Translated from Lithuanian

Standard

ĮST 4524122-1

Part II – Glass.

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1. Glass Cutting
   1.1. Annealed Glass. Regulatory standard EN 572.

Equipment technical specifications:

Glass thickness (mm)	Glass size (W x H, mm)	Maximum glass size (W x H, mm)	Maximum glass weight (kg)	Glass with a soft coating
2,8-19	6100 x 3210 5100 x 3210 4500 x 1860 (2040) 3210 x 2550 (2250)	6100 xf 3210	900	+

1.1.1. Annealed glass thicknesses and thickness tolerances.

Table 1. Nominal thicknesses and thickness tolerances. Dimensions are in millimetres.

Nominal thickness, d	Thickness tolerance for a particular type of glass			
	Float	Patterned	Drawn sheet glass	New antique, drawn sheet glass
2	± 0,2	not produced	± 0,2	not produced
3	± 0,2	± 0,5	± 0,2	not produced
4	± 0,2	± 0,5	± 0,2	± 0,3
5	± 0,2	± 0,5	± 0,3	not produced
6	± 0,2	± 0,5	± 0,3	± 0,3
8	± 0,3	± 0,8	± 0,4	not produced
10	± 0,3	± 1,0	± 0,5	not produced
12	± 0,3	± 1,5	± 0,6	not produced
14	not produced	± 1,5	not produced	not produced
15	± 0,5	± 1,5	not produced	not produced
19	± 1,0	± 2,0	not produced	not produced
25	± 1,0	not produced	not produced	not produced

1.1.2. Dimensional tolerances for annealed glass.

Table 2. Tolerances for width W and height H. Dimensions are in millimetres.

Nominal dimension of one side (W or H)	Nominal glass thickness d and tolerance, t			
	$d \leq 6$	$8 \leq d \geq 12$	d=15	d=19
≤ 1500	± 1,0	± 1.5	± 2,0	± 2,5
1500 < W or H ≤ 3000	± 1,5	± 2,0	± 2,5	± 3,0
>3000	± 2,0	± 2,5	± 3,0	± 3,5

Table 3. Deviation limit difference between the diagonals. Dimensions are in millimetres.

Nominal dimension of one side (W or H)	Nominal glass thickness d and tolerance, t		
	$d \leq 6$	$8 \leq d \geq 12$	$15 \leq d \geq 19$
≤ 1500	3	4	5
1500 < W or H ≤ 3000	4	5	6
>3000	5	6	8

1.2. Laminated cut glass. Regulatory standard EN 12543.
Equipment technical specifications:

Glass thickness (mm)	Thickness of the interlayer film (X, mm)	Maximum size of the glass workpiece (W x H, mm)	Maximum cut length (mm)	Maximum glass weight (kg)	Glass with a soft coating
Min. 33.X Max 88.X	Min. 0,38 Max. 3,8	6000/6100 x 3210	4600	350	+

1.2.1. Laminated glass thickness tolerances.

Table 4. Laminating film thickness tolerances. Dimensions are in millimetres.

Laminating film thickness	Thickness tolerance, t
≤ 2	± 0,1
>2	± 0,2

The thickness of the laminated glass must not exceed the sum of the thickness tolerances of the individual layers. For example: laminated glass is made of 2 x 3 mm float glass, with a nominal thickness of 3 mm ± 0,2 mm per glass and laminating film with a thickness of 0,5 mm ± 0,1 mm. Therefore, this laminated glass will have a thickness of 6.5 mm and a thickness tolerance of ± 0.5 mm.

1.2.2. Dimensional tolerances for laminated cut glass.

Table 5. Tolerances for cut laminated sheets are allowed. Dimensions are in millimetres.

Nominal dimension of one side (W or H)	Nominal thickness of laminated glass ≤ 8	Nominal thickness of laminated glass > 8	
		Each of the laminated glass sheets of nominal thickness < 10	At least one of the laminated glass sheets of nominal thickness ≥ 10
≤ 2000	+3,0 / -2,0	+ 3,5 / - 2,0	+ 5,0 / - 3,5
≤ 3000	+4,5 / -2,5	+ 5,0 / - 3,0	+ 6,0 / - 4,0
>3000	+5,0 / -3,0	+ 6,0 / - 4,0	+ 7,0 / - 5,0

Table 6. Deviation limit difference between the diagonals. Dimensions are in millimetres.

Nominal dimension of one side (W or H)	Nominal thickness of laminated glass ≤ 8	Nominal thickness of laminated glass > 8	
		Each of the laminated glass sheets of nominal thickness < 10	At least one of the laminated glass sheets of nominal thickness ≥ 10
≤ 2000	6	7	9
≤ 3000	8	9	11
>3000	10	11	13

Table 7. Edge displacement tolerances. Dimensions are in millimetres.

Nominal dimension of one side (W or H)	Edge displacement tolerance t,
≤ 1000	2
1000 < W or H ≤ 2000	3
2000 < W or H ≤ 4000	4
>4000	6

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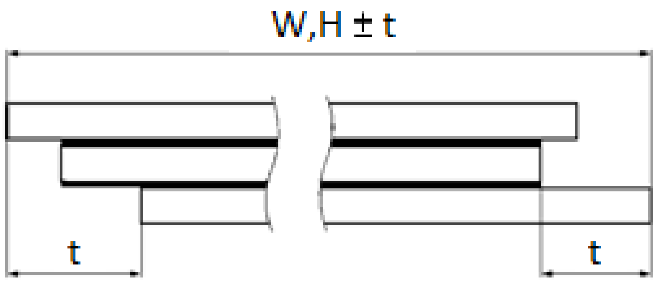


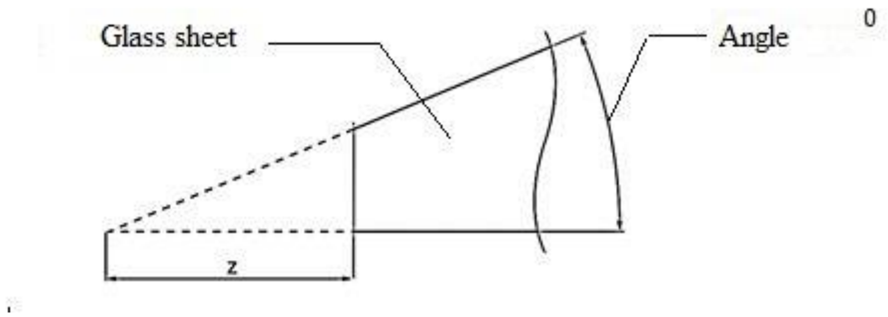
Picture 1. Edge displacement.

1.3. Defects in the edges of annealed and laminated cut glass.

1.3.1. Loss of the pointed apex of the figured glass.

Table 8. Glass part Z, which may be absent after cutting the glass.

Angle of the figured glass (^{0})	Monolithic glass Z (mm)	Laminated glass Z (mm)
≤ 12,5	30	65
≤ 20,0	18	35
≤ 35,0	12	12
≤ 45,0	8	8



Picture 2. The length of the Z segment

1.3.2. Glass edge defects.

Table 9. Edge cutting conicity defects. Dimensions are in millimetres.

Edge of monolithic glass	Nominal glass thickness, d			
	d ≤ 6	8 ≤ d ≥ 10	d=12	15 ≤ d ≥ 19
Maximum height, e	± 1	± 2	± 3	+ 5 / - 4

Table 10. Edge cutting defects. Fractures at the edges. Dimensions are in millimetres.

Nominal glass thickness, d		
d – 1	>	h_1
d / 4	>	p

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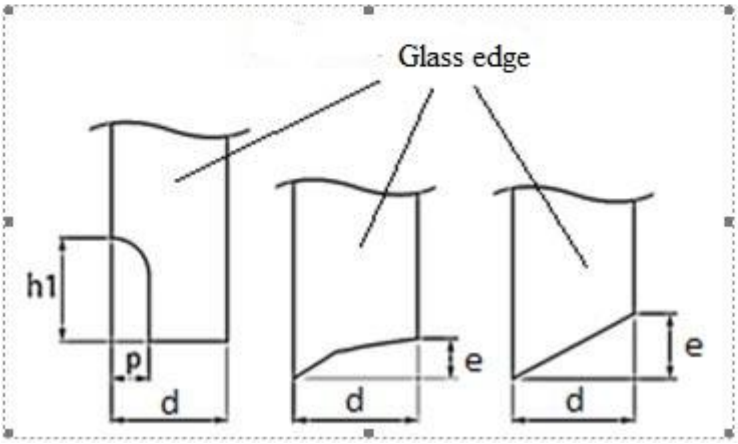
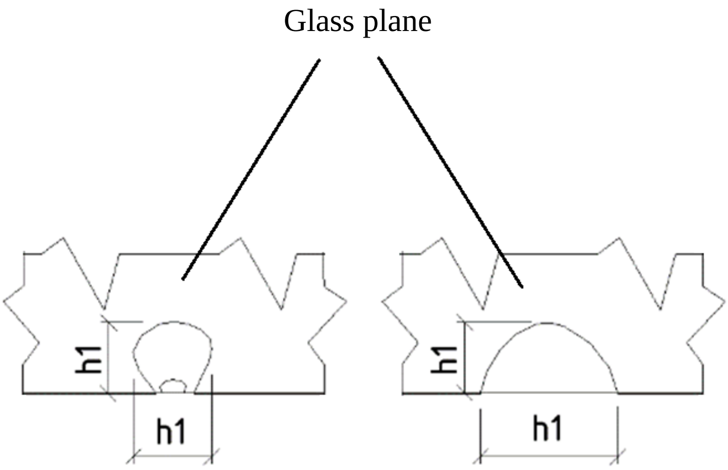




Picture 3. Glass edge defects.

1.4. Annealed and laminated cut glass with "soft" coating, coating deletion along the perimeter.

Table 11. Tolerances on the removal of the coating from the glass surface. Dimensions are in millimetres.

Coating removal width	Tolerance, t
≤10	± 1,0
≥11	+ 2,0 / - 1.0
For EasyPro or TPF protective glass coatings regardless of the removal width	+ 3 / - 1.0

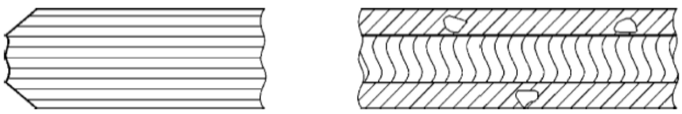
Warning.

Mechanical removal of the coating from the glass surface results in hair lines, streaks, stains or discoloration that are not considered glass defects. The polishing appearance of the coating may vary for each type of glass or removal width. If relevant, we always recommend agreeing the example.

2. Glass edge processing.

2.1.Sharpening / blunting of CNC glass edges.
Equipment technical specifications:

Glass thickness (mm)	Minimum glass size (W x H, mm)	Maximum glass size (W x H, mm)	Maximum glass weight (kg)	Glass with a soft coating
3-19	320 x 180	5000x2800	350	+



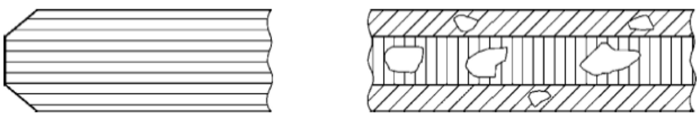
Picture 4. Sharpened / blunted glass edge, with empty spaces.

2.2. Rough grinding, fine grinding, polishing of CNC glass edges.
Equipment technical specifications:

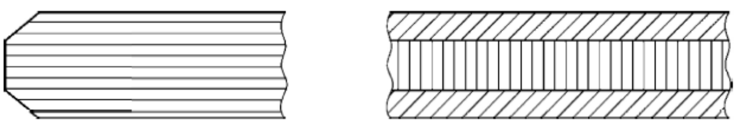
Glass thickness (mm)	Minimum glass size (W x H, mm)	Maximum glass size (W x H, mm)	Maximum glass weight (kg)	Glass with a soft coating
3-19	320 x 260	5000 x 2800	350	+

2.3.One-sided device, coarse sanding of glass edges, gentle sanding, polishing.
Equipment technical specifications:

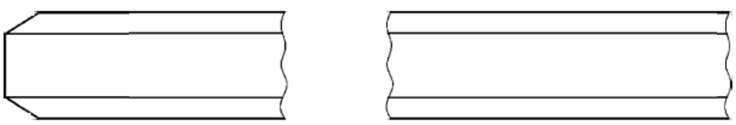
Glass thickness (mm)	Minimum glass size (W x H, mm)	Maximum glass size (W x H, mm)	Maximum glass weight (kg)	Glass with a soft coating
3-40	100 x 100	4500 x 2500	500	-



Picture 5. Roughly ground glass edge, with empty spaces.



Picture 6. Fine ground glass edge, without gaps.



Picture 7. Polished glass edge.

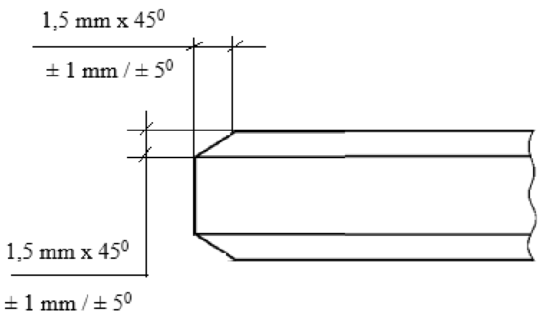
2.4.Edge machining tolerances.

Table 12. Tolerances for width W and height H. Dimensions are in millimetres.

Nominal dimension of one side (W or H)	Tolerance t	
	Nominal glass thickness d ≤ 8	Nominal glass thickness d > 8
≤ 2000	± 2,0	± 3,0
2000 < W or H ≤ 3000	± 3,0	± 4,0
> 3000	± 4,0	± 5,0

Table 13. Deviation limit difference between the diagonals. Dimensions are in millimetres.

Deviation limit v for the difference between the diagonals		
Nominal dimension W or H	Nominal glass thickness d ≤ 8	Nominal glass thickness d > 8
≤ 2000	≤ 4	≤ 6
2000 < W or H ≤ 3000	≤ 6	≤ 8
> 3000	≤ 8	≤ 10



Picture 8. Glass edge processing, slope tolerances.

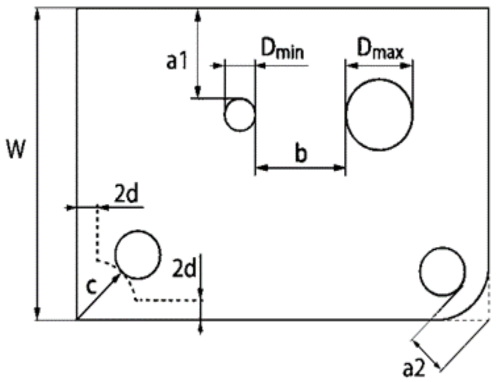
3. Drilling holes and cutting recesses.
Equipment technical specifications:

Glass thickness (mm)	Minimum glass size (W x H, mm)	Maximum glass size (W x H, mm)	Hole diameter (mm)	Maximum glass weight (kg)	Glass with a soft coating
3-25	100 x 100	4800 x 2800	4-130	500	+

3.1.Hole position restrictions on the glass sheet (ESG, HST, TVG).

Table 14. Requirements for the positioning of holes.

$D_{min.}$	≥	d
D_{max}	≤	1/3 x W
W	≥	8d
a1	≥	2d
a2	≥	4d
b	≥	2d
c	≥	6d



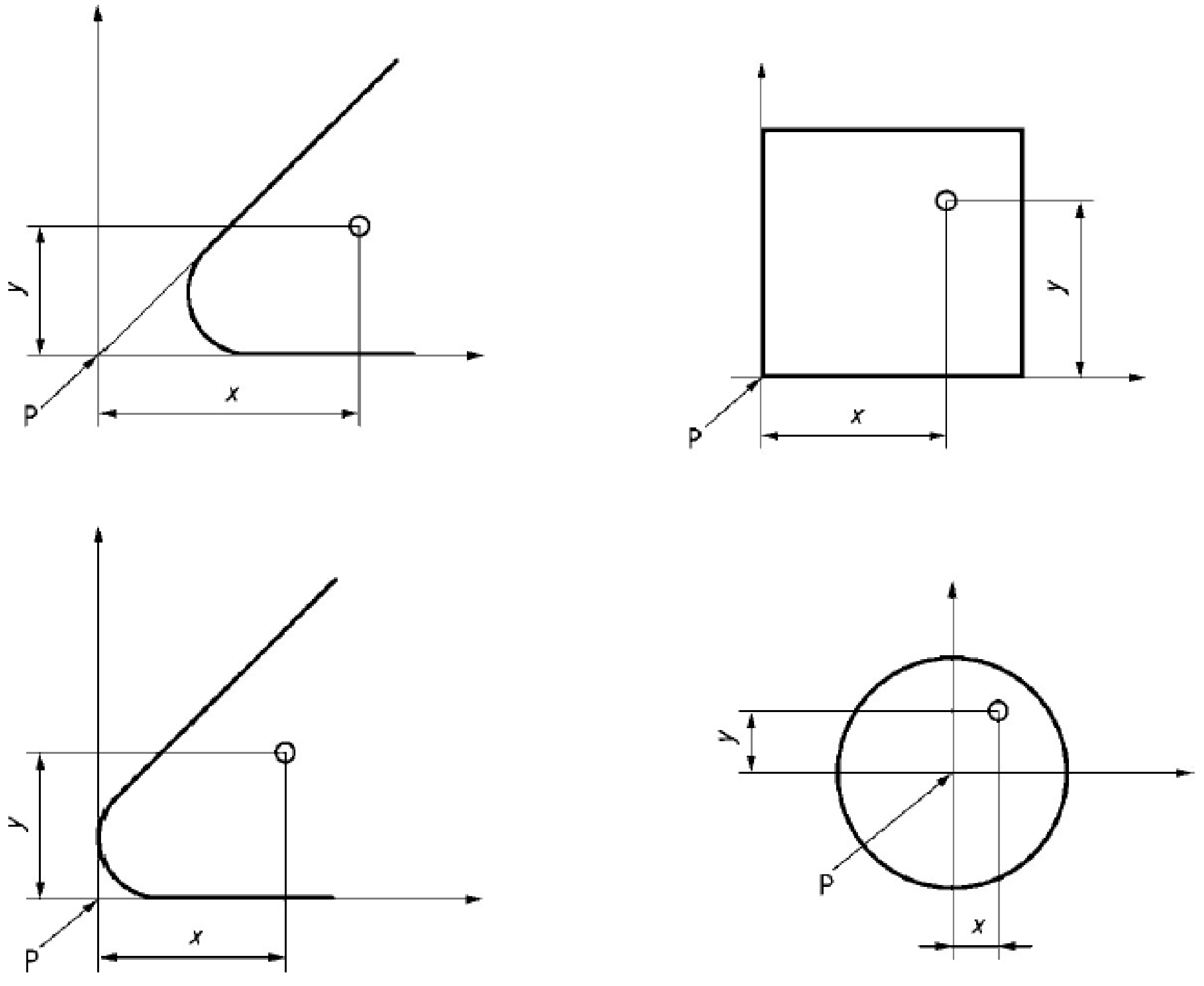
Picture 9. Hole positions on the glass sheet. d-Glass thickness.

3.2.Tolerance for holes.

Table 15. Hole diameter tolerances. Dimensions are in millimetres.

Nominal diameter of a hole, ø	Tolerances
4 ≤ ø ≤ 20	± 1,0
20 ≤ ø ≤ 100	± 2,0
100 < ø	± 2,5

The tolerances for the position of the holes are the same as the tolerances for the width W and the height H of the glass sheet (see Table 12). The positions of the holes are measured in two directions perpendicular to each other (x and y axes) from the zero point to the centre of the holes. The zero point is usually selected as real or virtual.

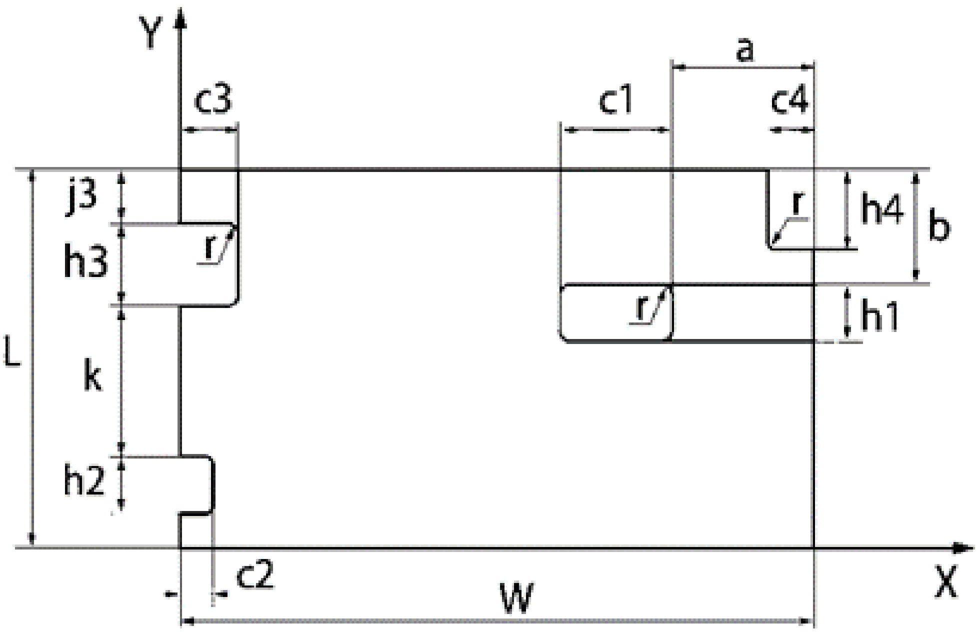


Picture 10. Tolerance of hole positions. P-zero point.

3.3.Limitations on the position of the cut outs in the glass sheet (ESG, HST, TVG).

Table 16. Requirements for the layout of recesses.

h 1-4	≤	1/3 x L
c 1-4	≤	1/3 x W
a	≥	1/2 x c1
b	≥	1/2 x h1
r	≥	1/2 d
k	≥	½ x h3 or h3 > h2
100 mm	< j3 ≥	1/2 x h3



Picture 11. Recess positions on the glass sheet. d-Glass thickness.

3.4.Tolerances for recesses.

Table 17. Tolerances for recesses. Dimensions are in millimetres.

Position	Tolerances
h 1-4 and c 1-4	±2 mm
a and b	According to Table 12.

4. Heat treatment of glass.

4.1.Thermally toughened soda lime silicate safety glass (ESG). Regulatory standard EN12150. Equipment technical specifications:

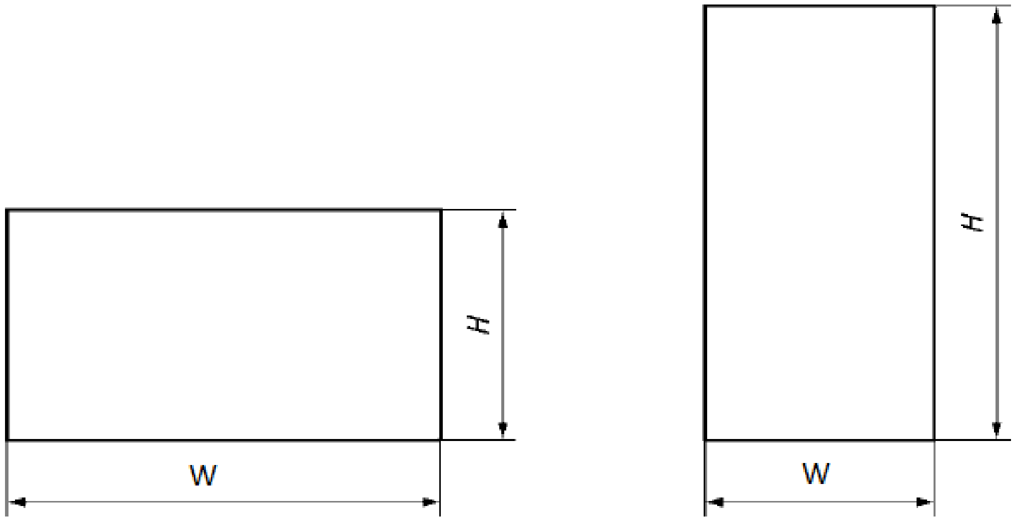
Glass thickness (mm)	Minimum glass size (W x H, mm)	Maximum glass size (W x H, mm)	Maximum glass weight (kg)	Glass with a soft coating
4	100 x 250	1800 x 2800	51	+
5	100 x 250	2300 x 3800	132	+
6-12	100 x 250	2800 x 4800	350	+
15-19	100 x 250	2800 x 4800	350	-

4.1.1. Nominal thickness and thickness tolerances.

Meets the requirements of Article no. 1.1.1. "Monolithic glass thicknesses and thickness tolerances".

4.1.2. Width and length (sizes mm).

When the dimensions of thermally toughened safety calcium sodium silicate glass are given for rectangular sheets, the first dimension must be the width W and the second dimension the height H. It must be clear, which dimension is the width W and which is the height H, when taking into account its installation location.



Picture 12. Dimensions of rectangular glass sheets. Width W and height H.

4.1.3. Direction of thermal toughening of glass.

Due to the method of thermal glass toughening process, it is not possible to obtain a product with the same optical properties as untoughened glass. Pursuing to maintain the optical integrity of the facade with toughened glass, it is necessary to specify in the order the direction of glass toughening. The direction is selected according to the position of the toughening furnace shafts with respect to the glass sheet. The width W of the glass sheet is parallel to the shafts of the toughening furnace and the height H of the glass sheet is perpendicular to the shafts of the toughening furnace. Glass sheets with a width W exceeding the maximum width of the toughening furnace (2800 mm) will be toughened in the other direction.

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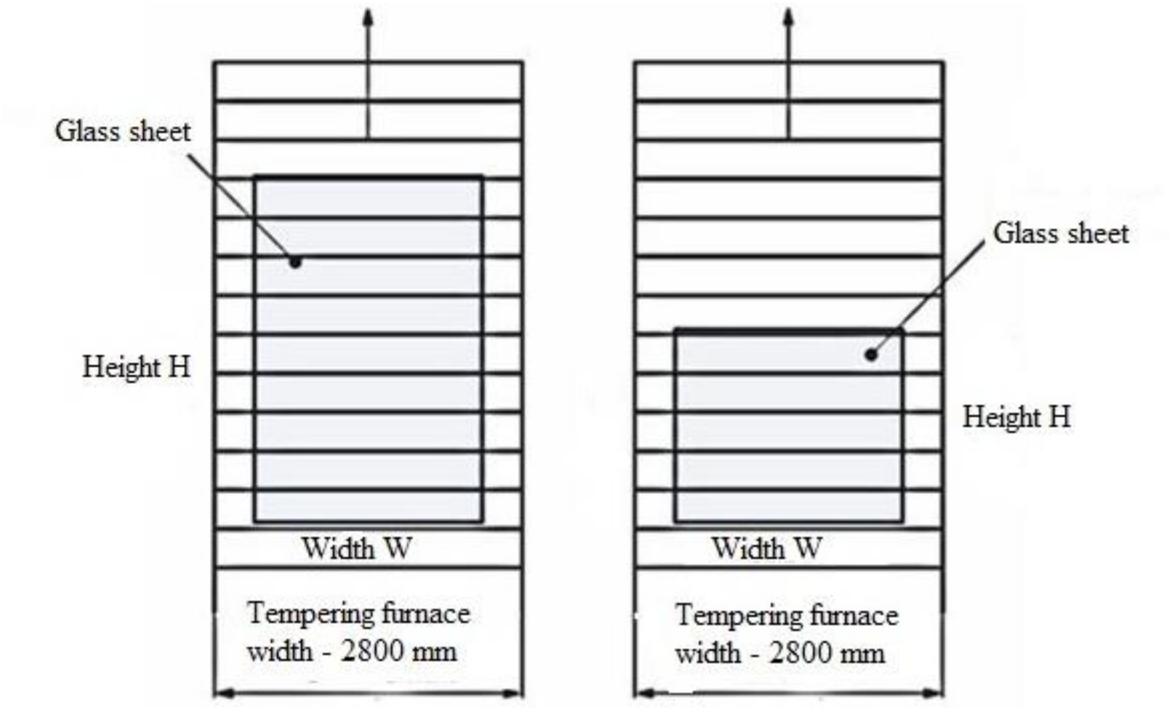

Picture 13. Toughening direction of the glass sheet, according to width W and height H.

4.1.4. Flatness of the glass sheet after the process of toughening.

During the horizontal toughening process of the glass sheet, the glass sheet loses its flatness. The loss of flatness depends on the type of glass, e.g., uncoated glass, hard-coated glass, glass with a soft coating, stained glass, etc., on the dimensions of the glass, i.e., nominal thickness, dimensions and relationship between dimensions.

Horizontally toughened glass has a total of 3 types of plane distortion:

4.1.4.1.General curvature of the glass sheet.

Table 18. Maximum permissible values of overall deflection for horizontally toughened glass.

Glass type	Maximum allowable limit for overall curvature, mm/m
Uncoated float glass, in compliance with EN 572-1 and EN 572-2.	3,0
Other glass.	4,0

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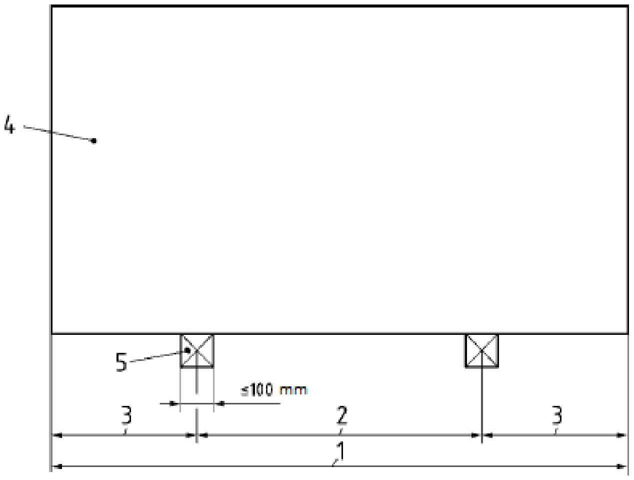
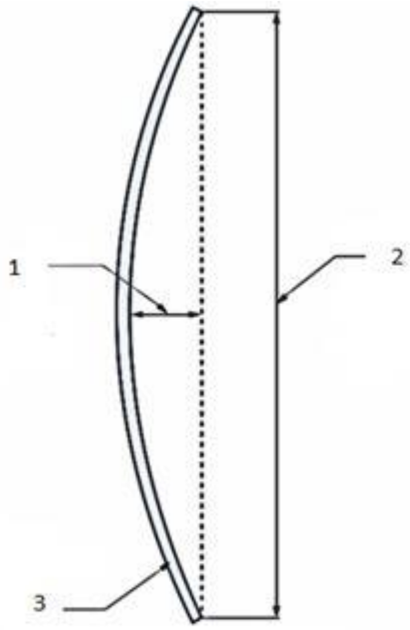


1 – W or H
2 – (W or H)/2
3 – (W or H)/4
4 – Thermally toughened glass sheet
5 – Supports

Picture 14. Support conditions for measuring of the overall deflection.



1 - Deformation in the calculation of the total deflection
2 – W or H, or diagonal
3 - Thermally toughened glass

Picture 15. View of the overall curvature.

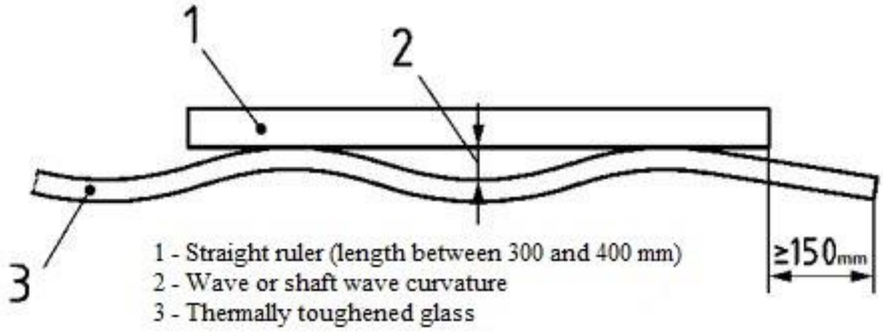
Method.

The thermally toughened glass sheet must be placed vertically on its long side, on two blocks at quarter points. The deformation must be measured at the edges and diagonals of the glass as the maximum distance between the straight metal ruler and the concave surface of the glass. The value of deflection is expressed as the deformation in millimetres divided by the measured sheet edge or diagonal length in meters. Measurements must be made at room temperature. The maximum allowable values are given in Table 18.

4.1.4.2.Shaft wave glass sheet distortion.

Table 19. Maximum permissible shaft wave deflection values for horizontally toughened glass.

Glass type	Maximum allowable limit for shaft wave deflection, mm
Float glass, in compliance with EN 572-1 and EN 572-2.	0,3
Other glass.	0,5

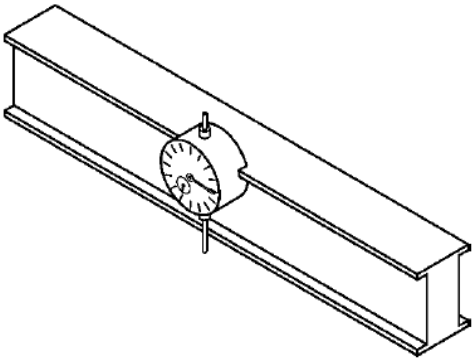


Picture 16. Measurement of shaft wave deflection with ruler and spacer.

Method.

The wave or shaft wave is measured using a straight ruler (length between 300 and 400 mm) placed perpendicular to the shaft wave and forming a bridge between the highest points of the wave (see Picture 16). A gap (various thicknesses increasing by 0.05 mm) is inserted between the glass surface and the straight edge. Increase the thickness of the gauge until it completely fills the gap between the glass surface and the ruler. Record the set gauge readings to the nearest 0.05 mm. Repeat the measurements at different points on the glass surface. The measured deflection of the wave or shaft wave is the maximum value recorded. The maximum permissible values are given in Table 19.

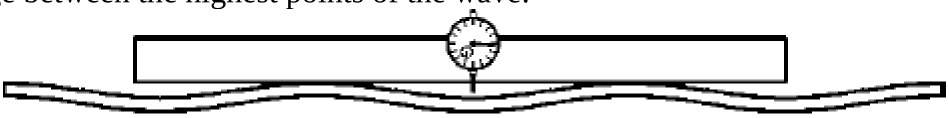
Limitations: A wave or shaft wave can only be measured on sheets with dimensions up to 600 mm perpendicular to the wave or shaft wave. The wave or shaft wave must not be measured closer than 150 mm from the edges, as this is the place where other deformations occur, this method cannot be used at those places. Glass sheets with a general curvature must be laid horizontally on a support in a straight plane, which allows gravity to straighten the curvature, while giving a more accurate measurement of the shaft wave.



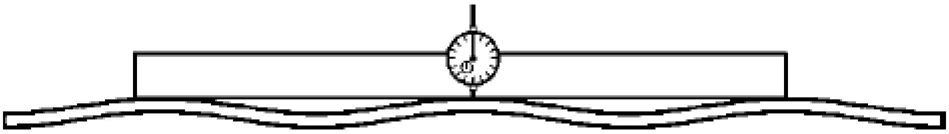
Picture 17. Measurement of shaft wave deflection with 350 mm long aluminium ruler and integrated deformation meter.

Method.

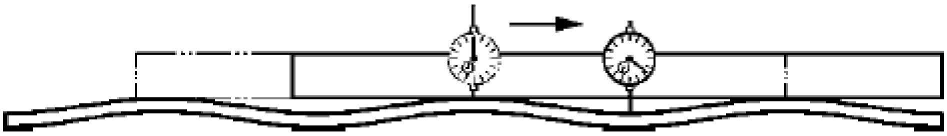
The measuring device is placed on a glass sheet perpendicular to the wave of shafts so that it can form a bridge between the highest points of the wave:



The measuring device is then pushed parallel to its axis until the meter captures the maximum value:



At this point, the strain gauge is at the highest point of the wave. The gauge pointer is rotated to show zero. The measuring device is then pushed again parallel to its axis until the meter captures the lowest value:



At this point, the meter shows the value of the lowest wave point. This value is recorded. The wave depth of the shafts is the difference between the zero point and the measured value. Note: The measuring scale is usually prepared in such a way that a positive value is recorded when the instrument is lifted. Careful reading of the gauge value is recommended to find the exact shaft wave depth.

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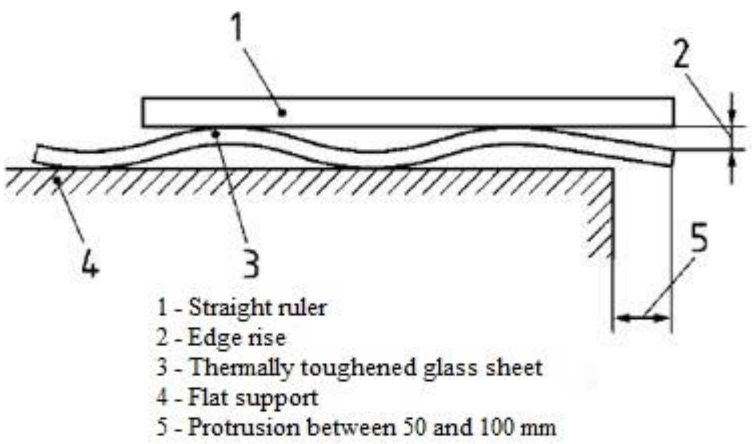
Restrictions: The measuring device must only be used with glass sheets with a dimension perpendicular to the shaft wave greater than 600 mm. There is also a separation zone 150 mm from the edge of the sheet where the use of the tool is not recommended. The deformation of the edges (up to 150mm from the edge of the sheet) may differ from the deformation of the shafts on a surface outside that area of glass. A true measurement of the shaft wave can only be obtained on a flat sheet of glass. If the glass sheet has a general curvature, this will change the measurement value of the shaft wave, and this should be taken into account. This error can be reduced by placing the sheet of glass on a straight table surface, which will reduce the overall curvature due to the weight of the glass itself, which straightens the sheet. This is especially helpful when measuring large sheets.

4.1.4.3.Lift of the edge of the glass sheet.

Table 20. Maximum permissible edge lift values for horizontally toughened glass.

Glass type	Glass thickness, mm	Maximum allowable limit for shaft wave deflection, mm
Uncoated float glass, in compliance with EN 572-1 and EN 572-2.	From 4 to 5	0,4
	From 6 to 19	0,3
Other glass.	From 3 to 19	0,5



Picture 18. Edge rise measurement.

Method.

The glass sheet must be placed on a flat support with the edge lift hanging close to the edge of the support, approximately between 50 and 100 mm. The straight edge is placed on the highest points of the wave and the roller wave and the gap between the ruler and the glass is measured with the aid of a spacing no (see Picture 18). The maximum permissible values are given in Table 20.

4.1.4.4.General curvature, shaft wave and edge lift restrictions for horizontally toughened glass

The maximum permissible values for general curvature, shaft waves, edge lift apply only to thermally toughened glass without holes and / or grooves and / or cut outs.

The incorporation of holes and / or grooves and / or cut outs in the glass sheet allows the formation of distortions during the tempering process due to the absence of glass and / or the increased length of the non-supported edges.

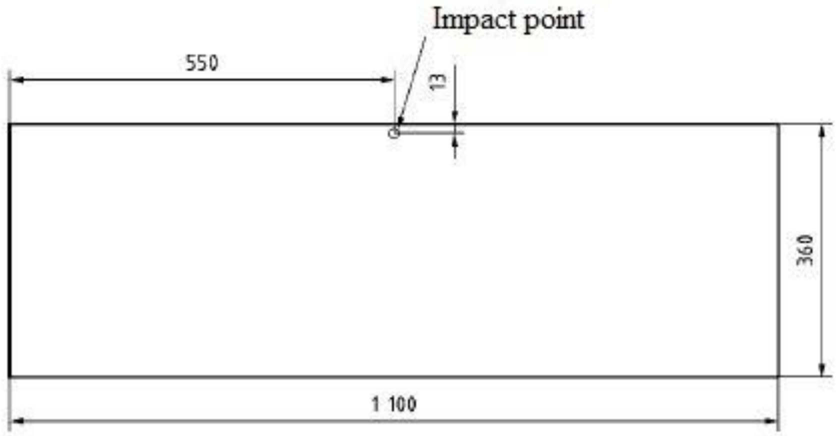
4.1.5. Fragmentation (crash) test for tempered glass.

Fragmentation (crash) test for tempered glass the test determines whether the glass shatters in the manner prescribed for thermally toughened safety soda lime silicate glass.

4.1.5.1.Determining the number of particles in a selected square.

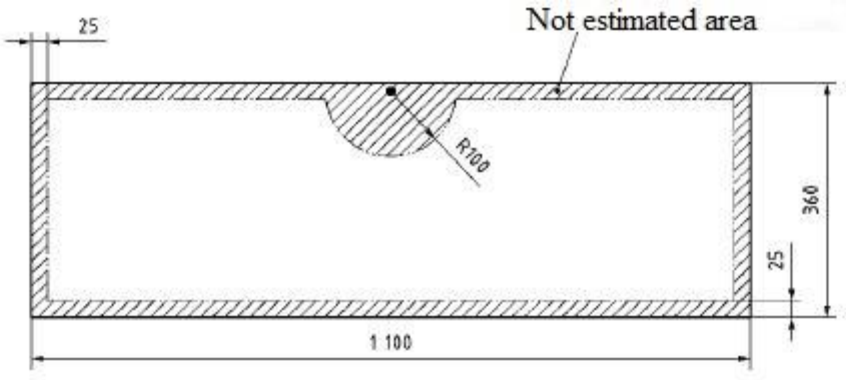
Method.

The dimensions of the samples must be 360 mm x 1100 mm without holes, grooves or cut outs. Five samples are used for the test. Each sample shall be broken using a pointed steel tool, approximately 13 mm from the longest edge in the middle.



Picture 19. Location of the point of impact. Dimensions are in millimetres.

Possible steel tools are a hammer weighing approximately 75 g, a spring hammer, or other similar tools with a hardened point of impact. The radius of curvature of the point must be approximately 0,2 mm. The sample is laid on a table without any mechanical constraints. To avoid scattering of the shards, the sample is easily held at the edges, for example by using adhesive tape or a small frame, etc., so that the shards remain connected but the expansion of the sample is not impeded. Particle counting and measurement of the largest particle should be performed between 3 and 5 min after disintegration. An area 100 mm in diameter with the centre as the point of impact and an edge 25 mm wide around the sides of the sample may not be used for evaluation.



Picture 20. Area not used in particle counting and measuring the largest particle. Dimensions are in millimetres.

Particle counting should be performed where disintegration is the most large-scaled (the purpose is to obtain a minimum value). The number of particles is determined by placing on a sample a square template with internal dimensions of 50 ± 1 mm x 50 ± 1 mm. The square shall be marked on the glass.

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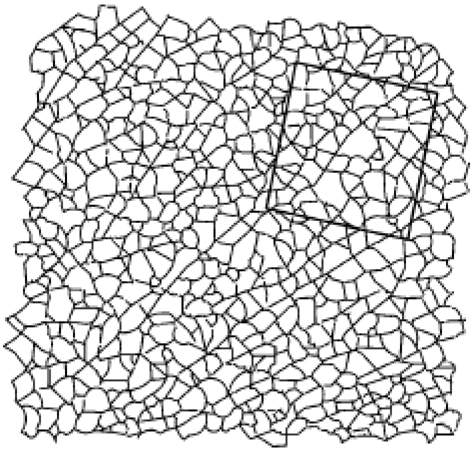
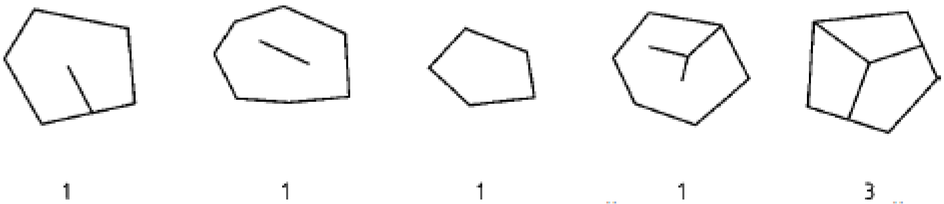


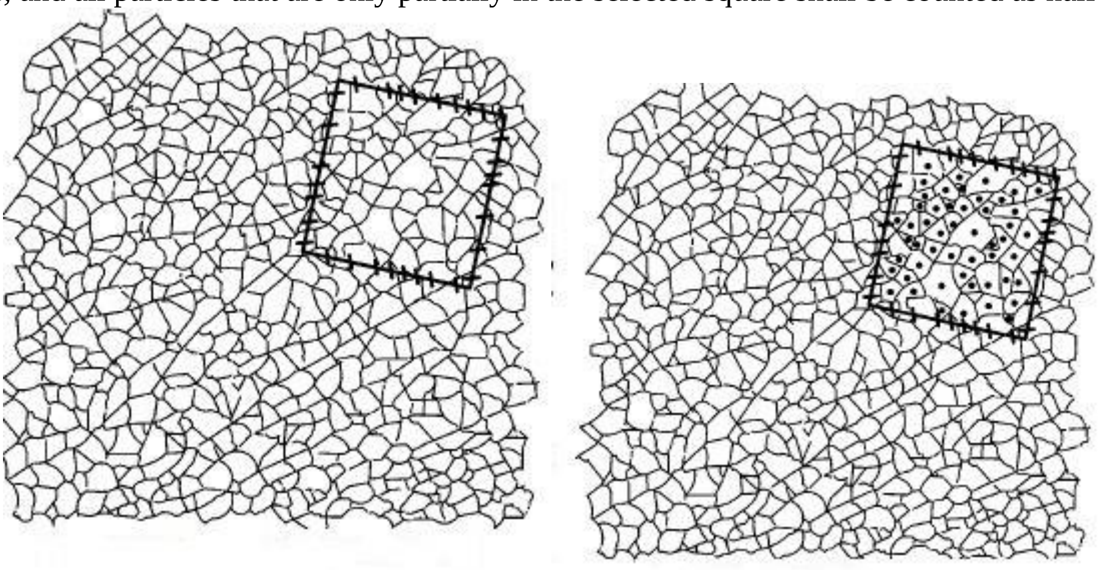
Picture 21. Example of the selection of the area with the most large-scaled disintegration.

The number of particles without cracks is calculated in the selected square. A particle is considered to be 'crack-free' if it does not contain any cracks that run from one edge to the other.



Picture 22. Examples of particle cracks and their evaluation in terms of numbers.

When calculating particles, all particles, which areas are in the selected square, shall be counted as one particle, and all particles that are only partially in the selected square shall be counted as half particles.



Number of particles in the perimeter = 32/2 = 16

Number of central particles = 53
Number of all particles = 16 + 53 = 69

Picture 23. Particle Marking and Calculation in a Sample.

To classify glass as thermally toughened safe calcium sodium silicate glass, the number of broken particles in each sample in the selected square shall not be less than the values given in Table 21.

Table 21. Minimum particle number values.

Glass type	Nominal glass thickness d, mm	Minimum number of particles, pcs.
All types of glass	From 4 to 12	40
	From 12 to 19	30

4.1.5.2.Selection of the longest particle.

Method.

The longest particle must be selected from the sample. It cannot be in an area not used for particle counting (see Picture 20). The length of the longest particle shall be measured and recorded. For the classification of glass as thermally toughened safe calcium sodium silicate glass, the length of the longest particle shall not exceed 100 mm.

4.1.6. Other physical characteristics and properties.

4.1.6.1.Optical distortion.

The shaft waves create an optical distortion that is usually visible in the reflection. Glass thicker than 8 mm may have small impressions on the glass - "shaft lifting".

4.1.6.2.Anisotropy (iridescence).

Anisotropy is a feature of heat-treated glass. This phenomenon occurs due to the formation of different stresses in the glass in its cross-sectional area, the stresses being caused by the rapid cooling of the glass during heat treatment. This effect can cause dark circles or strips, sometimes called “leopard spots,” that vary depending on the viewing angle if the glass is in polarised light or viewed through polarised glasses. Polarised light also occurs in normal daylight. The amount of polarised light depends on weather conditions and the angle of the sun. The effect is more noticeable when looking at glass at a sharp angle or in facades where the glass is installed at a right angle.
Anisotropy is not a defect, but simply a visible effect.

4.1.6.3.Heat resistance.

The mechanical properties of thermally toughened soda lime silicate safety glass do not change during continuous operation up to 250^{o} C, as well as at temperatures below 0^{o} C. Thermally toughened soda lime silicate safety glass is resistant to large temperature changes that can vary up to 200 degrees on the Kelvin scale.

Note: This characteristic has nothing to do with fire resistance.

4.1.6.4.Mechanical strength.

Mechanical strength is expressed by the bending force when tested in accordance with the procedure specified in standard EN 1288-3 (Glass in building. Determination of bending strength of glass. Part 3. Test of sample supported at two points).

Table 22. Minimum mechanical strength values for thermally toughened soda lime silicate safety glass.

Glass type	Minimum values for flexural strength, N/mm^2
Float glass: transparent, tinted, coated.	120
Enamelled glass (on the side of the enamelled surface).	75
Other glass.	90

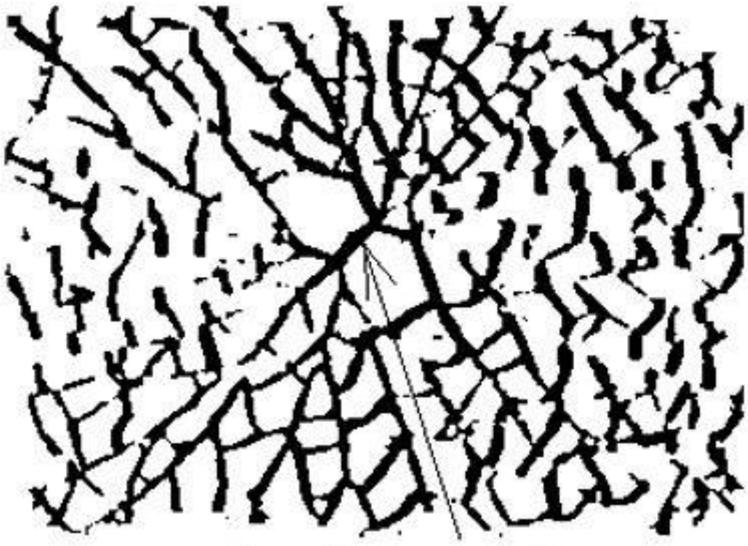
4.1.6.5.Classification in the event of an accidental human body contact with glass.

Thermally toughened soda lime silicate safety glass can be classified in compliance with the requirements of standard EN 12600 by simulating a human impact on the glass (pendulum test).

4.1.6.6.Spontaneous breakage of thermally toughened soda lime silicate safety glass.

Toughened glass can spontaneously break / explode on its own due to the presence of nickel sulphide (NiS) inclusions (particles). NiS particle is a rare but naturally occurring insert during the raw glass manufacturing process that can cause its spontaneous explosion even after several years of operation of the toughened glass.

We recommend that the heat soak test (HST - heat soak test EN 14179) be performed in all situations where the spontaneous breakage of thermally toughened safety calcium sodium silicate glass may pose a risk to the structural stability of the structure and to human safety. This test removes over 99% of thermally toughened soda lime silicate safety glass with NiS inserts, but this test cannot remove 100% of glass at risk.



Butterfly wing effect

Picture 24. Example of self-cracked thermally toughened glass due to NiS inclusions.

Warning.

Thermally toughened soda lime silicate safety glass, after the tempering process, must not be cut, drilled or otherwise surface-treated, nor may the edges be machined, as this increases the risk of breakage or the glass may break immediately.

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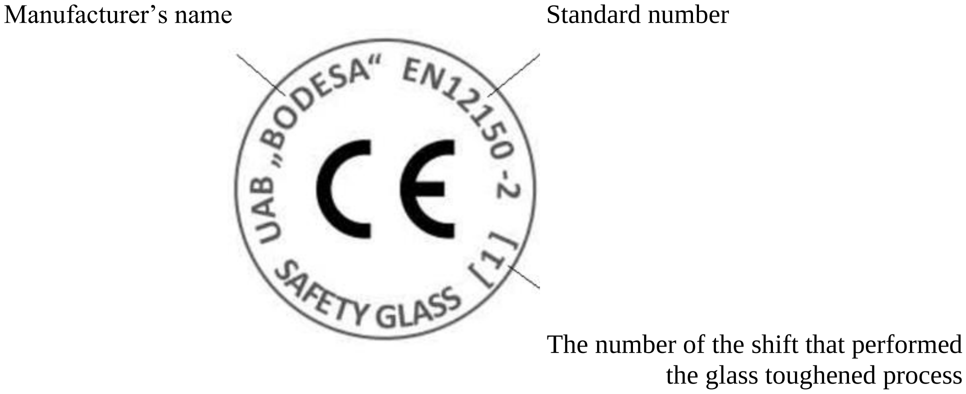
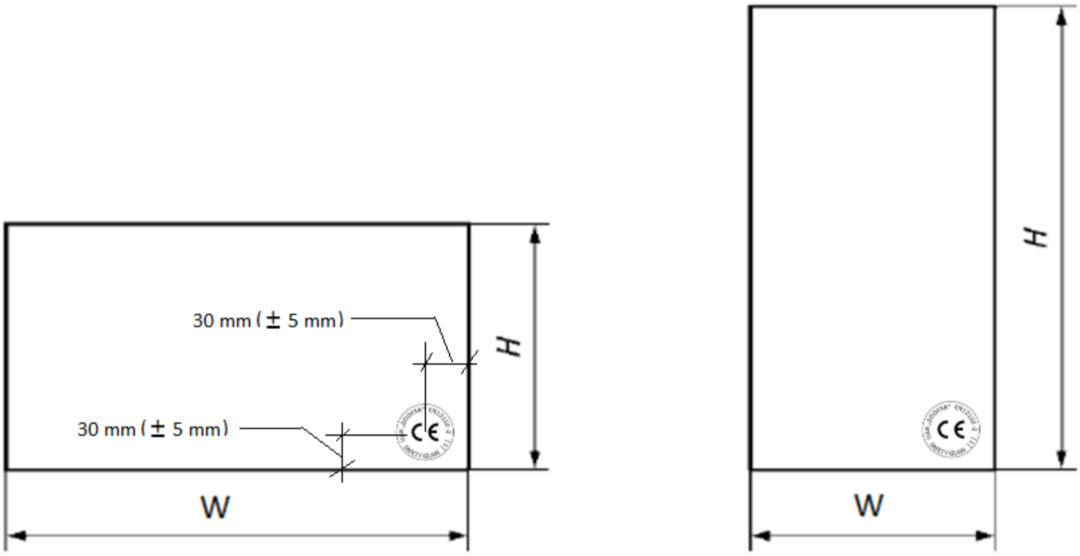
4.1.7. Marking.

Thermally toughened soda lime silicate safety glass in accordance with EN 12150 must always be marked. The label must include the standard number and the name of the trademark or manufacturer.



Picture 25. Marking of thermally toughened soda lime silicate safety glass.



Picture 26. Standard position of the marking mark for thermally toughened soda lime silicate safety glass on a glass sheet.

4.2. Heat soaked thermally toughened soda lime silicate safety glass (HST). Regulatory standard EN 14179.

Equipment technical specifications:

Glass thickness (mm)	Minimum glass size (W x H, mm)	Maximum glass size (W x H, mm)	Maximum glass weight (kg)	Glass with a soft coating
4	470 x 200	1800 x 2800	51	+
5	470 x 200	2300 x 3800	132	+
6-12	470 x 200	2800 x 4800	350	+
15-19	470 x 200	2800 x 4800	350	-

4.2.1. Heat soaking process of thermally toughened safe calcium sodium silicate glass

4.2.1.1. Requirements for glass.

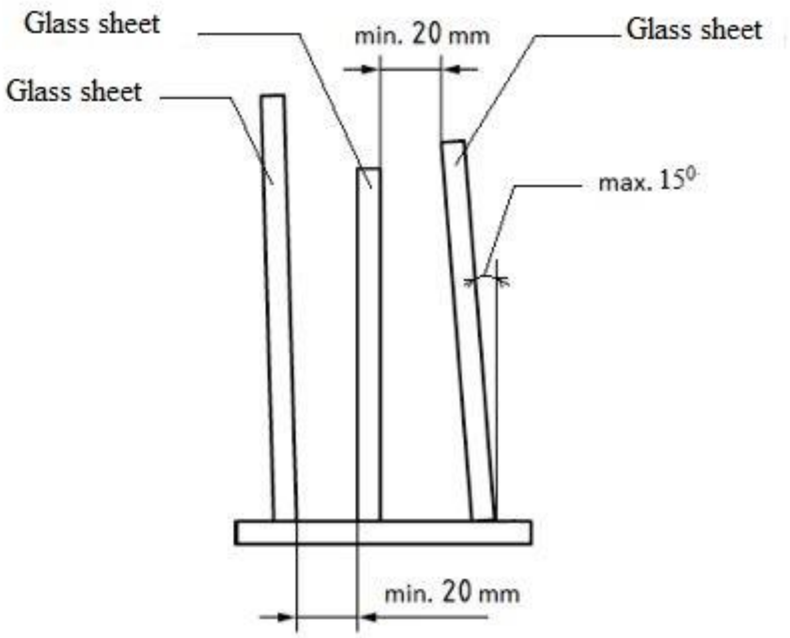
The heat soak test can only be performed on glass that is thermally toughened soda lime silicate safety glass and meets the requirements of the standard EN 12150.

4.2.1.2. Equipment requirements.

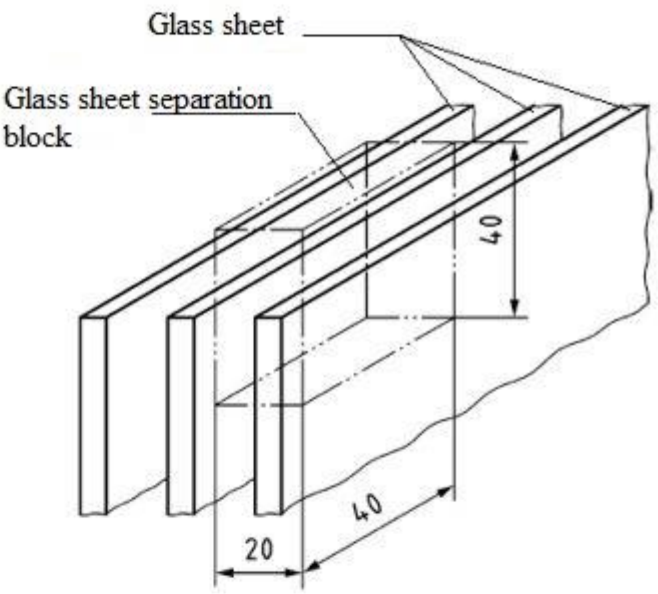
Heat soak equipment must be adapted to specifically this process and meet the requirements for glass assembly, heating, keeping in the temperature and cooling. Equipment calibration is performed after equipment installation before production, then after 1 year and every 5 years.

4.2.1.3. Requirements for the assembly of glass.

The glass sheets shall be stacked vertically or at an angle of up to 150 degrees. The glass must not be fixed in such a way that it cannot move freely. A gap of at least 20 mm must be maintained between the sheets of glass to allow air to circulate freely.



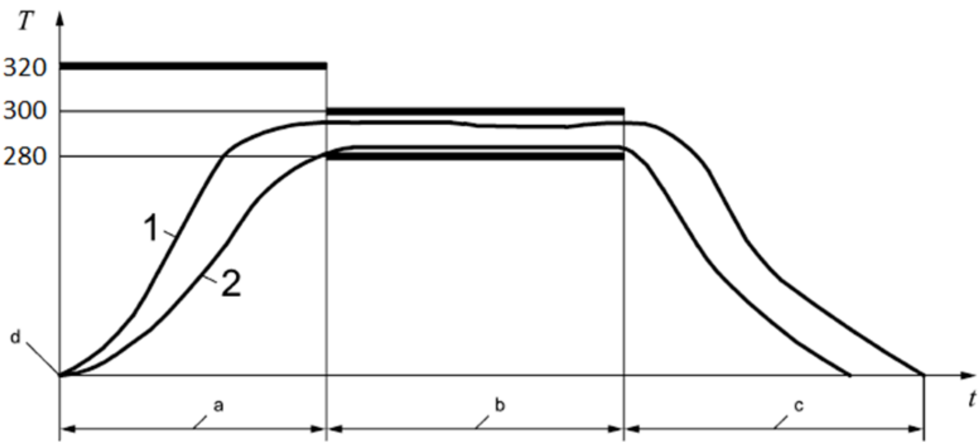
Picture 27. Stacking of glass sheets for the heat soak test.



Picture 28. Example of a glass sheet separation system. Dimensions are in millimetres.

4.2.1.4.Heat soak process cycle.

The cycle consists of three phases: heating, holding, cooling



T glass temperature at any point, °C
t time, h
1 the first glass reaches 280 °C
2 the last glass reaches 280 °C
d ambient temperature
a heating phase
b holding phase
c cooling phase

Picture 29. Heat soak process cycle.

The heating phase starts at the ambient temperature of the glass and ends when the temperature of the last glass surface reaches 280 °C. The maximum heating speed is 2° C per minute.
The holding phase begins when the surface temperature of all glasses reaches 280° C. The minimum holding time is 2 h. A temperature of 290° C ± 10° C is maintained to ensure the required temperature of the glass surface.
The cooling phase begins when the last glass, reaching 280° C, is held at a temperature of 290° C ± 10° C for at least 2 hours. At this stage, the panes must be cooled to the ambient temperature or when the air temperature in the heating furnace drops to 70° C. The cooling rate must be controlled to reduce glass breakage due to thermal stress.

4.2.2. Nominal thickness and thickness tolerances.
Meets the requirements of Article no. 1.1.1. “Monolithic glass thicknesses and thickness tolerances”.

4.2.3. Width and length (sizes mm).
Meets the requirements of Article no. 4.1.2. “Width and length (sizes mm) “.

4.2.4. Direction of thermal toughening of glass.
Meets the requirements of Article no. 4.1.3. “Direction of thermal toughening of glass “.

4.2.5. Flatness of the glass sheet after the process of toughening.
Meets the requirements of Article no. 4.1.4. “Flatness of the glass sheet after the process of toughening “.

4.2.5.1. General curvature of the glass sheet.
Meets the requirements of Article no. 4.1.4.1. “General curvature of the glass sheet “.

4.2.5.2. Shaft wave glass sheet distortion.
Meets the requirements of Article no. 4.1.4.2. “Shaft wave glass sheet distortion “.

4.2.5.3. Rise of the edge of the glass sheet.
Meets the requirements of Article no. 4.1.4.3. “Rise of the edge of the glass sheet “.

4.2.5.4. Limitations on overall deflection, shaft waveform and edge lift for heat-soaked thermally toughened glass.
Meets the requirements of Article no. 4.1.4.4. “General curvature, shaft wave and edge lift limitations for horizontally toughened glass”.

4.2.6. Fragmentation (crash) test for tempered glass.
Meets the requirements of Article no. 4.1.5. “Fragmentation (crash) test for tempered glass “.

4.2.6.1. Determining the number of particles in a selected square.
Meets the requirements of Article no.4.1.5.1. “Determining the number of particles in a selected square “.

4.2.6.2. Selection of the longest particle.
Meets the requirements of Article no. 4.1.5.2. “Selection of the longest particle “

4.2.7. Other physical characteristics and properties.
Meets the requirements of Article no. 4.1.6. “Other physical characteristics and properties “.

4.2.7.1. Optical distortion.
Meets the requirements of Article no. 4.1.6.1. “Optical distortion “.

4.2.7.2. Anisotropy (iridescence).
Meets the requirements of Article no. 4.1.6.2. “Anisotropy (iridescence) “.

4.2.7.3. Heat resistance.
Meets the requirements of Article no.4.1.6.3. “Heat resistance “.

4.2.7.4. Mechanical strength.
Meets the requirements of Article no. 4.1.6.4. “Mechanical strength “.

4.2.7.5.Classification in the event of an accidental human body contact with glass.

Meets the requirements of Article no. 4.1.6.5. “Classification in the event of an accidental human body contact with glass “.

4.2.7.6.Residual risk level after heat soak test.

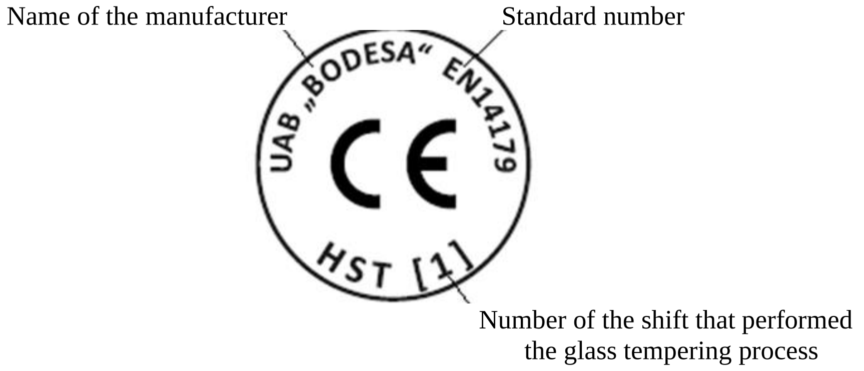
The residual risk of spontaneous breakage of heat-soaked thermally tempered soda lime silicate safety glass due to critical nickel sulphide (NiS) inclusions shall not exceed one breakage for 400 tonnes of glass.

Warning.

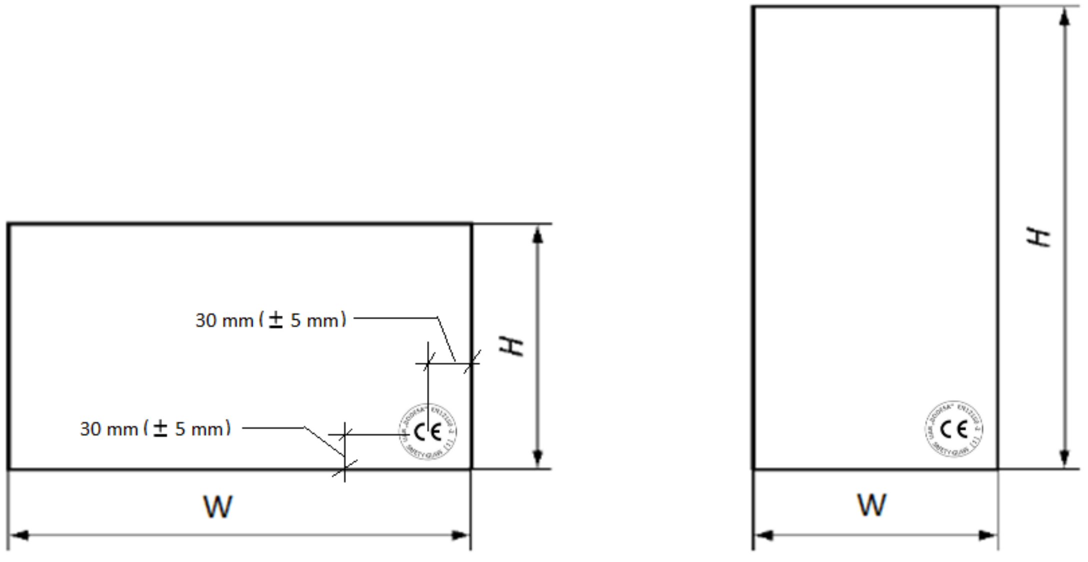
Heat soaked thermally toughened soda lime silicate safety glass must not be cut, drilled or otherwise surface-treated after the tempering process, nor may the edges be machined, as this increases the risk of breakage or the glass may break immediately.

4.2.8. Marking.

Heat soaked thermally toughened soda lime silicate safety glass in accordance with EN 14179 must always be marked. The mark must include the standard number and the name of the trademark or manufacturer.



Picture 30. Heat soaked thermally tampered soda lime silicate safety glass marking.



Picture 31. The standard position of the marking on the sheet of heat soaked thermally tampered soda lime silicate safety glass.

4.3. Heat strengthened soda lime silicate glass (TVG). Regulatory standard EN 1863.
Equipment technical specifications:

Glass thickness (mm)	Minimum glass size (W x H, mm)	Maximum glass size (W x H, mm)	Maximum glass weight (kg)	Glass with a soft coating
4	100 x 250	1800 x 2800	51	+
5	100 x 250	2300 x 3800	132	+
6-10	100 x 250	2800 x 4800	350	+

4.3.1. Nominal thickness and thickness tolerances.
Meets the requirements of Article no. 1.1.1. "Monolithic glass thicknesses and thickness tolerances".

4.3.2. Width and length (sizes mm).
Meets the requirements of Article no. 4.1.2. „Width and length (sizes mm)".

4.3.3. Direction of the heat strengthening of glass.
Meets the requirements of Article no. 4.1.3. „Direction of thermal toughening of glass".

4.3.4. Flatness of the glass sheet after the process of heat strengthening.
Meets the requirements of Article no. 4.1.4. "Flatness of the glass sheet after the process of toughening".

4.3.4.1. General curvature of the glass sheet.
Meets the requirements of Article no. 4.1.4.1. "General curvature of the glass sheet".

4.3.4.2. Shaft wave glass sheet distortion.
Meets the requirements of Article no. 4.1.4.2. „Shaft wave glass sheet distortion".

4.3.4.3. Rise of the edge of the glass sheet.
Meets the requirements of Article no. 4.1.4.3. "Rise of the edge of the glass sheet".

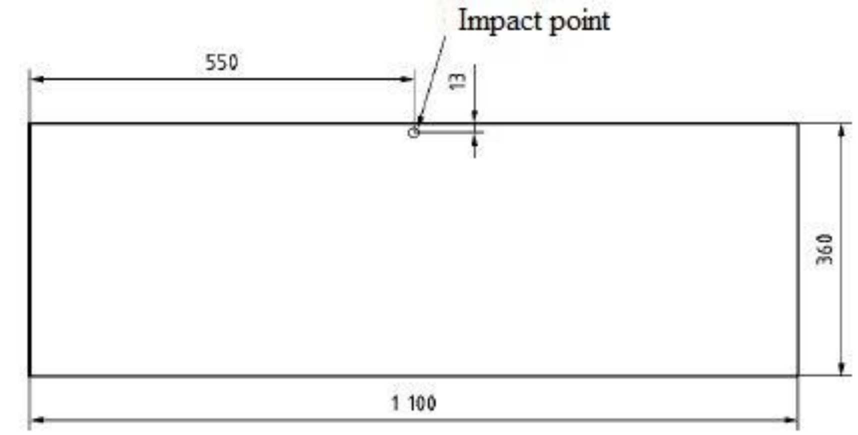
4.3.4.4. Limitations on overall deflection, shaft waveform and edge lift for thermally strengthened glass.
Meets the requirements of Article no.: 4.1.4.4. "General curvature, shaft wave and edge lift limitations for horizontally toughened glass".

4.3.5. Fragmentation (crash) test.

The fragmentation (crash) test determines whether the glass breaks in the manner prescribed for heat strengthened soda lime silicate glass.

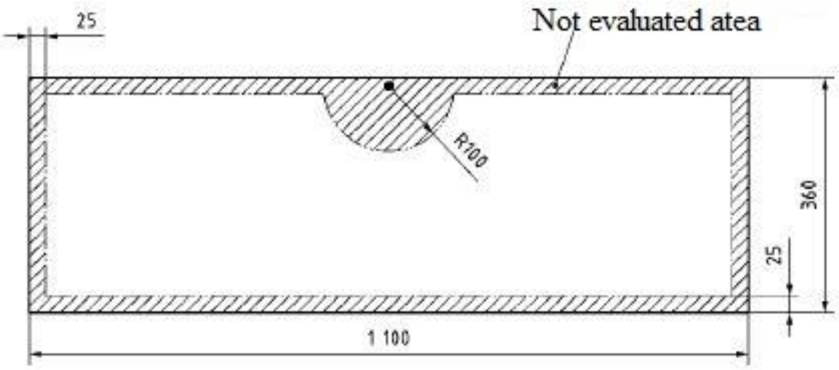
4.3.5.1. Determination of crash fragmentation.

Method.
The dimensions of the samples must be 360 mm x 1100 mm without holes, grooves or notches. Five samples are used for the test. Each sample shall be broken using a pointed steel tool, approximately 13 mm from the longest edge in the centre.



Picture 32. Location of the point of impact. Dimensions are in millimetres.

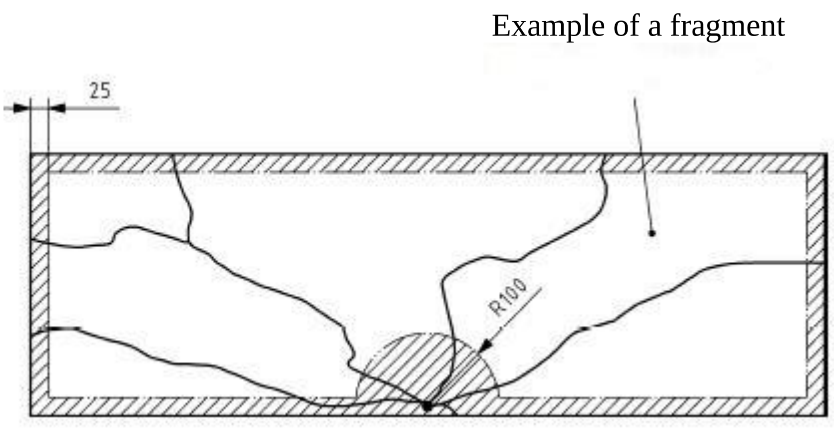
Possible steel tools are a hammer weighing approximately 75 g, a spring hammer, or other similar tools with a hardened point of impact. The radius of curvature of the point must be approximately 0,2 mm. The sample is laid on a table without any mechanical constraints. To avoid scattering of the shards, the sample is easily held at the edges, for example by using adhesive tape or a small frame, etc., so that the shards remain connected but the expansion of the sample is not impeded. Fracture fragmentation must be assessed within 5 min of glass breakage. An area 100 mm in diameter with the centre as the point of impact and an edge 25 mm wide around the edges of the sample may not be used for evaluation.



Picture 33. Area not used in fragmentation evaluation. Dimensions are in millimetres.

Each fragment obtained during the test shall be evaluated as follows:

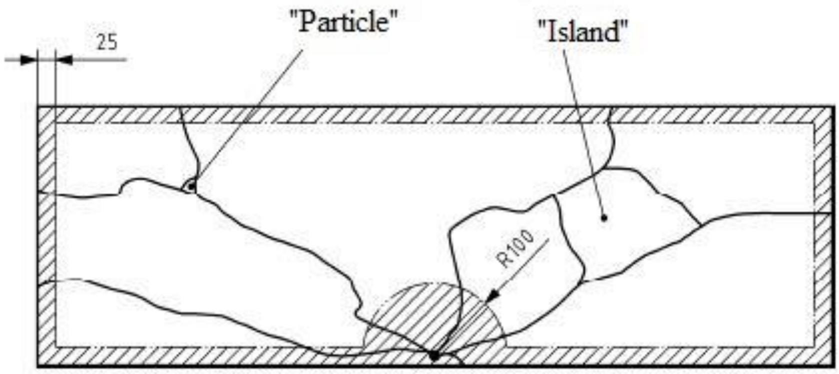
1) at least one edge of the fragment must reach the area not used in evaluation (see Picture 34).



Picture 34. Fragmentation assessment. Dimensions are in millimetres.

2) if there are fragments where any edges of the fragment do not reach the zone not used for evaluation (see Picture 35), such fragments are called "island" or "particle". "Particles" are fragments with an area / mass equivalent of less than 100 mm². "Islands" are fragments with an area / mass equivalent of 100 mm² or more.

NOTE: area = mass / (thickness x density), for example, 6 mm thick 1.5 g glass fragment area / mass 100 mm² equivalent.



Picture 35. Evaluation of "islands" and "particles". Dimensions are in millimetres.

3) The number of fragments of the "island" is counted and each "island" is weighed.
4) The "particles" are collected and weighed.

4.3.5.2.Evaluation of crash fragmentation.

At least four of the five samples tested must meet these requirements in order for the product to be classified as heat strengthened soda lime silicate glass.

Each testing sample:
1) shall have not more than two (2) "island" fragments;
2) shall not contain "island" fragments with an area / mass equivalent greater than 1 000 mm^2 (see 4.3.5.1);
3) the area and mass equivalent of all "particles" must not exceed 5 000 mm^2 (see 4.3.5.1).

If one of the five samples tested does not meet these requirements, it must meet and not exceed the following requirements:
4) there must be no more than 3 "island" fragments;
5) the area / mass equivalent of all "islands" and "particles" must not exceed 50 000 mm^2 (see 4.3.5.1).

4.3.6. Other physical characteristics and properties.

4.3.6.1.Optical distortion.

Meets the requirements of Article no. 4.1.6.1. „Optical distortion".

4.3.6.2.Anisotropy (iridescence).

Meets the requirements of Article no. 4.1.6.2. „Anisotropy (iridescence)".

4.3.6.3.Heat resistance.

The mechanical characteristics of heat strengthened soda lime silicate glass do not change during continuous operation up to 200° C, as well as at temperatures below 0° C. The heat-strengthened soda lime silicate glass is resistant to sudden changes in temperature, which can vary by up to 100 degrees on the Kelvin scale.

Note: This property has nothing to do with fire resistance.

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4.3.6.4.Mechanical strength.

Mechanical strength is expressed by the bending force when tested in accordance with the procedure specified in standard EN 1288-3 (Glass in building. Determination of the bending strength of glass Test with sample supported at two points).

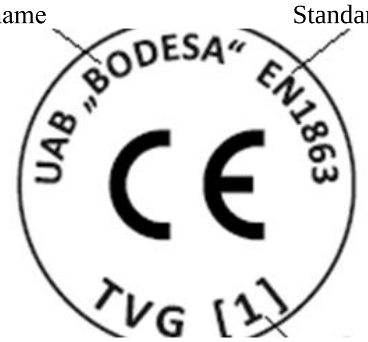
Table 23. Minimum mechanical strength values for heat strengthened soda lime silicate glass.

Glass type	Minimum values for bending strength, N/mm^2
Float glass: transparent, tinted, coated.	70
Enamelled glass (as per the side of the enamelled surface).	45
Other glass.	55

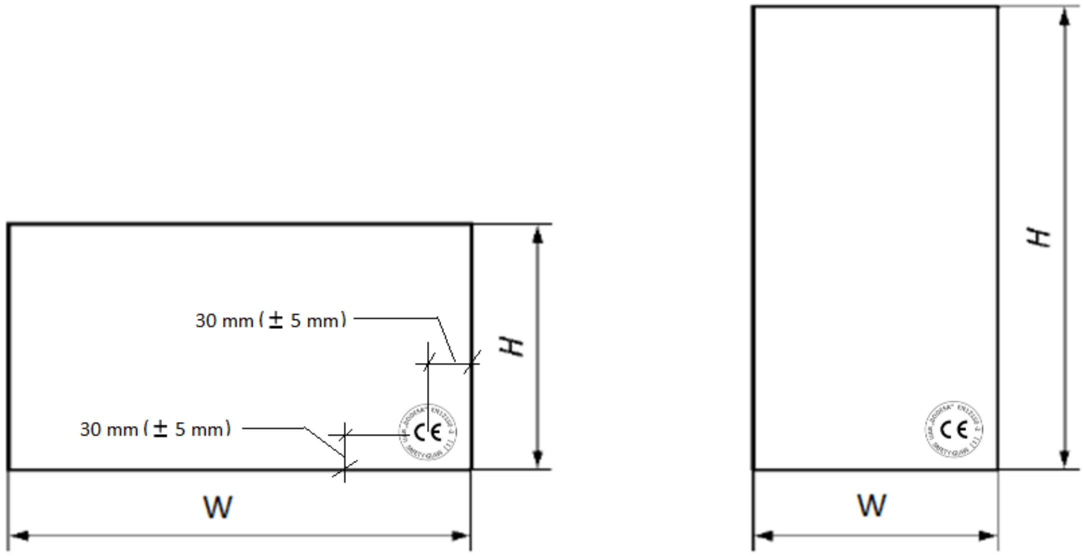
Warning.
After the process of heat strengthening, the heat-strengthened soda lime silicate glass must not be cut, drilled or otherwise surface-treated, nor may the edges be machined, as this increases the risk of breakage or the glass may break immediately.

4.3.7. Marking.

Heat strengthened soda lime silicate glass in accordance with EN 1863 must always be marked. The marking must include the standard number and the name of the trademark or manufacturer.



Picture 36. Marking of the heat strengthened soda lime silicate glass.



Picture 37. Standard position of the marking for the heat strengthened soda lime silicate glass on the sheet of glass.

5. Bibliography.

Standards:

EN 572. Glass in building. Basic soda lime silicate glass products.
EN 12543. Glass in building — Laminated glass and laminated safety glass.
EN 12150. Glass in building. Thermally toughened soda lime silicate safety glass.
EN 14179. Glass in building. Heat soaked thermally toughened soda lime silicate safety glass.
EN 1863. Glass in building. Heat strengthened soda lime silicate glass.

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