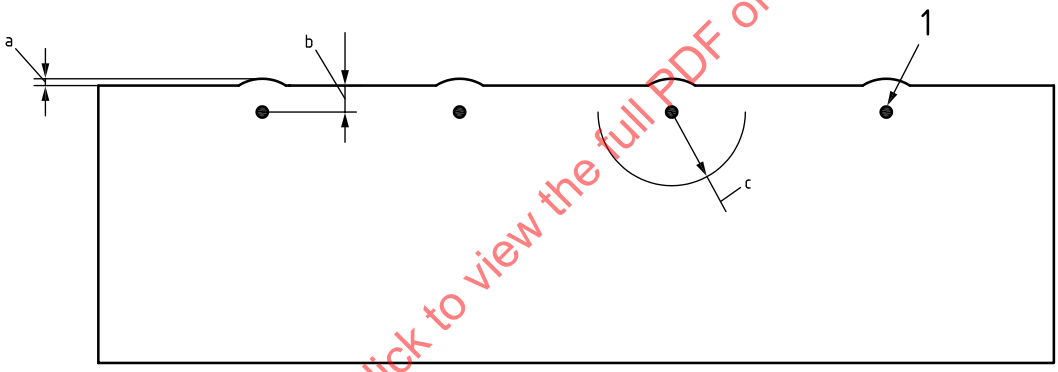
Table 3 — Limit deviations, *v*, for the difference between diagonals

Dimensions in millimetres

Nominal dimension, *B* or *H*	Limit deviation, *v*, on the difference between diagonals	
	Nominal glass thickness, $d \leq 8$	Nominal glass thickness, $d > 8$
≤ 1 000	4	6
1 000 < *B* or *H* ≤ 2 000	6	6
2 000 < *B* or *H* ≤ 3 000	8	8
> 3 000	8	10

6.2.4 Edge deformation produced by vertical heat strengthening

The tongs used to suspend the glass during heat strengthening 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 in 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 tong mark

[a] Deformation in the tolerances of Table 2.

[b] Up to 20 mm.

[c] 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 heat strengthening 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), glass dimensions, i.e. the nominal thickness, the dimensions, the ratio between the dimensions and the type of heat strengthening process employed.

There are six kinds of distortion:

a) overall bow (see Figure 3);

b) roller wave distortion (for horizontally heat strengthened glass only) (see Figure 4);

c) edge lift (for horizontally heat strengthened glass only) (see Figure 5);

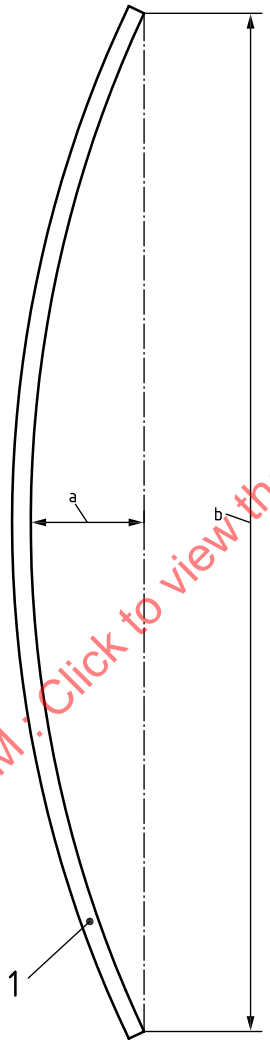
d) local distortion (for vertically heat strengthened glass only) (see Figure 6);

e) wave distortion (for air cushion heat strengthened glass only) (see Figure 4);

f) perimeter deformation (for air cushion heat strengthened glass only) (see Figure 10).

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

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



Key

1 heat strengthened glass

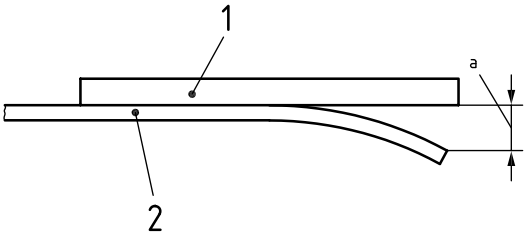
a Deformation for calculating overall bow.

b *B*, or *H*, or diagonal length.

Figure 3 — Representation of overall bow

[a] Roller wave distortion.

Figure 4 — Representation of wave or roller wave distortion



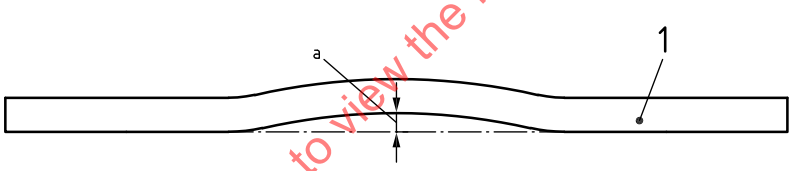
Key

1 straight edge

2 heat strengthened glass

[a] Edge lift.

Figure 5 — Representation of edge lift



Key

1 heat strengthened glass

[a] Local distortion.

Figure 6 — Representation of local distortion

6.3.2 Measurement of overall bow

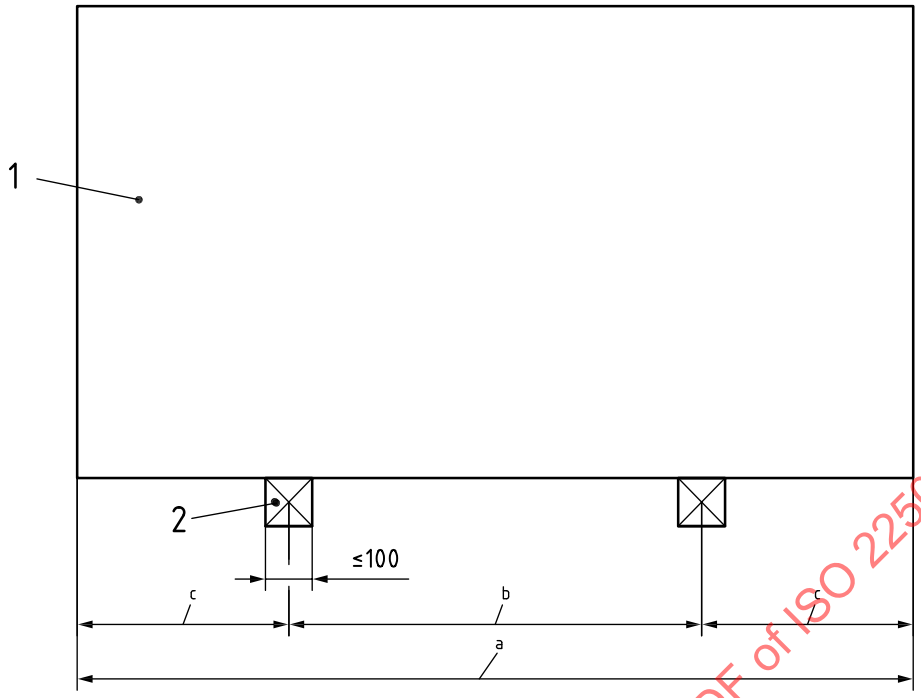
The pane of glass shall be placed in a vertical position and supported on its longer side by two load bearing blocks at the quarter points (see Figure 7).

For glass thinner than 4 mm nominal thickness, a solid back support with an angle between 3° and 7° from the vertical can be used.

The deformation shall be measured along the edges of the glass and along the diagonals, as the maximum distance between a straight metal ruler, or a stretched wire, and the concave surface of the glass (see Figure 3).

The value for the bow is then expressed as the deformation, in millimetres, divided by the measured length of the edge of the glass, or diagonal, in millimetres, as appropriate.

The measurement shall be carried out at room temperature.



Key

1 heat strengthened glass
2 load bearing blocks
a B or H.
b (B or H)/2.
c (B or H)/4.

Figure 7 — Support conditions for the measurement of overall bow

Special care shall be taken for large and thin panes because they may show a buckling which is different from an overall bow caused by the heat strengthening process. Results from this test method for glasses thinner than 4mm may be inaccurate.

6.3.3 Measurement of wave or roller wave distortion

6.3.3.1 General

The wave or roller wave distortion is measured by means of a straight edge, or equivalent, being placed at right angles to the wave or roller wave and bridging from peak to peak of the wave (see Figure 8).

NOTE This section deals with measurement using a straight edge and feeler gauges. An alternative method is described in Annex A.

6.3.3.2 Apparatus

6.3.3.2.1 A straight edge, with a length between 300 mm and 400 mm.

NOTE The actual length of straight edge required depends on the wavelength of the wave or roller wave.

6.3.3.2.2 Feeler gauges, with various thicknesses in units of 0,05 mm.

6.3.3.3 Method

Place the straight edge so that it bridges across adjacent peaks. Insert the feeler gauge between the glass surface and the straight edge. Increase the thickness of the feeler gauges until they just fill the gap between glass surface and the straight edge. Record the thickness of feeler gauge(s) to an accuracy of 0,05 mm.

Repeat the measurement at several places over the glass surface.

The measured wave or roller wave distortion is the maximum value measured. The maximum allowable values are given in Table 4 and Table 6.

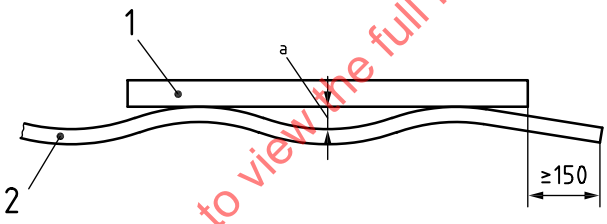
6.3.3.4 Limitations

The following limitations apply:

— the wave or roller wave can only be measured on panes with a dimension greater than 600 mm measured at right angles to the waves or roller waves;

— the wave or roller wave cannot be measured in an exclusion area that is 150 mm from the edges of the pane. The apparatus should not be used in the exclusion area;

— panes with an overall bow shall be laid on a flat support. This will allow gravity to flatten out the overall bow and hence give a truer result for the wave or roller wave.



Key

1 straight edge

2 heat strengthened glass

a Wave or roller wave distortion.

Figure 8 — Measurement of wave or roller wave distortion

6.3.4 Measurement of edge lift (for horizontally heat strengthened glass only)

6.3.4.1 Apparatus

6.3.4.1.1 Straight edge, with a length between 300 mm and 400 mm.

NOTE The actual length of the straight edge required depends on the wavelength of the roller wave.

6.3.4.1.2 Feeler gauges, with various thicknesses in units of 0,05 mm.

6.3.4.2 Method

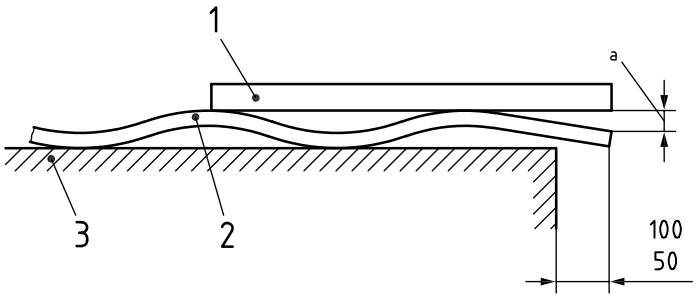
The glass shall be placed on a flat support with the edge lift overhanging the edge of the support. The overhanging distance should be between 50 mm and 100 mm.

The straight edge shall be placed on the peaks of the roller waves and the gap between the ruler and the glass is measured using a feeler gauge (see Figure 9).

The maximum values for edge lift are given in Table 5.

The values in Table 5 only apply to heat strengthened glass having edgework complying with Figures 12 to 15. For profiled edges or other types of edgework, contact the manufacturer.

Dimensions in millimetres



Key

1 straight edge
2 heat strengthened glass
3 flat support
a Edge lift.

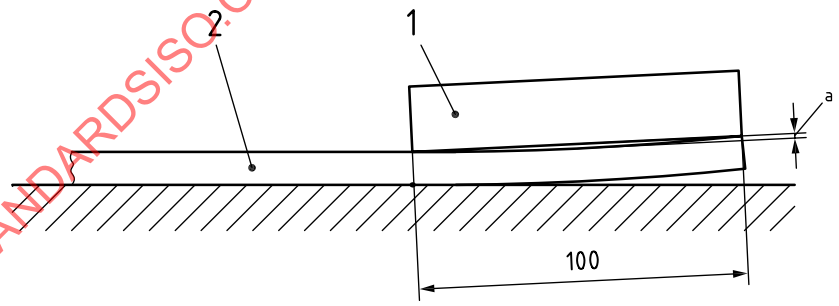
Figure 9 — Measurement of edge lift

6.3.5 Measurement of perimeter deformation of glass produced by air cushion toughening process

The glass shall be placed on a flat surface with the concave side facing upwards; see Figure 10. A 100 mm straight edge is laid on the pane at right angles to the edge. The gap between the ruler and the glass is measured using a feeler gauge (see Figure 10). The perimeter deformation is the maximum distance between the surface of the pane and the straight edge.

The maximum allowable values for perimeter deformation are given in Table 7.

Dimensions in millimetres



Key

1 straight edge
2 heat strengthened glass
a Perimeter deformation.

Figure 10 — Measurement of perimeter deformation

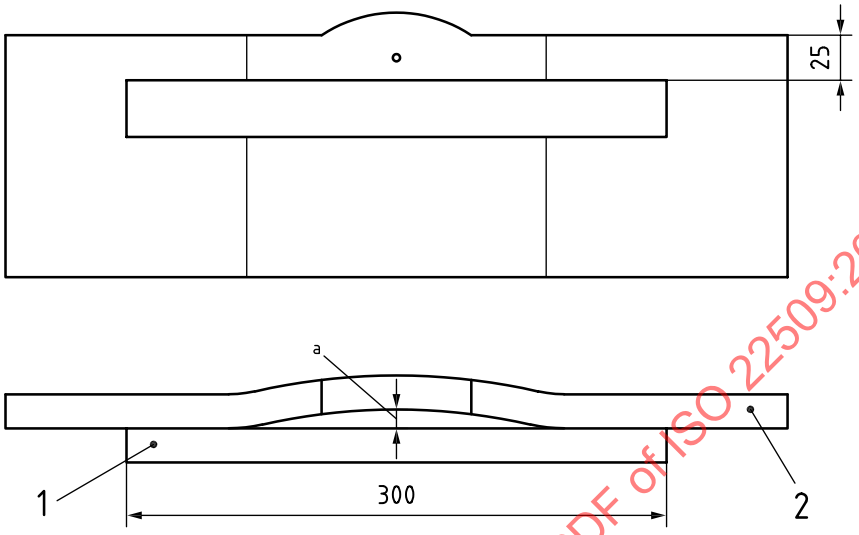
6.3.6 Measurement of local distortion (for vertically heat strengthened glass only)

Local distortion can occur over relatively short distances on the edges with tong mark of the vertically heat strengthened glass that contained the tong marks (see Figure 2) of the glass. Local distortion shall

be measured over a limited length of 300 mm by using a straight ruler, or a stretched wire, parallel to the edge at a distance of 25 mm from the edge of the glass (see Figure 11).

Local distortion is expressed as mm/300 mm length.

Dimensions in millimetres



Key

1 straight edge
2 heat strengthened glass
[a] Local distortion.

Figure 11 — Measurement of local distortion

For patterned glass, local distortion shall be determined by using a straight ruler resting on the high points of the pattern and measuring to a high point of the pattern.

6.3.7 Limitation on overall bow, roller wave and edge lift for horizontally heat strengthened glass

The maximum allowable values for the overall bow, when measured according to 6.3.2, for the roller wave, when measured according to 6.3.3, and for edge lift, when measured according to 6.3.4, are given in Tables 4 and 5. These values only apply to heat strengthened glass without holes and/or notches and/or cut-outs.

Table 4 — Maximum allowable values of overall bow and roller wave distortion for horizontally heat strengthened glass

Glass type	Maximum allowable value for distortion	
	Overall bow	Roller wave
	mm/m	mm
Uncoated float according to ISO 16293-2	3,0	0,4
Others[a]	4,0	0,5
[a] For enamelled glass which is not covered over the whole surface, the manufacturer should be consulted.		

Depending on the wavelength of the roller wave, an appropriate length of straight edge shall be used.

Table 5 — Maximum allowable values of edge lift for horizontally heat strengthened glass

Glass type	Thickness of glass mm	Maximum allowable values mm
Uncoated float according to ISO 16293-2	3	0,5
	4 to 5	0,5
	6 to 12	0,3
Others[a]	all	0,5
[a] For enamelled glass which is not covered over the whole surface, the manufacturer should be consulted.		

Depending on the wavelength of the roller wave, an appropriate length of straight edge shall be used.

6.3.8 Limitation on overall bow, wave and perimeter deformation for heat strengthened glass manufactured by air cushion process

The maximum allowable values for the overall bow, when measured according to 6.3.2, for the wave, when measured according to 6.3.3, and for perimeter deformation, when measured according to 6.3.5, are given in Tables 6 and 7. These values only apply to heat strengthened glass without holes and/or notches and/or cut-outs.

Table 6 — Maximum allowable values of overall bow and wave distortion for heat strengthened glass manufactured by air cushion process

Glass Type	Maximum allowable value for distortion	
	Overall bow mm/m	Wave mm
Uncoated float according to ISO 16293-2 and coated float glass according to ISO 11479-1	3,0	0,3
Others[a]	4,0	0,5
For other glass types, the manufacturer should be consulted. [a] For enamelled glass which is not covered over the whole surface the manufacturer should be consulted.		

Table 7 — Maximum allowable values of perimeter deformation for heat strengthened glass manufactured by air cushion process

Glass type	Thickness of glass mm	Maximum allowable values mm
Uncoated float according to ISO 16293-2 and coated float glass according to ISO 11479-1	up to 12	0,3
Others[a]	up to 12	0,5
For other glass types, the manufacturer should be consulted. [a] For enamelled glass which is not covered over the whole surface, the manufacturer should be consulted.		

6.3.9 Limitation on overall bow and local distortion for vertically heat strengthened glass

The maximum allowable values for the overall bow, when measured according to 6.3.2, and the local distortion, when measured according to 6.3.6, are given in Table 8. These values only apply to heat strengthened glass without holes and/or notches and/or cut-outs.

Table 8 — Maximum allowable values of overall bow and local distortion for vertically heat strengthened glass

Glass type	Maximum allowable value for distortion	
	Overall bow mm/m	Local distortion mm/300 mm
All[a]	5,0	1,0
[a] For enamelled glass which is not covered over the whole surface, the manufacturer should be consulted.		

6.3.10 Other distortions

The incorporation of holes and/or notches in a plate gives the possibility of distortions being produced during the heat strengthening process as a result of the absence of glass and/or an increase in unsupported edges. The magnitude of these distortions is generally less than edge lift in horizontally heat strengthened glass or local distortion in vertically heat strengthened glass.

7 Edge work, holes, notches and cut-outs

7.1 General

Heat strengthened glass should not be cut, sawed, drilled, edge-worked or surface finished (e.g. sandblasting, acid etching) after heat strengthening because the risk of breakage is increased or the glass can be destroyed immediately. Glasses cut, sawed, drilled, edge-worked or surface finished (e.g. sandblasting, acid etching) after heat strengthening are not covered by this document.

No modification that will affect the structural characteristics or integrity of heat strengthened glass as specified in this document shall be made.

Marking in the corner of a product after heat strengthening, as specified in Clause 10, is allowed.

7.2 Edge working of glass for heat strengthening

The simplest type of edge working is the arrissed edge (see Figure 12). Other common types are shown in Figures 13 to 15. For specialist edge work, such as “water jet cutting”, the manufacturers should be consulted. Corners may not be treated unless required by the customer.

Correctly cut edges may be heat strengthened without further edge working.

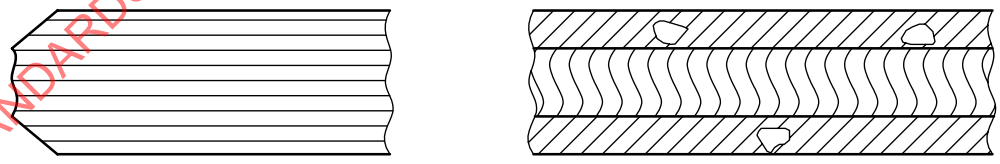


Figure 12 — Arrissed edge (with blank spots)

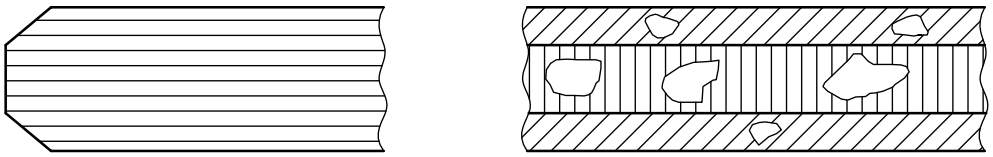


Figure 13 — Ground edge (with blank spots)

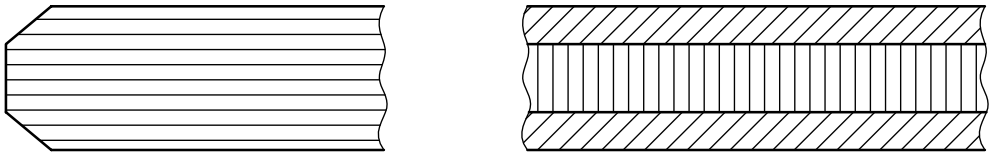


Figure 14 — Smooth ground edge (no blank spots)

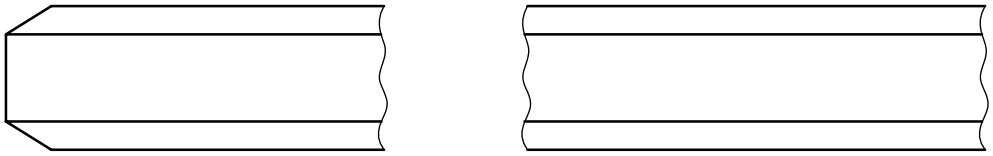


Figure 15 — Polished edge

7.3 Profiled edges

Various other edge profiles can be manufactured with different types of edgework. This kind of product is not covered by Table 5 due to the influence of the profile.

7.4 Round holes

7.4.1 General

This document considers only round holes in glass of no less than 4 mm nominal thickness. For holes in glasses thinner than 4 mm, the manufacturer should be consulted. The manufacturer should be consulted about edge working of holes.

7.4.2 Diameter of holes

The diameter of holes, ∅, shall not, in general, be less than the nominal thickness of the glass. For smaller holes, the manufacturer should be consulted.

7.4.3 Limitations on position of holes

In general, the limitations on hole positions relative to the edges of the glass pane, the corners of the glass pane and to each other depend on:

g) the nominal glass thickness (d);

h) the dimensions of the pane (B, H);

i) the hole diameter (∅);

j) the shape of the pane;

k) the number of holes.

Glasses produced following the recommendations given below are assumed to satisfy the requirements of this document.

1) The distance, a, from the edge of a hole to the glass edge should be not less than $2d$ (see Figure 16 for an example).

   $a \geq 2d$

   For holes less than $2d$ from the edge, consult the manufacturer.

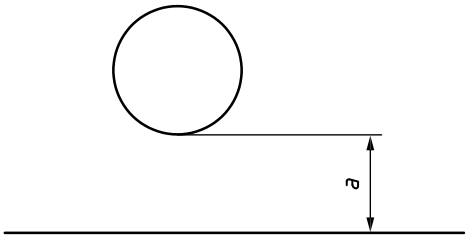


Figure 16 — Relationship between hole and edge of pane

2) The distance, b, between the edges of two holes should be not less than $2d$ with a minimum distance of b = 10 mm (see Figure 17 for an example).

$b \geq 2d$

For hole separation (b) less than $2d$ from the edge, consult the manufacturer.

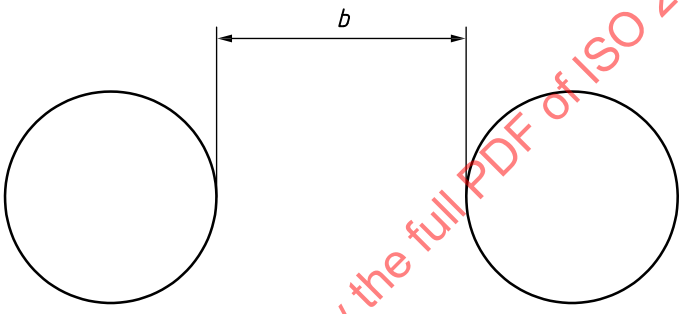


Figure 17 — Relationship between two holes

3) The distance, c, from the edge of a hole to the corner of the glass should be not less than $6d$ (see Figure 18 for example).

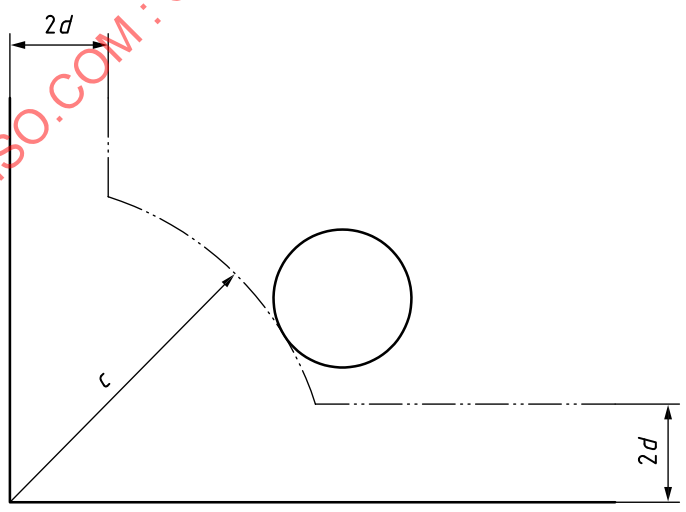


Figure 18 — Relationship between hole and corner of pane

For a distance c less than $6d$, the manufacturer should be consulted.

If one of the distances from the edge of the hole to the edge of the glass is less than 35 mm, it can be necessary to position the hole asymmetrically with respect to the corner. The manufacturer should be consulted.

7.4.4 Tolerances on hole diameters

The tolerances on hole diameters are given in Table 9.

Table 9 — Tolerances on hole diameters

Dimensions in millimetres

Nominal hole diameter ⌀	Tolerances
4 ≤ ⌀ ≤ 20	±1,0
20 < ⌀ ≤ 100	±2,0
100 < ⌀	consult the manufacturer

7.4.5 Tolerances on position of holes

The tolerances on positions of holes are given in Table 10. The positions of holes are measured in two directions at right angles (x- and y-axes) from a reference point to the centre of the holes. The datum point is generally chosen as a real or virtual corner of the pane (see Figure 19 for examples).

The position of a hole (X, Y) is ($x \pm t$, $y \pm t$), where x and y are the required dimensions and t is the tolerance from Table 10.

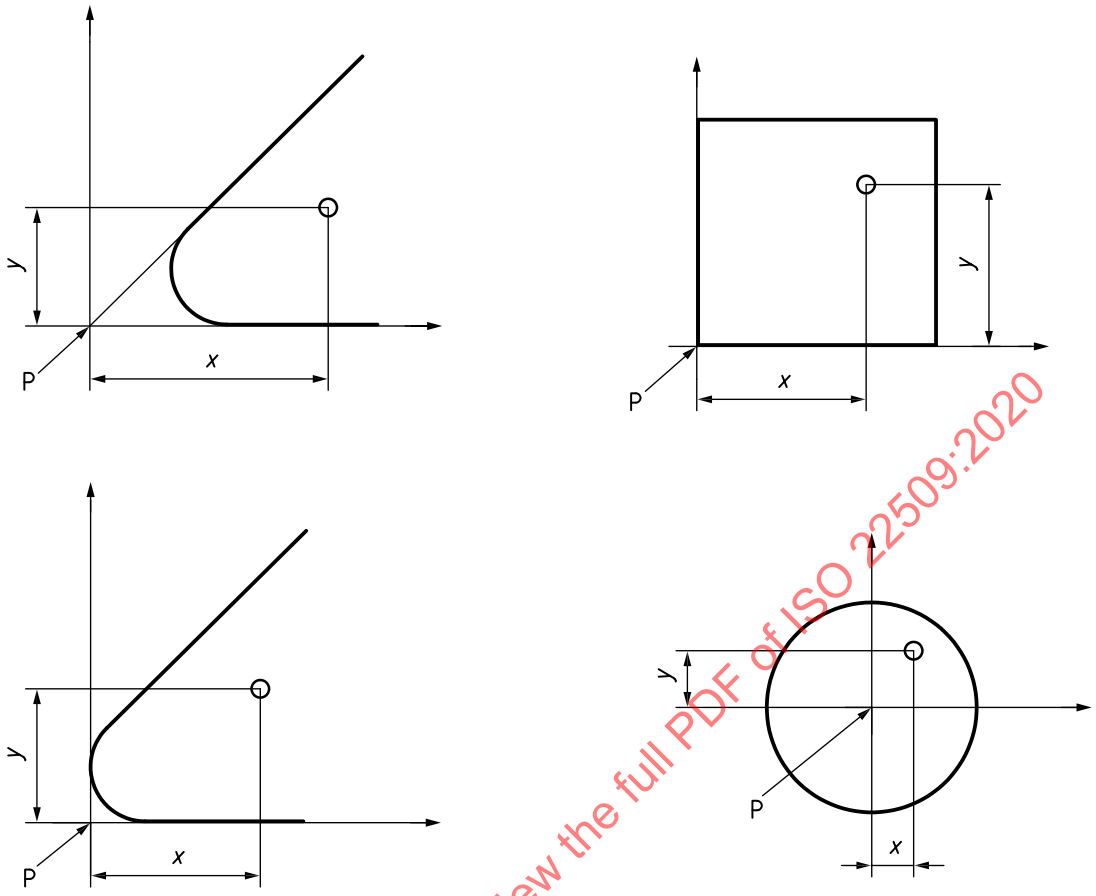
Table 10 — Tolerances on positions of holes

Dimensions in millimetres

Nominal dimension of side, B or H	Tolerance, t
	Nominal glass thickness, $d \leq 12$
< 2 000	±2,5 (horizontal and air cushion heat strengthening) ±3,0 (vertical heat strengthening)
2 000 < H or B < 3 000	±3,0
< 3 000	±4,0

The manufacturer should be consulted if tighter tolerances on hole positions are required.

Other types of hole are possible, for instance countersunk holes (see Figure 20). The manufacturer shall be consulted for the tolerances on hole position, shape and dimensions, and on possible hole edge work.



Key

P datum point

Figure 19 — Examples of the positioning of holes relative to the reference point

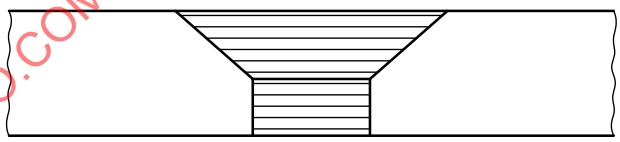


Figure 20 — Countersunk hole

7.5 Notches and cut-outs

Many configurations of notches and cut-outs can be supplied. For example, see Figure 21.

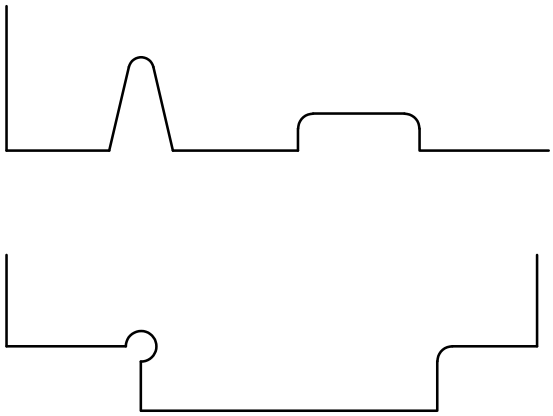


Figure 21 — Examples of notches and cut outs

The manufacturer should be consulted about edge working of notches and cut-outs.

7.6 Shaped panes

Many non-rectangular shapes can be manufactured and manufacturers should be consulted.

8 Fragmentation test

8.1 General

The fragmentation test determines whether the glass breaks in the manner prescribed for a heat strengthened glass. This fragmentation test shows the type of breakage of a heat strengthened glass due to the pre-stress only, without any other stress from external action. In service, the real breakage behaviour can be different.

8.2 Dimensions and number of test specimens

The dimensions of the test specimens shall be 360 mm × 1 100 mm, without holes, notches or cut-outs.

Five specimens shall be tested.

8.3 Test procedure

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 22).

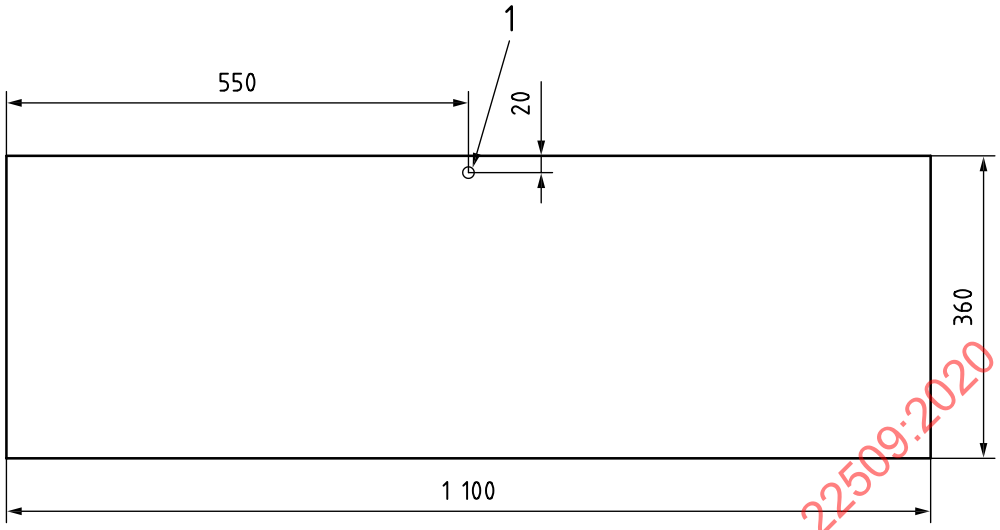
NOTE The fragmentation characteristics of glass are unaffected by temperatures between –50 °C and +100 °C.

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.

The test specimen shall be laid flat on a table without any mechanical constraint. In order to prevent scattering of the fragments, the specimen shall be simply held at the edges (e.g. by a small frame, adhesive tape), so that the fragments remain interlocked after breakage yet extension of the specimen is not hindered.

The use of adhesive backed polymeric films is not recommended as it can constrain the glass when broken.

Dimensions in millimetres



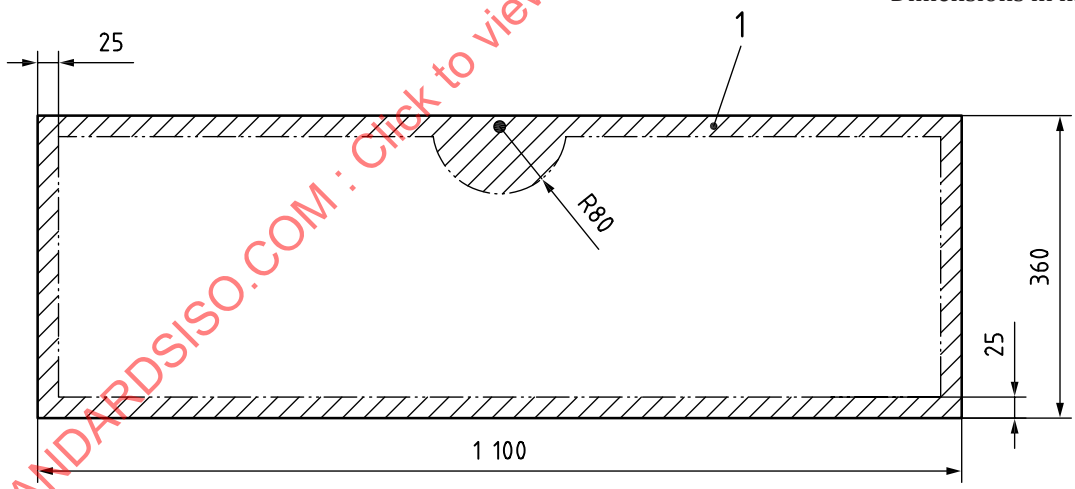
Key

1 impact point

Figure 22 — Position of impact point

For heat strengthened glass manufactured by vertical heat strengthening, the impact point shall not be on the tong mark edge.

Dimensions in millimetres



Key

1 excluded area

Figure 23 — Area to be excluded from the assessment of fragmentation

8.4 Assessment of fragmentation

Each test specimen shall be examined for its fragmentation pattern. 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 23), shall be excluded from the assessment.

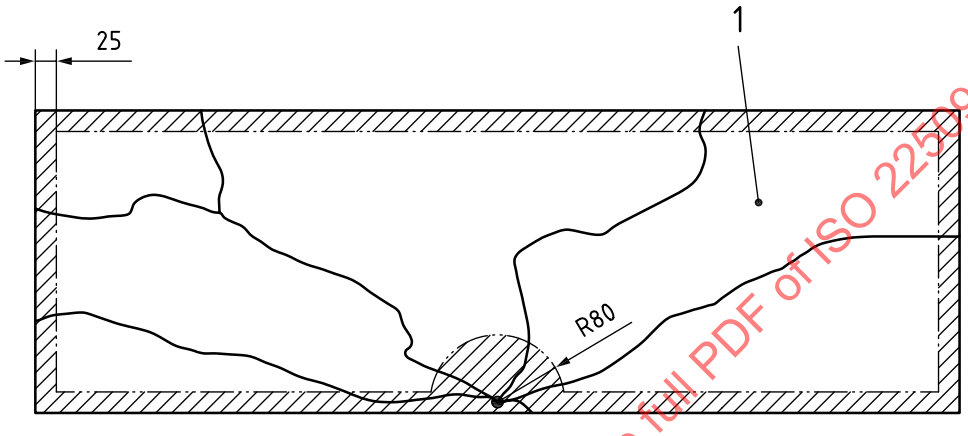
The examination shall be completed within 5 min of fracturing the glass. The weighing can be performed later.

Each fragment produced during the test shall be examined as follows.

a) At least one edge of the fragment shall reach the excluded area (see Figure 24).

b) Where no edge of the fragment reaches the excluded area (see Figure 25), either an "island" or a "particle" is produced. Particles are fragments with area/mass equivalent less than 100 mm^2. Islands are fragments with area/mass equivalent greater than or equal to 100 mm^2.

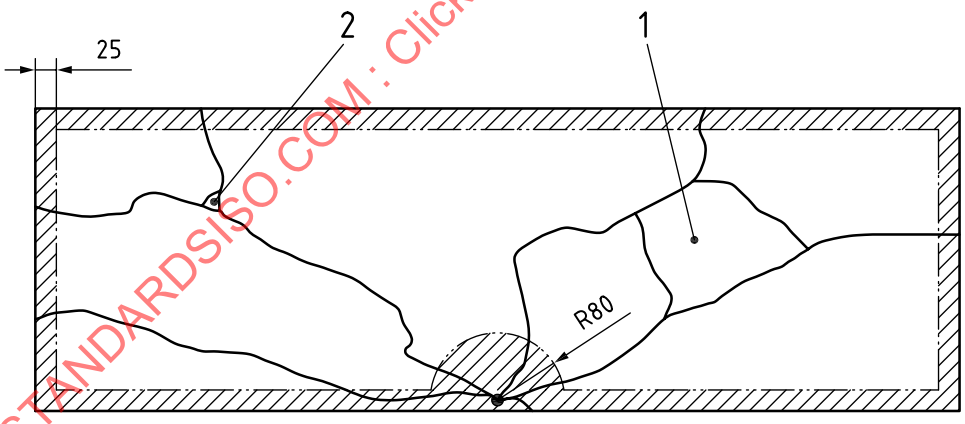
NOTE Area = mass/(thickness × density), e.g. a fragment of 6 mm thick glass of mass 1,5 g has an area/mass equivalent of 100 mm^2.



Key

1 example of fragment

Figure 24 — Representation of fragmentation



Key

1 island

2 particle

Figure 25 — Representation of island and particle

c) The number of island fragments shall be counted and each island shall be weighed.

d) The particles shall be collected and weighed.

8.5 Evaluation of fragmentation

At least four out of the five specimens tested shall meet the following requirements in order for the product to be classified as heat strengthened glass.

Each test specimen:

a) shall have no more than two island fragments;

b) shall not have any island fragments with area/mass equivalent exceeding 1 000 mm^2 (see 8.4);

c) shall not have the area/mass equivalent of all particles exceeding 5 000 mm^2 (see 8.4).

If only one of the five specimens fails to meet the above requirements, then it shall meet the following requirements in order for the product to be classified as heat strengthened glass.

d) It shall have no more than three island fragments;

e) The area/mass equivalent of all islands and particles shall not exceed 50 000 mm^2 (see 8.4).

8.6 Test report

The following information shall be reported:

— reference to this document, i.e. ISO 22509:2020;

— identification of the specimen;

— number of island fragments: 0; 1; 2; 3; more than 3;

— area/mass equivalent of the island fragments;

— area/mass equivalent of the particle fragments;

— 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.

9 Other physical characteristics

9.1 Optical distortion

9.1.1 Heat strengthened glass produced by vertical heat strengthening

The tong marks can produce additional optical distortion, which is generally in an area of radius 100 mm centred on the tong mark (see Figure 2).

9.1.2 Heat strengthened glass produced by horizontal heat strengthening

While the hot glass is in contact with the rollers during the heat strengthening process, a surface distortion is produced by a deviation from surface flatness, known as “roller wave”. Roller wave is generally noticed in reflection. See also 6.3.3.

Small imprints can be shown in the surface of the glass (“roller pick-up”).

9.1.3 Heat strengthened glass produced by the air cushion process

While the hot glass is in contact with supporting transport rolls during the strengthening process, those can generate little imprints at the glass lateral edges. Those defects can be visible but are usually hidden by the framing system.

9.2 Anisotropy (iridescence)

The heat strengthening process produces areas of different stress in the cross section of the glass. These areas of stress produce a birefringent effect in the glass, which is visible in polarized light.

When heat strengthened glass is viewed in polarized light, the areas of stress show up as coloured zones, sometimes known as “leopard spots”.

Polarized light occurs in normal daylight. The amount of polarized light depends on the weather and the angle of the sun. The birefringent effect is more noticeable when the heat strengthened glass is examined either at a glancing angle or through polarized spectacles.

Anisotropy is a visible physical effect but not a defect.

9.3 Thermal durability

The mechanical properties of heat strengthened glass are unchanged for continuous service up to 200 °C and are unaffected by sub-zero temperatures. Heat strengthened glass is capable of resisting both sudden temperature changes and temperature differentials up to 100 K.

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.

9.4 Mechanical strength

The value of mechanical strength can only be given as a statistical value associated with a particular probability of breakage and with a particular type of loading, i.e. four point bending test according to ISO 1288-3.

NOTE The values given in Table 11 are determined in accordance with ISO 1288-3.

Table 11 — Minimum values for the characteristic bending strength of heat strengthened glass

Glass type	Minimum values for characteristic bending strength MPa
Float: clear tinted coated	65
Enamelled float (based on the enamelled surface under tensile stress)	45
Patterned glass	55

While achieving the minimum values for mechanical strength in Table 11, the fragmentation of heat strengthened glass shall satisfy the requirements of 8.5.

WARNING — Values that are too high for the mechanical strength affect the fracture characteristics.

At least 10 specimens of heat strengthened glass shall be tested according to ISO 1288-3. The 5 % breakage probability, statistically evaluated at the lower limit of the 95 % confidence interval, shall be not less than the value in Table 11.