BRITISH STANDARD

BS EN
14321-1:2005

Glass in building — Thermally toughened alkaline earth silicate safety glass —

Part 1: Definition and description

The European Standard EN 14321-1:2005 has the status of a British Standard

ICS 81.040.20

National foreword

This British Standard is the official English language version of EN 14321-1:2005.

The UK participation in its preparation was entrusted by Technical Committee B/520, Glass and glazing in building, to Subcommittee B/520/1, Glass and glazing in building — Basic and transformed glass products, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 26, an inside back cover and a back cover.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 11 July 2005

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 46363 X

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14321-1

June 2005

ICS 81.040.20

English version

Glass in building - Thermally toughened alkaline earth silicate safety glass - Part 1: Definition and description

Verre dans la construction - Verre de silicate alcalino-terreux de sécurité trempé thermiquement - Partie 1 : Définition et description

Glas im Bauwesen - Thermisch vorgespanntes Erdalkali-Silicat-Einscheibensicherheitsglas - Teil 1: Definition und Beschreibung

This European Standard was approved by CEN on 19 May 2005.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Ref. No. EN 14321-1:2005: E

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Foreword

This European Standard (EN 14321-1:2005) has been prepared by Technical Committee CEN/TC 129 “Glass in building”, the secretariat of which is held by IBN/BIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2005, and conflicting national standards shall be withdrawn at the latest by December 2005.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

No existing European Standard is superseded.

This Part of the European Standard does not stand-alone, it is a part of one standard:

— EN 14321-1: Glass in building – Thermally toughened alkaline earth silicate safety glass – Part 1: Definition and description;

— prEN 14321-2: Glass in building – Thermally toughened alkaline earth silicate safety glass – Part 2: Evaluation of conformity.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

Thermally toughened alkaline earth silicate safety glass has a safer breakage behaviour when compared with annealed glass. When it should be used to offer protection under accidental human impact, thermally toughened alkaline earth silicate safety glass also should be classified according to EN 12600.

NOTE CEN/TC129/WG8 is producing standards for the determination of the design strength of glass and is preparing a design method.

1 Scope

This European Standard specifies tolerances, flatness, edgework, fragmentation and physical and mechanical characteristics of monolithic flat thermally toughened alkaline earth silicate safety glass for use in buildings.

Information on curved thermally toughened alkaline earth silicate safety glass is given in Annex A, but this product does not form part of this European Standard.

Other requirements, not specified in this European Standard, can apply to thermally toughened alkaline earth 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 alkaline earth silicate safety glass, in this case, does not lose its mechanical or thermal characteristics.

2 Normative references

The following referenced documents are indispensable for the application 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.

EN 1096-1, *Glass in building — Coated glass — Part 1: Definitions and classification*

EN 12600, *Glass in building — Pendulum test — Impact test method and classification for flat glass*

EN 14178-1, *Glass in building — Basic alkaline earth silicate glass products — Part 1: Float glass*

3 Terms and definitions

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

3.1
thermally toughened alkaline earth 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

3.2
flat thermally toughened alkaline earth silicate safety glass
thermally toughened alkaline earth silicate safety glass that has not been deliberately given a specific profile during manufacture

3.3
enamelled thermally toughened alkaline earth silicate safety glass
thermally toughened alkaline earth 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

NOTE In the UK, this glass is also known as opaque thermally toughened alkaline earth silicate safety glass.

3.4
horizontal toughening
process in which the glass is supported on horizontal rollers

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

4 Glass products

Thermally toughened alkaline earth silicate safety glass shall be made from a monolithic glass generally corresponding to the following standard:

— alkaline earth silicate glass according to EN 14178-1 (float glass);

— this may also be coated in accordance with EN 1096-1.

5 Fracture characteristics

In the event of breakage, thermally toughened alkaline earth 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.

6 Dimensions and tolerances

6.1 Nominal thickness and thickness tolerances

The nominal thicknesses and thickness tolerances shall be those given in the relevant product standard (see Clause 4), some of which are reproduced in Table 1.

Table 1 — Nominal thicknesses and thickness tolerances

Dimensions in millimetres

Nominal	Thickness tolerances for glass type
Thickness d	Alkaline earth silicate - Float
4	± 0,2
5	± 0,2
6	± 0,2
8	± 0,3
10	± 0,3
12	± 0,3
15	± 0,5

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, and away from the area of any tong marks (see Figure 3), which may be present.

6.2 Width and length (sizes)

6.2.1 General

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

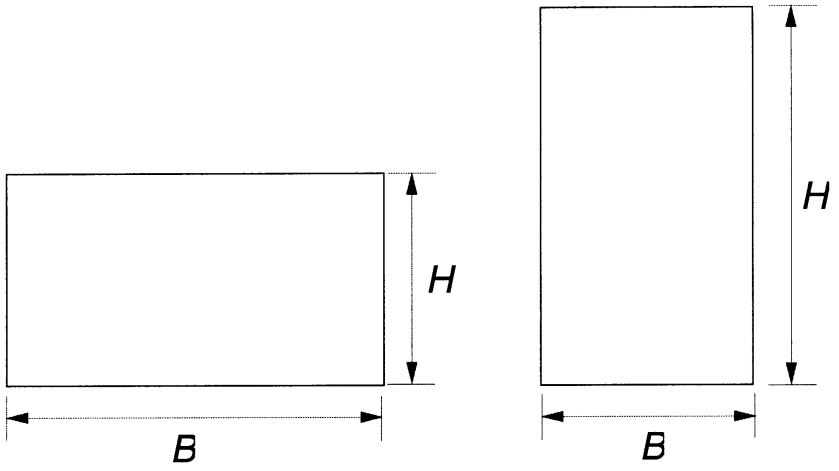


Figure 1 — Examples of width, *B*, and length, *H*, relative to the pane shape

6.2.2 Maximum and minimum sizes

For maximum and minimum sizes, the manufacturer shall 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 a prescribed rectangle resulting from the nominal dimensions increased by the tolerance, *t*, or smaller than a prescribed rectangle reduced by the tolerance, *t*. The sides of the prescribed rectangles are parallel to one another and these rectangles shall have a common centre (see Figure 2). The limits of squareness shall be determined by the prescribed rectangles. Tolerances are given in Table 2.

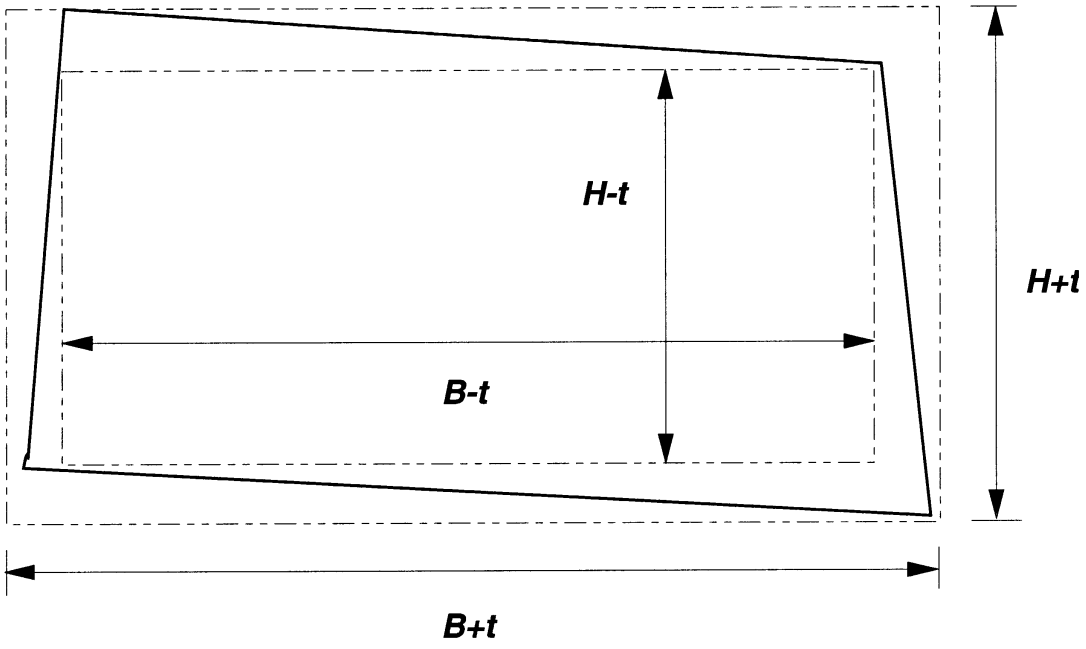


Figure 2 — Tolerance limits for dimensions of rectangular panes

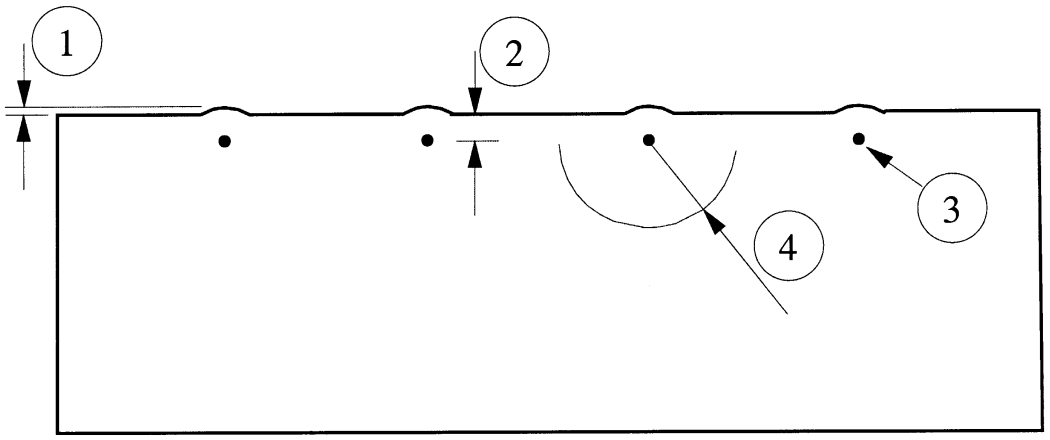
Table 2 — Tolerances on width, *B*, and length, *H*

Dimensions in millimetres

Nominal dimension	Tolerance, *t*	
of side, B or H	nominal glass thickness, $d \leq 12$	nominal glass thickness, $d > 12$
≤ 2 000	± 2,5 (horizontal toughening) ± 3,0 (vertical toughening)	± 3,0
2 000 < *B* or *H* ≤ 3 000	± 3,0	± 4,0
> 3 000	± 4,0	± 5,0

6.2.4 Edge deformation produced by vertical toughening

The tongs used to suspend the glass during toughening can result in surface depressions, known as tong marks (see Figure 3). The centres of the tong marks may be 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 can also be an area of optical distortion. These deformations shall be included in the tolerances in Table 2.



Key

1) deformation
2) up to 20 mm
3) tong mark
4) 100 mm radius maximum area of optical distortion

Figure 3 — Tong mark deformation

6.3 Flatness

6.3.1 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. Therefore a distortion known as overall bow may occur. There are two kinds of bow (see Figure 4):

— overall or general bow;

— local bow.

NOTE 1 Overall bow can, in general, be accommodated by the framing system.

NOTE 2 Local bow needs to be allowed for in the glazing materials and the weather seals. For special requirements the manufacturers should be consulted.

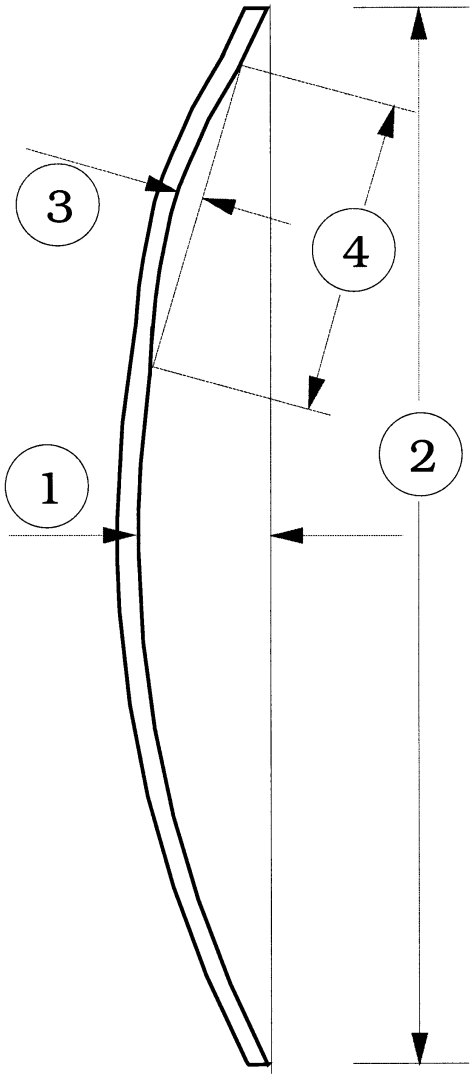
6.3.2 Measurement of overall bow

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 5).

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 4).

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.

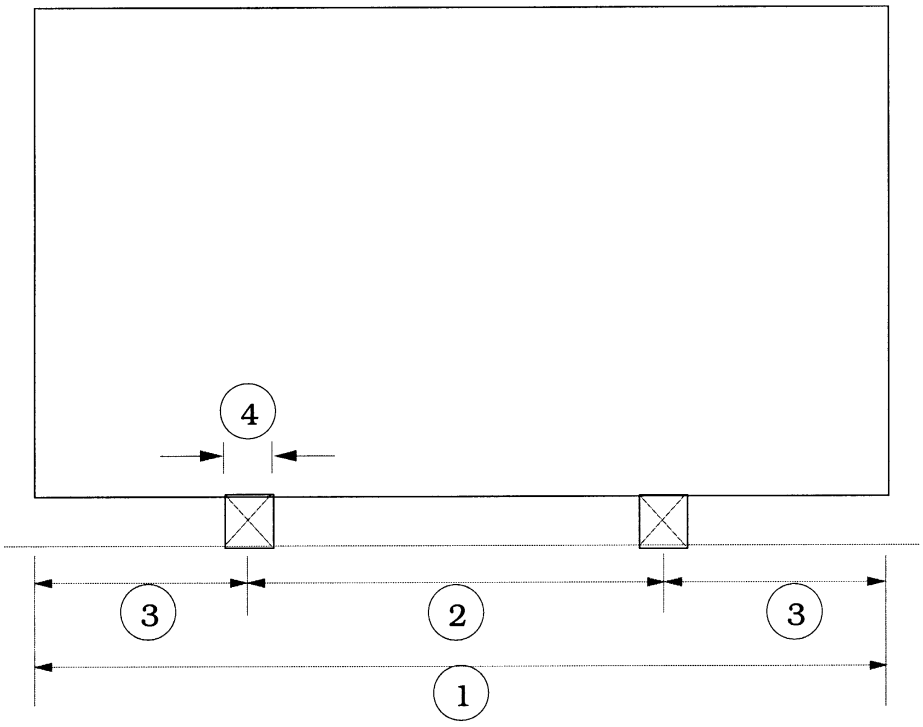
The measurement shall be carried out at room temperature.



Key

1 deformation for calculating overall bow
2 *B*, or *H*, or diagonal length
3 local bow
4 300 mm length

Figure 4 — Representation of overall and local bow



Key

1) *B* or *H*
2) (*B* or *H*)/2
3) (*B* or *H*)/4
4) maximum 100 mm

Figure 5 — Support conditions for the measurement of overall bow

6.3.3 Measurement of local bow

Local bow can occur over relatively short distances on the edges 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 4).

Local bow is expressed as millimetres / 300 mm 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.

6.3.4 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 shall not exceed those given in Table 3.

Table 3 — Maximum values for overall and local bow

Toughening process	Type of glass	Maximum values	
		Overall bow mm/mm	Local bow mm/300 mm
Horizontal	Alkaline earth silicate – Float	0,003	0,5
Vertical	Alkaline earth silicate – Float	0,005	1,0

7 Edge work, holes, notches and cut-outs

7.1 Warning

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

7.2 Edge working of glass before toughening

Every glass that shall be thermally toughened has to be edge worked prior to toughening.

The simplest type of edge working is the arrissed edge (see Figure 6 a)). Other common types are shown in Figures 6 b) to 6 d). For specialist edge work, such as 'water jet cutting', the manufacturers should be consulted.

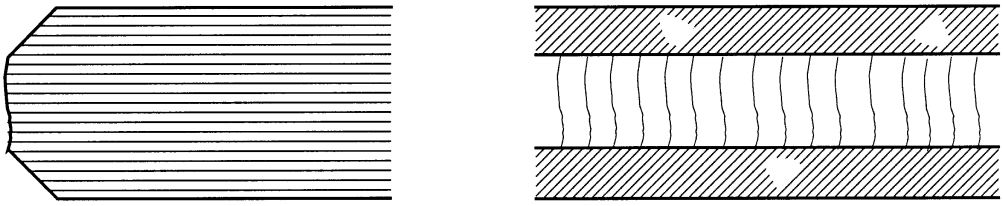


Figure 6 a) — Arrissed edge (with blank spots)

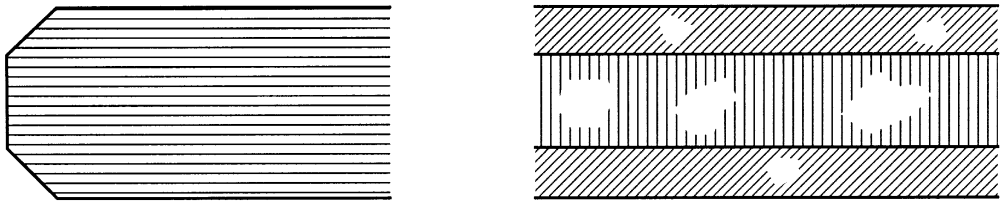


Figure 6 b) — Ground edge (with blank spots)

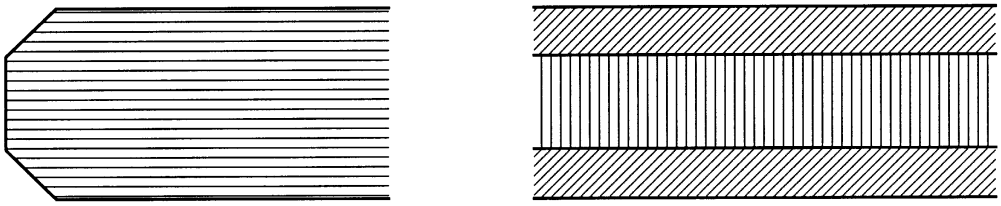


Figure 6 c) — Smooth ground edge (no blank spots)

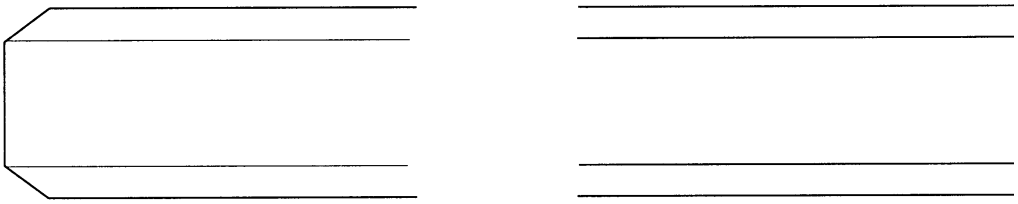


Figure 6 d) — Polished edge

7.3 Profiled edges

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

7.4 Round holes

7.4.1 General

This European 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.

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 depends on:

— nominal glass thickness (*d*);

— dimensions of the pane (*B*, *H*);

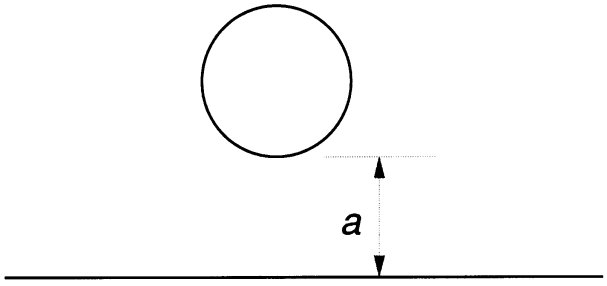
— hole diameter (∅);

— shape of the pane;

— number of holes.

The recommendations given below are those that are normally available and are limited to panes with a maximum of 4 holes.

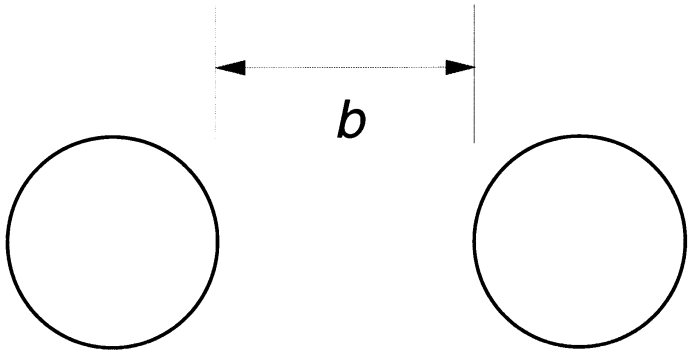
1) The distance, *a*, of the edge of a hole to the glass edge should be not less than 2*d*.



$$a \geq 2d$$

Figure 7 — Relationship between hole and edge of pane

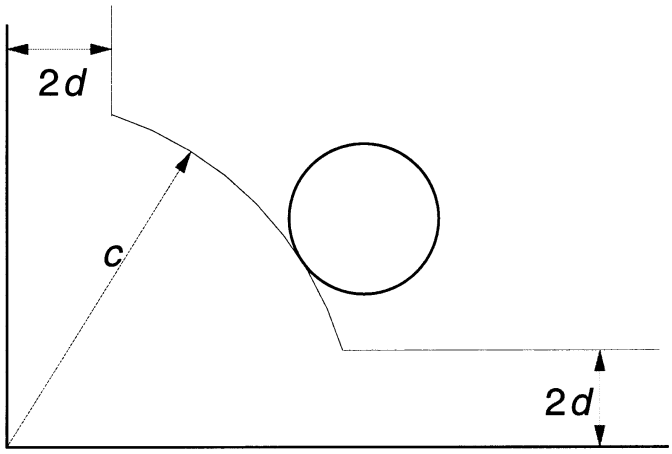
2) The distance, *b*, between the edges of two holes should be not less than 2*d*.



$$b \geq 2d$$

Figure 8 — 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 6*d*.



$c \geq 6d$

Figure 9 — 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.

7.4.4 Tolerances on hole diameters

The tolerances on hole diameters are given in Table 4.

Table 4 — Tolerances on hole diameters

Dimensions in millimetres

Nominal hole diameter, ∅	Tolerances
$4 \leq \varnothing \leq 20$	± 1,0
$20 < \varnothing \leq 100$	± 2,0
$100 < \varnothing$	consult the manufacturer

7.4.5 Tolerances on position of holes

The tolerances on positions of holes are the same as the tolerances 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 10 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.

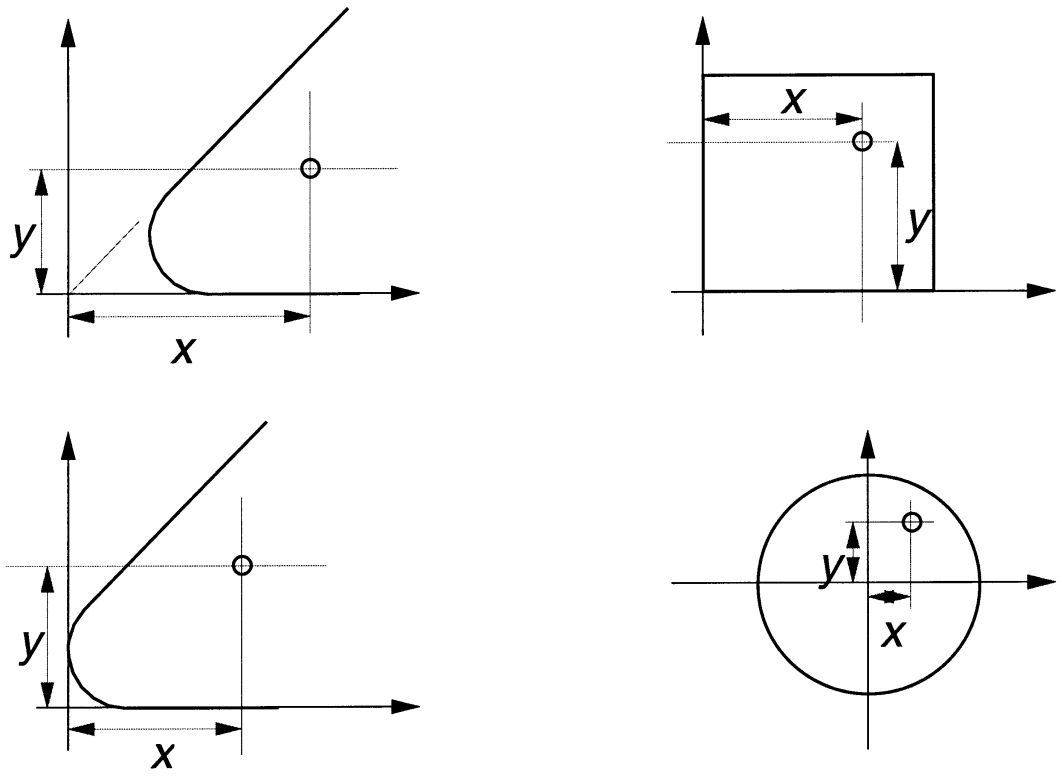


Figure 10 — Examples of the positioning of holes relative to the datum point

7.5 Notches and cut-outs

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

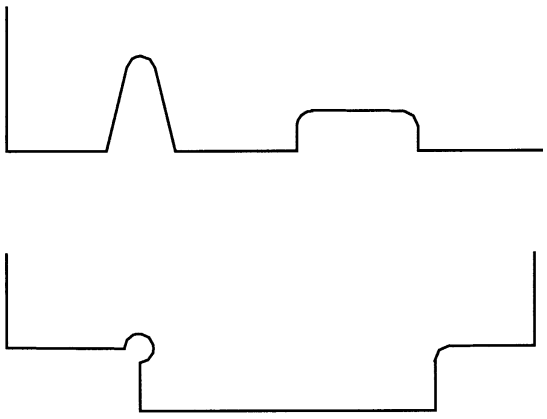


Figure 11 — Examples of notches and cut-outs

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 thermally toughened alkaline earth silicate safety glass.

8.2 Dimensions and number of test specimens

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

Five specimens shall be tested.

8.3 Test procedure

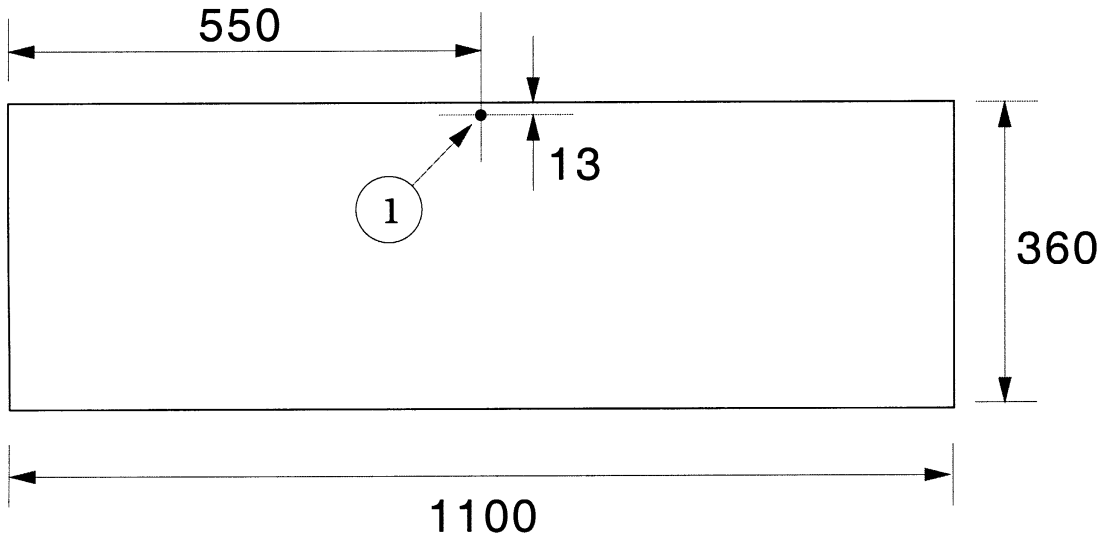
Each test specimen shall be impacted, using a pointed steel tool, at a position 13 mm in from the longest edge of the test specimen at the mid-point of that edge, until breakage occurs (see Figure 12).

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

Dimensions in millimetres



Key

1 impact point

Figure 12 — Position of impact point

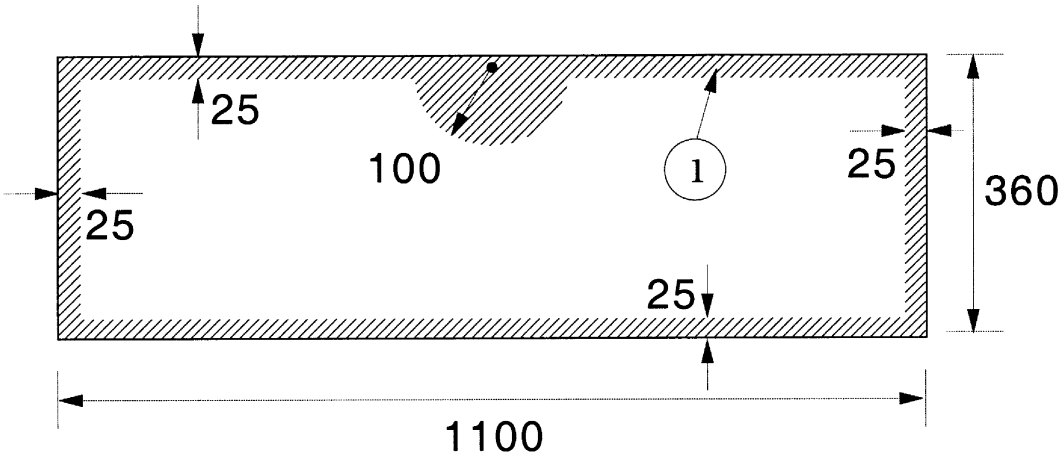
For thermally toughened alkaline earth silicate safety glass manufactured by vertical toughening, the impact point shall not be on the tong mark edge.

8.4 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 13), 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 B). 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 14).

Dimensions in millimetres



Key

1 excluded area

Figure 13 — Area to be excluded from the particle count determination and largest particle measurement

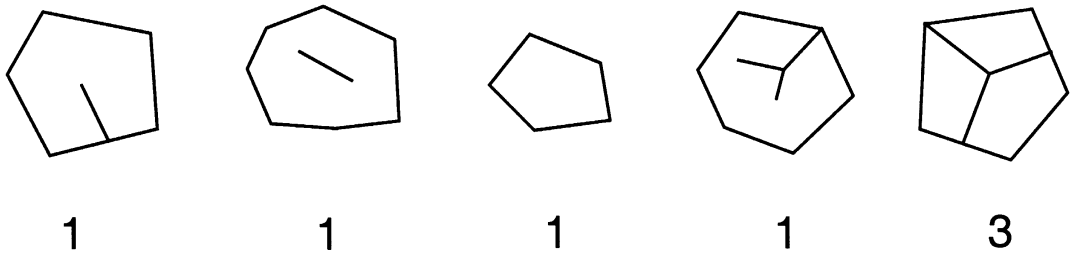


Figure 14 — Examples of crack-free particles and the assessment regarding the number

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

8.5 Minimum values from the particle count

In order to classify a glass as a thermally toughened alkaline earth 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

Glass type	Nominal thickness (*d*) in mm	Minimum particle count
Alkaline earth silicate - float	4 to 12	40
	15	30

8.6 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).

8.7 Maximum length of longest particle

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

9 Other physical characteristics

9.1 Optical distortion

9.1.1 Thermally toughened alkaline earth 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 (see Figure 3).

9.1.2 Thermally toughened alkaline earth 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 8 mm can show signs of small imprints in the surface (‘roller pick-up’).

9.2 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 polarised light.

When thermally toughened alkaline earth silicate safety glass is viewed in polarised light, the areas of stress show up as coloured zones, sometimes known as ‘leopard spots’.

Polarised light occurs in normal daylight. The amount of polarised 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 polarised spectacles.

9.3 Thermal durability

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

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 alkaline earth silicate safety glass

Type of glass	Values for mechanical strength N/mm^2
Float: Clear Tinted Coated	120
Enamelled float (based on the enamelled surface in tension)	75

NOTE The values in Table 6 represent the strength of thermally toughened alkaline earth silicate safety glass (4 mm and thicker) that meets the requirements of 8.5.

9.5 Classification of performance under accidental human impact

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

10 Marking

Thermally toughened alkaline earth silicate safety glass conforming to this European Standard shall be permanently marked. The marking shall give the following information:

— name or trademark of manufacturer;

— number of this European Standard: EN 14321-1.

Annex A
(informative)

Curved thermally toughened alkaline earth silicate safety glass

Curved (in the UK also called bent) thermally toughened alkaline earth silicate safety glass has been deliberately given a specific profile during the course of manufacture. It is not included in this European Standard since there is insufficient data available to standardise the product. However, the information given in this European Standard on thickness, edge work and fragmentation is also applicable to curved thermally toughened alkaline earth silicate safety glass.

Annex B
(informative)

Example of particle count

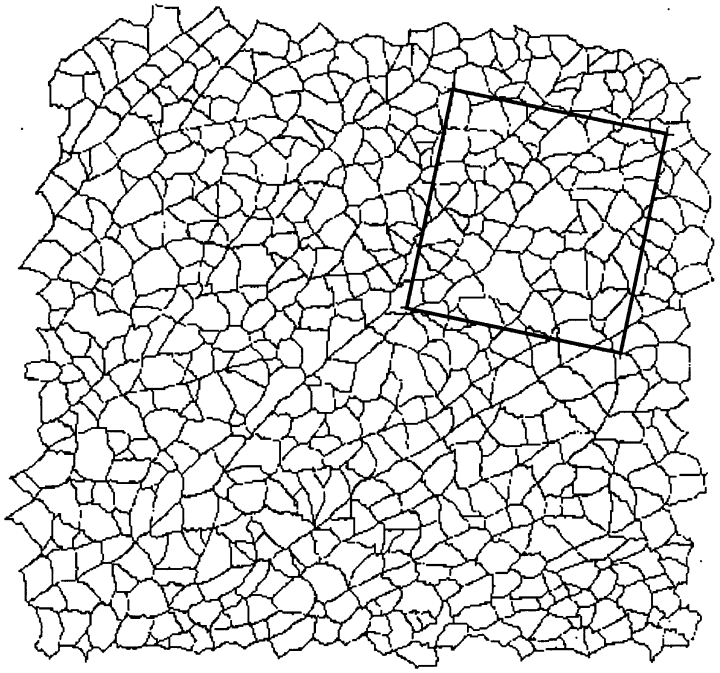
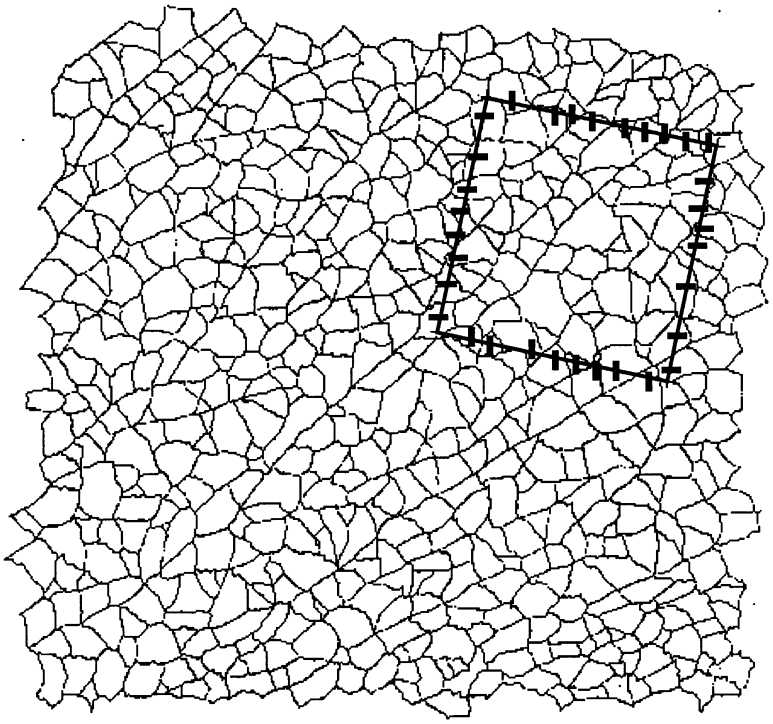
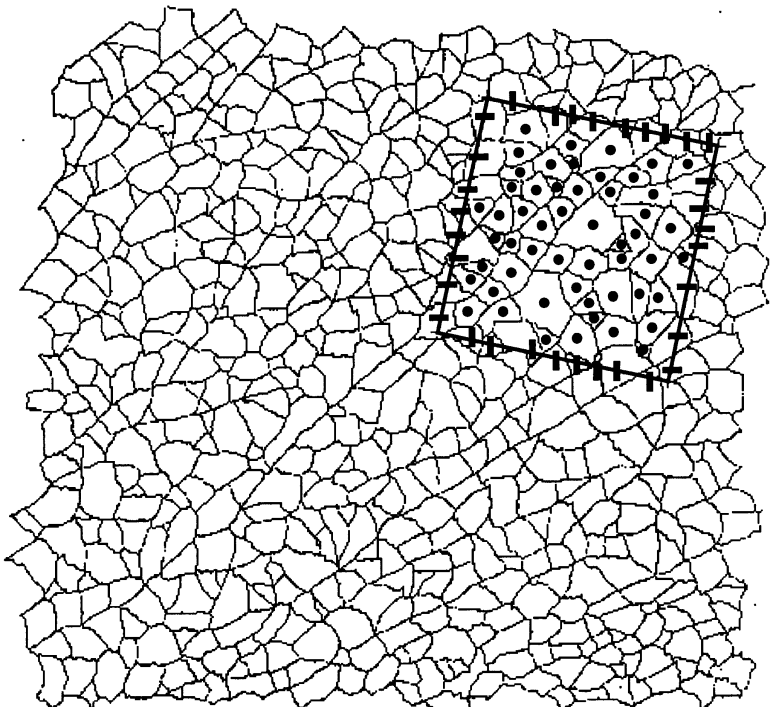


Figure B.1 — Select the area of coarsest fracture, place the template on the test specimen and draw round the template



Number of perimeter particles = 32/2 = 16

Figure B.2 — Mark and count the perimeter fragments as 1/2 particle each



Number of central particles = 53

Total number of particles = 16 + 53 = 69

Figure B.3 — Mark and count the central fragments and add these to the perimeter count to obtain the particle count for the specimen

blank

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