Selection Guide for Flat
Thermally Toughened
Soda Lime
Silicate Safety Glass

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Administer by

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Foreword

This selection guide has been based on EN 12150-1:2000 Glass in building – Thermally toughened soda lime silicate safety glass. Part 1: Definition and description.

Amendments have been made to suit local manufacture and compliance with legal requirements VC9003 and SANS 1263-1.

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INTRODUCTION

Thermally toughened soda lime silicate safety glass has safer breakage behaviour when compared with annealed glass. When it should be used to offer protection under accidental human impact, thermally toughened soda lime silicate safety glass also should be classified according to SAN 1263-1: 2013 Edition 3.2.

1. SCOPE

This AAAMSA Selection Guide specifies tolerance, flatness, edgework, fragmentation and physical and mechanical characteristics of monolithic flat thermally toughened soda lime silicate safety glass for use in buildings.

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

2. DEFINITIONS

For the purposes of this AAAMSA Selection Guide the following definitions apply.

2.1 thermally toughened soda lime silicate safety glass: glass within which a permanent surface compressive stress has been induced by a controlled heating and cooling process in order to give it greatly increased resistance to mechanical and thermal stress and prescribed fragmentation characteristics.

2.2 enamelled thermally toughened soda lime silicate safety glass: thermally toughened soda lime silicate safety glass which has a ceramic frit fired into the surface during the toughening process. After toughening, the ceramic frit becomes an integral part of the glass.

2.3 roller wave distortion

2.4 overall bow

3. GLASS PRODUCTS

Thermally toughened soda lime silicate safety glass is made from a monolithic glass generally corresponding to one of the following standards:

- soda lime silicate glass according to SANS 50572-1;
- float glass according to SANS 50572-2;
- patterned glass according to SANS 50572-5;
- coated glass according to EN 1096-1.

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

4. FRACTURE CHARACTERISTICS

In the event of breakage, thermally toughened soda lime silicate safety glass fractures into numerous small pieces, the edges of which are generally blunt.

NOTE: Fragmentation in service does not always correspond to that described in clause 8, due to restraint from fixing or reprocessing (e.g. laminating), or due to the cause of fracture.

5. DIMENSIONS AND TOLERANCE

5.1 Normal thickness and thickness tolerance

The nominal thicknesses and thickness tolerance are those given in the relevant product standard (see clause 3), some of which are reproduced in Table 1.
Table 1: Nominal thicknesses and thickness tolerances

Dimensions in millimetres

<table>
<thead>
<tr>
<th>Nominal Thickness</th>
<th>Thickness tolerances for glass type</th>
<th>Patterned</th>
<th>Float</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>±0,5</td>
<td></td>
<td>±0,2</td>
</tr>
<tr>
<td>4</td>
<td>±0,5</td>
<td></td>
<td>±0,2</td>
</tr>
<tr>
<td>5</td>
<td>±0,5</td>
<td></td>
<td>±0,2</td>
</tr>
<tr>
<td>6</td>
<td>±0,5</td>
<td></td>
<td>±0,2</td>
</tr>
<tr>
<td>8</td>
<td>±0,8</td>
<td></td>
<td>±0,3</td>
</tr>
<tr>
<td>10</td>
<td>±1,0</td>
<td></td>
<td>±0,3</td>
</tr>
<tr>
<td>12</td>
<td>±1,5</td>
<td></td>
<td>±0,3</td>
</tr>
<tr>
<td>15</td>
<td>±1,5</td>
<td></td>
<td>±0,5</td>
</tr>
<tr>
<td>19</td>
<td>±1,5</td>
<td></td>
<td>±1,0</td>
</tr>
</tbody>
</table>

The thickness of a pane shall be determined as for the basic product. The measurement shall be taken at the centres of the 4 sides.

5.2 Width and Height (sizes)

5.2.1 General

When thermally toughened soda lime silicate safety glass dimensions are quoted for rectangular panes, the first dimension shall be the width, $W$, and the second dimension the height, $H$, as shown in Figure 1. It shall be made clear which dimension is the width, $W$, and which is the height, $H$, when related to its installed position.

![Figure 1: Examples of width, $W$, and height, $H$, relative to the pane shape](image)

NOTE: For thermally toughened soda lime silicate safety glass manufactured from patterned glass, the direction of the pattern should be specified relative to one of the dimensions.

5.2.2 Maximum and minimum sizes

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

5.2.3 Tolerances and squareness

The nominal dimensions for width and height being given, the finished pane shall not be larger than a prescribed rectangle resulting from the nominal dimensions increased by the tolerance, $t$, or smaller than a prescribed rectangle reduced by the tolerance, $t$. Tolerances are given in Table 2.
Table 2: Tolerances on width, $W$, and height, $H$

Dimensions in millimetres

<table>
<thead>
<tr>
<th>Nominal dimension of side, $W$ or $H$</th>
<th>Tolerance, $t$ (nominal glass thickness, $d$ ≤ 12)</th>
<th>Tolerance, $t$ (nominal glass thickness, $d$ &gt; 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 2000</td>
<td>±2,5</td>
<td>±3,0</td>
</tr>
<tr>
<td>$W$ &gt; 2000 or $H$ ≤ 3000</td>
<td>±3,0</td>
<td>±4,0</td>
</tr>
<tr>
<td>&gt; 3000</td>
<td>±4,0</td>
<td>±5,0</td>
</tr>
</tbody>
</table>

5.3 Flatness

5.3.1 General

By the very nature of the toughening process, it is not possible to obtain a product as flat as annealed glass. The difference depends on the nominal thickness, the dimensions and the ratio between the dimensions. There are two kinds of bow (see Figure 2):

- overall bow;
- roller wave distortion.

NOTE 1: Overall bow can usually be accommodated by the framing system.

5.3.2 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 3).

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 2).

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.

![Figure 2: Representation of overall and local bow](image-url)

1) deformation for calculating overall bow
2) $W$, or $H$, or diagonal length
3) Local bow
4) 300 mm length
1) \( W \) or \( H \)
2) \( (W \text{ or } H)/2 \)
3) \( (W \text{ or } H)/4 \)
4) Maximum 100 mm

Figure 3: Support conditions for the measurement of overall bow

5.3.3 Measurement of local bow

Local bow can occur over relatively short distances on the edge of the glass. Local bow 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 2).

Local bow is expressed as millimetres/300mm length.

For patterned glass, local bow 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.

5.3.4 Limitation on overall and local bow

The maximum allowable values for the overall bow, when measured according to 6.3.2, and local bow, when measured according to 6.3.3, for glass without holes and/or notches and/or cut-outs are given in Table 3.

Table 3: Maximum values for overall and local bow

<table>
<thead>
<tr>
<th>Toughening process</th>
<th>Type of glass</th>
<th>Maximum values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Overall bow mm/mm</td>
</tr>
<tr>
<td>Horizontal</td>
<td>Float to SANS 50572-2</td>
<td>0,003</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>0,004</td>
</tr>
<tr>
<td>Vertical</td>
<td>All</td>
<td>0,005</td>
</tr>
</tbody>
</table>

6. EDGE WORK, HOLES, NOTCHES AND CUT-OUTS

6.1 Warning

WARNING: Thermally toughened soda lime silicate safety glass should not be cut, sawed, drilled or edge worked after toughening.

6.2 Edge working of glass for toughening

Every glass which is to be thermally toughened has to be edge worked prior to toughening.
The simplest type of edge working is the arrissed edge (see Figure 4 a). Other common types are shown in figures 4 b) to 4 d). For specialist edge work, such as ‘water jet cutting’, the manufacturer should be consulted.

Figure 4 a): Arrissed edge (with blank spots)

Figure 4 b): Ground edge (with blank spots)

Figure 4 c): Smooth ground edge (no blank spots)

Figure 4 d): Polished edge

6.3 **Profiled edge**

Various other edge profiles can be manufactured with different types of edgework.

6.4 **Round holes**

6.4.1 **General**

This standard considers only round holes in glass that is not less than 4 mm nominal thickness. The manufacturer should be consulted about edge working of holes.

6.4.2 **Diameter of holes**

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

6.4.3 **Limitations on position of holes**

In general, the limitation on holes positions relative to the edge of the glass pane, the corners of the glass pane and to each other depends on:

- the nominal glass thickness (d);
- the dimensions of the pane \((W, H)\);
- the hole diameter (Ø);
- the shape of the pane;
- the number of holes.
The recommendations given below are those which are normally available and limited to panes with a maximum of 4 holes.

1. The distance, \(a\), of the edge of a hole to the glass edge should be not less than \(2d\).

![Diagram](https://via.placeholder.com/150)

\[ a \geq 2d \]

**Figure 5: Relationship between hole and edge of pane**

2. The distance, \(b\), between the edges of two holes be not less than \(2d\).

![Diagram](https://via.placeholder.com/150)

\[ b \geq 2d \]

**Figure 6: Relationship between two holes**

3. The distance, \(c\), of the edge of a hole to the corner of the glass should be not less than \(6d\).

![Diagram](https://via.placeholder.com/150)

\[ C \geq 6d \]

**Figure 7: Relationship between hole and corner of pane**

**NOTE:** 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.

6.4.4 **Tolerances on hole diameters**

The tolerances on hole diameters are given in Table 4.

**Table 4: Tolerances on hole diameters**

<table>
<thead>
<tr>
<th>Nominal hole diameter, (\Omega)</th>
<th>Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4 \leq \Omega \leq 20)</td>
<td>(\pm 1,0)</td>
</tr>
<tr>
<td>(20 &lt; \Omega \leq 100)</td>
<td>(\pm 2,0)</td>
</tr>
<tr>
<td>(100 &lt; \Omega)</td>
<td>consult the manufacturer</td>
</tr>
</tbody>
</table>
6.4.5 **Tolerances on position of holes**

The tolerances on positions of holes are the same as the tolerance on the width, \(B\), and the length, \(H\) (see Table 2). The positions of holes are measured in two directions at right angles (\(x\)- and \(y\)- axes) from a datum point to the centre of the holes. The datum point is generally chosen as a real or virtual corner of the pane (see Figure 8 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 2.

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

![Figure 8: Examples of the positioning of holes relative to the datum point](image)

6.5 **Notches and cut-outs**

Many configurations of notches and cut-outs can be supplied.

![Figure 9: Examples of notches and cut-outs](image)

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

6.6 **Shaped panes**

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

7. **FRAGMENTATION TEST**

7.1 **General**

The fragmentation test determines whether the glass breaks in the manner prescribed for a thermally toughened soda lime silicate safety glass.

7.2 **Dimensions and number of test specimens**

The dimensions of the test specimens shall be 360 mm x 1100 mm, without holes, notches or cut-outs. At least two specimens shall be tested.
7.3 Test procedure

Each test specimen shall be impacted, using a pointed steel tool, at a position 13 mm in from the longest edge of the test specimen at the mid-point of the edge, until breakage occurs (see Figure 10).

**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 75g 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, etc., so that the fragments remain interlocked after breakage yet extension of the specimen is not hindered.

![Figure 10: Position of impact point](image)

Dimensions in millimetres

1) impact point

For thermally toughened soda lime silicate safety glass manufactured by vertical toughening, the impact point shall not be on the tong mark edge.

7.4 Assessment of fragmentation

The particle count and measuring of the dimensions of the largest particle shall be made between 4 min to 5 min after fracture. An area of radius 100 mm, centred on the impact point, and a border of 25 mm, round the edge of the test specimen (see Figure 11), shall be excluded from the assessment.

The particle count shall be made in the region of coarsest fracture (the aim being to obtain the minimum value). The particle count shall be made by placing a mask of (50 ± 1) mm x (50 ± 1) mm on the test piece (see annex C). The number of crack-free particles within the mask shall be counted. A particle is ‘crack-free’ if it does not contain any cracks which run from one edge to another (see Figure 12).

![Figure 11: Area to be excluded from the particle count determination and largest particle measurement](image)

Dimensions in millimetres

1) excluded area
In the particle count, all particles wholly contained within the area of the mask shall be counted as one particle each and all the particles which are partially within the mask shall be counted as $\frac{1}{2}$ particle each (see annex C).

7.5 Minimum values from the particle count

In order to classify a glass as a thermally toughened soda lime silicate safety glass, the particle count of each test specimen shall not be less than the values given in Table 5.

### Table 5: Minimum particle count values

<table>
<thead>
<tr>
<th>Glass type</th>
<th>Nominal thickness ($d$) in mm</th>
<th>Minimum particle count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Float and drawn sheet</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>4 to 12</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>15 to 19</td>
<td>40</td>
</tr>
<tr>
<td>Patterned</td>
<td>4 to 10</td>
<td>40</td>
</tr>
</tbody>
</table>

7.6 Selection of the longest particle

The longest particle shall be chosen from the body of the test specimen. It shall not be in the excluded area (see 8.4).

7.7 Maximum length of longest particle

In order to classify the glass as thermally toughened soda lime silicate safety glass, the length of the longest particle shall not exceed 100mm.

8. OTHER PHYSICAL CHARACTERISTICS

8.1 Optical distortion

8.1.1 Thermally toughened soda lime silicate safety glass produced by vertical toughening

The tong marks can produce additional optical distortion which is generally in an area of radius 100 mm centred on the tong mark.

8.1.2 Thermally toughened soda lime silicate safety glass produced by horizontal toughening

While the hot glass is in contact with the rollers during the toughening process, a surface distortion is produced by a reduction in surface flatness, known as ‘roller wave’. Roller wave is generally noticed in reflection. Glass which is thicker than 7 mm can show signs of small imprint in the surface (‘roller pick-up’).

8.2 Anisotropy (iridescence)

The toughening process produces areas of different stress in the cross section of the glass. These areas of stress produce a bi-refringent effect in the glass, which is visible in polarized light.

When thermally toughened soda lime silicate safety 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 bi-refringent effect is more noticeable either at a glancing angle or through polarized spectacles.
8.3 **Thermal durability**

The mechanical properties of thermally toughened soda lime silicate safety glass are unchanged for continuous service up to 250°C and are unaffected by sub-zero temperatures. Thermally toughened soda lime silicate safety glass is capable of resisting both sudden temperature changes and temperature differentials up to 200 K.

8.4 **Mechanical strength**

The value of mechanical strength can only be given as a statistical value associated with particular probability of breakage and with a particular type of loading.

The mechanical strength values apply to quasi-static loading over a short time, e.g. wind loading, and relate to a 5% probability of breakage at the lower limit of the 95% confidence interval. The values for different types of glass are listed in Table 6.

Table 6: Values for the mechanical strength of thermally toughened soda lime silicate safety glass

<table>
<thead>
<tr>
<th>Type of glass</th>
<th>Values for mechanical strength N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Float: clear</td>
<td>100</td>
</tr>
<tr>
<td>tinted</td>
<td></td>
</tr>
<tr>
<td>coated</td>
<td></td>
</tr>
<tr>
<td>Enamelled float</td>
<td>80</td>
</tr>
<tr>
<td>(based on the enamelled surface in tension)</td>
<td></td>
</tr>
<tr>
<td>Patterned glass and drawn sheet</td>
<td>90</td>
</tr>
</tbody>
</table>

**NOTE:** The values in table 6 represent the strength of thermally toughened soda lime silicate safety glass (4mm and thicker) which meets the requirements of 8.5.

8.5 **Classification of performance under accidental human impact**

Thermally toughened soda lime silicate safety glass can be classified, as to its performance under accidental human impact, by testing in accordance with prEN 12600.

9. **MARKING**

Thermally toughened soda lime silicate safety glass conforming to this AAAMSA Selection Guide shall be permanently marked. The marking shall give the following information:

- name or trademark of manufacturer;
- NRCS number refer VC9003
Example of particle count

Figure A.1: Select the area of coarsest fracture, place the template on the test specimen and draw round the template

Number of perimeter particles \(=\frac{32}{2} = 16\)

Figure A.2: Mark and count the perimeter fragments as \(\frac{1}{4}\) particle each

Number of central particles = 53

Total number of particles = 16 + 53 = 69

Figure A.3: Mark and count the central fragments and add these to the perimeter count to obtain the particle count for the specimen
Annex B (informative)

Curved thermally toughened soda lime silicate safety glass

Curved thermally toughened soda lime silicate safety glass has been deliberately given a specific profile during the course of manufacture. It is not included in this standard since there is insufficient data available to standardize the product. However, the information given in this standard on thickness, edge work and fragmentation is also applicable to curved thermally toughened soda lime silicate safety glass.