BS EN 14179-1:2016

BSI Standards Publication

Glass in building — Heat soaked thermally toughened soda lime silicate safety glass

Part 1: Definition and description

National foreword

This British Standard is the UK implementation of EN 14179-1:2016. It supersedes BS EN 14179-1:2005 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/520/1, Basic and transformed glass products.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

ISBN 978 0 580 87502 1

ICS 81.040.20

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 August 2016.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14179-1

July 2016

ICS 81.040.20

Supersedes EN 14179-1:2005

English Version

Glass in building - Heat soaked thermally toughened soda lime silicate safety glass - Part 1: Definition and description

Verre dans la construction - Verre de silicate sodo-calcique de sécurité trempé et traité Heat Soak - Partie 1: Définition et description

Glas im Bauwesen - Heißgelagertes thermisch vorgespanntes Kalknatron-Einscheibensicherheitsglas - Teil 1: Definition und Beschreibung

This European Standard was approved by CEN on 12 May 2016.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 14179-1:2016 E

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European foreword

This document (EN 14179-1:2016) has been prepared by Technical Committee CEN/TC 129 "Glass in building", the secretariat of which is held by NBN.

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of an identical text or by endorsement, at the latest by January 2017, and conflicting national standards shall be withdrawn at the latest by January 2017.

This document supersedes EN 14179-1:2005.

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

EN 14179, *Glass in building — Heat soaked thermally toughened soda lime silicate safety glass*, is composed of the following parts:

— *Part 1: Definition and description*;

— *Part 2: Evaluation of conformity / Product standard*.

This European Standard differs from EN 14179-1:2005 as follows:

a) some figures have been revised and some new figures have been added;

b) new terms and definitions have been included in Clause 3, e.g. air cushion process (3.7), edge lift (3.10) and roller wave distortion (3.14) further nominal thicknesses have been included in Table 1;

c) the glass temperature during the holding time of the heat soak process cycle has been reduced,

d) subclause 8.2.3 "Tolerances and squareness" has been completely revised; the squareness of rectangular glass panes is now expressed by the difference between its diagonals;

e) Clauses 8 and 9 have been completely revised (including the air cushion manufacturing process);

f) the informative Annex "Curved heat soaked thermally toughened soda lime silicate safety glass" has been deleted;

g) a new informative Annex dealing with an alternative method for the measurement of roller wave distortion has been added.

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

Introduction

Heat soaked thermally toughened soda lime silicate safety glass has a safer breakage behaviour when compared with annealed glass. It also has a known level of residual risk of spontaneous breakage arising from the possible presence of critical nickel sulphide (NiS) inclusions in the heat soaked thermally toughened soda lime silicate glass.

NOTE 1 This case deals with extremely large quantities of glass. These quantities are dealt with on a statistical basis. Therefore, it is impossible to select a quantity of heat soaked thermally toughened soda lime silicate safety glass, for a building, and claim that 'no break' by NiS inclusion can occur. The breakage of heat soaked thermally toughened soda lime silicate safety glass caused by other influences is not considered in this European Standard.

When used to offer protection under accidental human impact, heat soaked thermally toughened soda lime silicate safety glass also should be classified according to EN 12600.

NOTE 2 CEN/TC 129/WG 8 is producing standards for the determination of the design strength of glass and is preparing a design method.

The European Committee for Standardization (CEN) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning heat soak tests.

CEN takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has ensured CEN that he / she is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with CEN. Information may be obtained from:

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1 Scope

This European Standard specifies the heat soak process system together with tolerances, flatness, edgework, fragmentation and physical and mechanical characteristics of monolithic flat heat soaked thermally toughened soda lime silicate safety glass for use in buildings.

Curved heat soaked thermally toughened soda lime silicate safety glass is not part of this European Standard.

Other requirements, not specified in this European Standard, can apply to heat soaked 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. Heat soaked thermally toughened soda lime silicate safety glass, in this case, does not lose its bending strength characteristics and its resistance to temperature differentials.

Surface finished glasses (e.g. sandblasted, acid etched) after toughening are not covered by this European Standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 572-1, *Glass in building - Basic soda lime silicate glass products - Part 1: Definitions and general physical and mechanical properties*

EN 572-2, *Glass in building - Basic soda lime silicate glass products - Part 2: Float glass*

EN 572-4, *Glass in building - Basic soda lime silicate glass products - Part 4: Drawn sheet glass*

EN 572-5, *Glass in building - Basic soda lime silicate glass products - Part 5: Patterned glass*

EN 572-8, *Glass in building - Basic soda lime silicate glass products - Part 8: Supplied and final cut sizes*

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

EN 1288-3, *Glass in building - Determination of the bending strength of glass - Part 3: Test with specimen supported at two points (four point bending)*

3 Terms and definitions

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

3.1
heat soaked thermally toughened soda lime silicate safety glass
glass within which a permanent surface compressive stress, additionally to the basic mechanical strength, has been induced by a controlled heating and cooling process in order to give it greatly increased resistance to mechanical and thermal stress and prescribed fragmentation characteristics and which has a known level of residual risk of spontaneous breakage due to the presence of critical nickel sulphide (NiS) inclusions

Note 1 to entry: The mechanical properties, i.e. thermal durability and mechanical strength, and safety properties, i.e. fragmentation characteristics, are generated by the level of surface compression. These properties are not size dependent.

3.2
level of residual risk
risk of spontaneous breakage of heat soaked thermally toughened soda lime silicate safety glass, on a statistical basis, due to the presence of critical nickel sulphide inclusions, is no more than one breakage per 400 t of heat soaked thermally toughened soda lime silicate safety glass

3.3
flat heat soaked thermally toughened soda lime silicate safety glass
heat soaked thermally toughened soda lime silicate safety glass that has not been deliberately given a specific profile during manufacture

3.4
curved heat soaked thermally toughened soda lime silicate safety glass
heat soaked thermally toughened soda lime silicate safety glass which has been deliberately given a specific profile during manufacture

Note 1 to entry: This product is excluded from the scope.

3.5
heat soaked enamelled thermally toughened soda lime silicate safety glass
heat soaked thermally toughened soda lime silicate safety glass which has a ceramic frit fired into the surface during the toughening process

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

Note 2 to entry: In the UK, this glass is also known as opaque heat soaked thermally toughened soda lime silicate safety glass.

Note 3 to entry: The application of the ceramic frit may be by a continuous process or discontinuous application, e.g. screen printing. The enamelled surface could be partially or wholly.

3.6
horizontal process
process in which the glass is supported on horizontal rollers

3.7
air cushion process
process in which the glass is supported by an air cushion with or without additional rollers

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

3.8
vertical process
process in which the glass is suspended by tongs

3.9
edge deformation
deformation of the edge cause by the tong marks for vertically toughened glass

3.10
edge lift
distortion produced in horizontal toughened glass, at the leading and trailing edge of the plate

3.11
perimeter deformation
distortion around the edge of toughened glass manufactured by air cushion process

3.12
local distortion
local deformation of vertically toughened glass underneath the tong marks

3.13
overall bow
deformation of the whole pane of toughened glass caused by the heating and cooling process

3.14
roller wave distortion
distortion produced in horizontally toughened glass as a result of the glass during toughening process being in contact with the rollers

3.15
wave distortion
distortion produced in toughened glass manufactured by air cushion process as a result of the glass toughening process

4 Glass products

Heat soaked thermally toughened soda lime silicate safety glass shall be made from a monolithic glass product generally corresponding to one of the following standards:

— soda lime silicate glass according to EN 572-1;

— float glass according to EN 572-2;

— drawn sheet glass according to EN 572-4;

— patterned glass according to EN 572-5;

— supplied and final cut sizes according to EN 572-8;

— coated glass according to EN 1096-1.

Glass of nominal thicknesses other than those covered in the above standards is possible.

5 Manufacturing processes

5.1 General

Heat soaked thermally toughened soda time silicate safety glass is manufactured as follows:

Basic soda lime silicate glass products (see Clause 4) are cut to size, shaped and edgeworked (see Clause 9).

The prepared glass panes are then thermally toughened (see 5.2).

The thermally toughened panes are then subjected to the heat soak process cycle.

After manufacture, the heat soaked thermally toughened soda lime silicate glass shall comply with the fragmentation test (see Clause 10) and mechanical strength requirement (see 11.4).

5.2 Toughening process

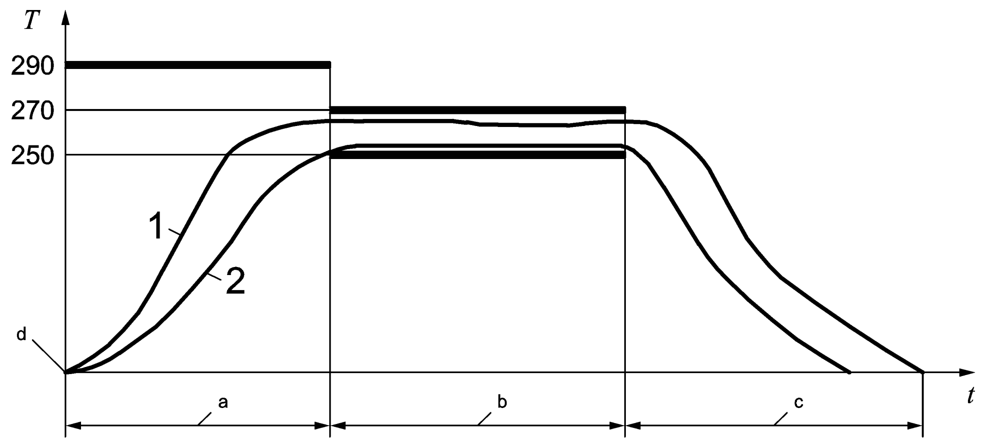
The cut, shaped and edgeworked glasses are toughened. The glasses toughened by the horizontal or air cushion or vertical process shall comply with the flatness criteria (see 8.3).

The thermally toughened soda lime silicate safety glass shall have a level of fragmentation that will ensure that after the glass has been through the heat soak process, and subsequently tested to the fragmentation test (see Clause 10), it shall comply with 10.5.

5.3 Heat soak process cycle

5.3.1 General

The heat soak process cycle consists of a heating phase, a holding phase and a cooling phase (see Figure 1).



Key

T glass temperature at any point, °C
t time, h
1 first glass to reach 250 °C
2 last glass to reach 250 °C
d ambient temperature
a heating phase
b holding phase
c cooling phase

Figure 1 — Heat soak process cycle

5.3.2 Heating phase

The heating phase commences with all the glasses at ambient temperature and concludes when the surface temperature of the last glass reaches 250 °C. The maximum heating rate is 3° C per minute. The time to reach this temperature is defined in the calibration process. This time will be dependent on the size of the oven, the amount of glass to be treated, the separation between glasses and the heating system capacity.

NOTE 1 The glass separation and rate of heating should be controlled to minimize the risk of glass breakage as a result of thermal stress.

To facilitate economic heating, the air temperature within the oven may exceed 290 °C. However, the glass surface temperature shall not be allowed to exceed 290 °C. The period of glass surface temperature in excess of 270 °C shall be minimized.

NOTE 2 Care should be taken to ensure the maximum temperature of the glass does not exceed 270° C as there is a possibility of the nickel sulphide inclusion reconverting.

5.3.3 Holding phase

The holding phase commences when the surface temperature of all the glasses has reached a temperature of 250 °C. The minimum duration of the holding phase is 2 hours.

Precise oven control is necessary in order to ensure that the glass surface temperature shall be maintained in the range of 260 °C ± 10 °C during the holding phase.

5.3.4 Cooling phase

The cooling phase commences when the last glass to reach 250 °C has completed its holding phase, i.e. been held for minimum 2 hours at 260 °C ± 10 °C. During this phase the glass temperature shall be brought down to ambient temperature.

The cooling phase can be concluded when the air temperature in the oven reaches 70 °C.

The rate of cooling should be controlled to minimize the risk of glass breakage as a result of thermal stress.

6 Heat soak process system

6.1 General

The heat soak process system consists of:

— oven (see 6.2);

— glass support (see 6.3);

— separation system (see 6.4).

The oven shall be calibrated, see 6.5 and Annex A, and this determines the method of operation of the heat soak process system during manufacture of heat soaked thermally toughened soda lime silicate safety glass.

6.2 Oven

The oven shall be heated by convection and shall allow an unhindered air circulation around each glass pane. In the event of glass breakage the airflow shall not be hindered. The airflow in the oven shall be led parallel to the glass surfaces.

The openings in the oven for the air ingress / egress should be designed to ensure that fragments of broken glass do not cause blockages.

6.3 Glass support

Glasses may be supported vertically or horizontally. The glasses shall not be fixed or clamped, they have to be supported to allow free movement.

NOTE Vertically means true vertical or up to 15° either side of true vertical.

The distance between glasses affects the airflow, heat exchange and the heating time. Glass to glass contact shall not be allowed.

6.4 Glass separation

The glasses shall be separated in a manner that does not hinder the airflow. The separators shall also not hinder the airflow e.g. see Figure 2.

Dimensions in millimetres

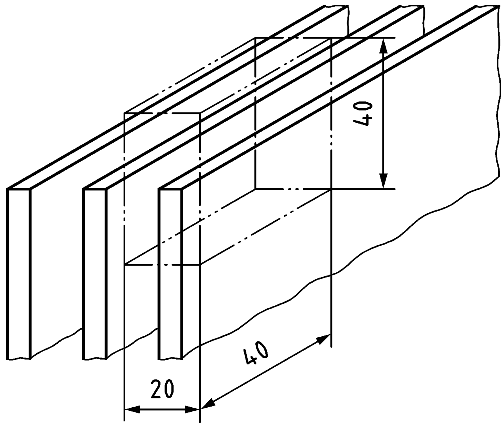


Figure 2 — Example of a vertical glass separator

The minimum separation of the glasses shall be determined during the calibration of the oven, see 6.5 and Annex A.

Generally, a minimum separation of 20 mm is recommended (see Figure 3).

NOTE If glasses of very different size are put on the same stillage, they will require greater separation in order to prevent glass breakage when the furnace is opened after the heat soak process. The same applies to glasses with holes, notches and cut-outs.

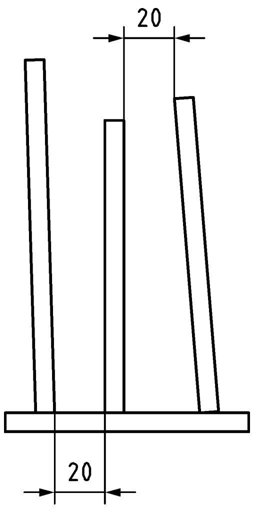


Figure 3 — Recommended separation between glass

The positioning of the separators, material of the manufacture and their shape shall be specified during the calibration test of the oven and shall be reproduced during the manufacturing process.

6.5 Calibration

The heat soak system, e.g. oven, glass separation, separators, etc., shall be calibrated, see Annex A.

The calibration shall determine the heating phase of the process, glass separation distance, the positioning, material and shape of separators, the type and positioning of stillage(s) and define the operating conditions for use during manufacture.

7 Fracture characteristics

The fracture characteristics of heat soaked thermally toughened soda lime silicate safety glass are directly related to the amount of surface compression. These properties are not size dependent.

When the heat soaked thermally toughened soda lime silicate safety glass is manufactured with the correct degree of surface compression then in the event of breakage heat soaked thermally toughened soda lime silicate safety glass fractures into numerous small pieces, the edges of which are generally blunt.

NOTE 1 The degree of surface compression required is dependent upon glass type and thickness.

NOTE 2 The fracture characteristics of glass are unaffected by temperatures between –50 °C and +100 °C.

The fragmentation described in Clause 8 is undertaken on unrestrained test specimens.

The fragmentation in service may not always correspond to that determined during the fragmentation test due to the imposition of other stresses, i.e. from fixing or from reprocessing (e.g. laminating).

8 Dimensions and tolerances

8.1 Nominal thickness and thickness tolerances

The nominal thicknesses and thickness tolerances are 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*	**Float**	**Patterned**	**Drawn sheet**	**New antique drawn sheet**
2	±0,2	not manufactured	±0,2	not manufactured
3	±0,2	±0,5	±0,2	not manufactured
4	±0,2	±0,5	±0,2	±0,3
5	±0,2	±0,5	±0,3	not manufactured
6	±0,2	±0,5	±0,3	±0,3
8	±0,3	±0,8	±0,4	not manufactured
10	±0,3	±1,0	±0,5	not manufactured
12	±0,3	±1,5	±0,6	not manufactured
14	not manufactured	±1,5	not manufactured	not manufactured
15	±0,5	±1,5	not	not

			manufactured	manufactured
19	±1,0	±2,0	not manufactured	not manufactured
25	±1,0	not manufactured	not manufactured	not manufactured

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 5), which may be present.

8.2 Width and length (sizes)

8.2.1 General

When heat soaked thermally toughened soda lime 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 4. It shall be made clear which dimension is the width, *B*, and which is the length, *H*, when related to its installed position.

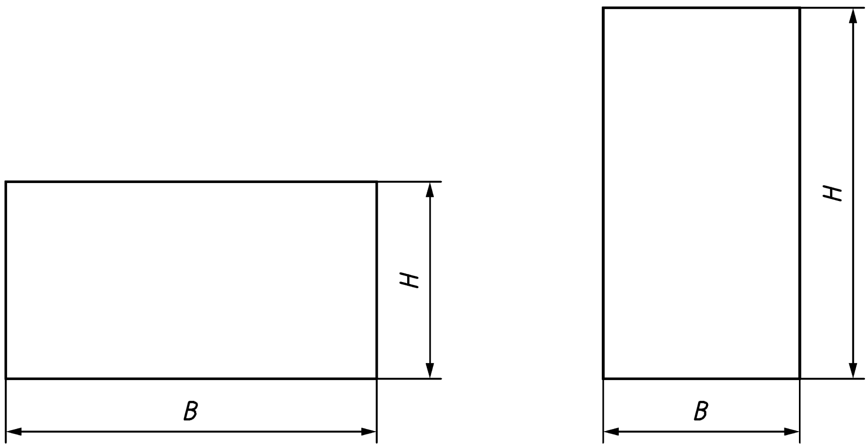


Figure 4 — Examples of width, B, and length, H, relative to the pane shape

For heat soaked 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.

8.2.2 Maximum and minimum sizes

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

8.2.3 Tolerances and squareness

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

The squareness of rectangular glass panes is expressed by the difference between its diagonals.

The difference between the two diagonal lengths of the pane of glass shall not be larger than the deviation limit, *v*, as specified in Table 3.

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

Dimensions in millimetres

Nominal dimension of side, *B* or *H*	Tolerance, *t*	
	nominal glass thickness, $d \leq 8$	nominal glass thickness, $d > 8$
≤ 2 000	±2,0	±3,0
2 000 < *B* or *H* ≤ 3 000	±3,0	±4,0
> 3 000	±4,0	±5,0

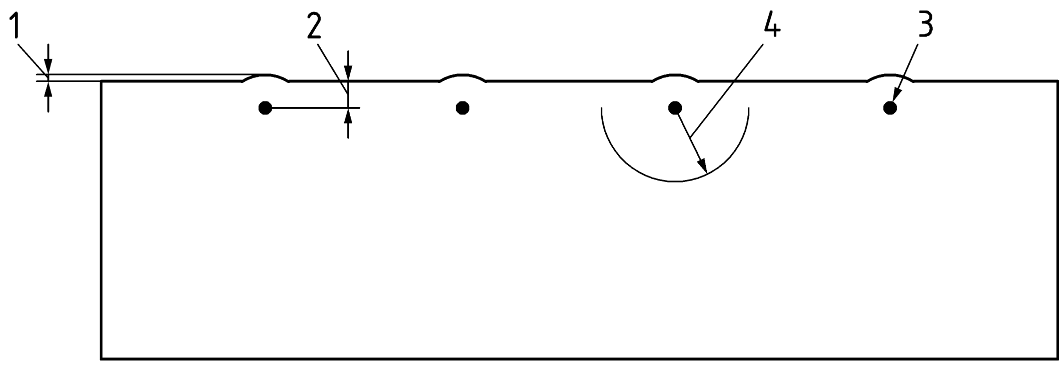
Table 3 — Limit deviations for the difference between diagonals

Dimensions in millimetres

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

8.2.4 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 5). 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 5 — Tong mark deformation

8.3 Flatness

8.3.1 General

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

There are six kinds of distortion:

— overall bow (see Figure 6);

— roller wave distortion (for horizontally toughened glass only) (see Figure 7);

— wave distortion (for toughened glass manufactured by air cushion process only) (see Figure 11);

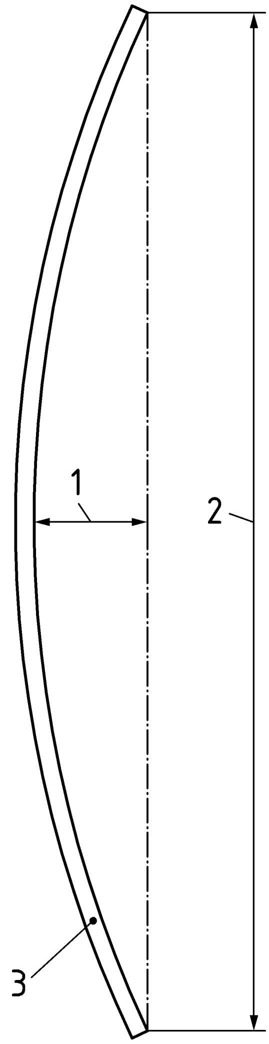
— edge lift (for horizontally toughened glass only) (see Figure 8);

— perimeter deformation (for toughened glass manufactured by air cushion process only) (see Figure 13);

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

— local distortion (for vertically toughened glass only) (see Figure 9).

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



Key

1 deformation for calculating overall bow

2 *B*, or *H*, or diagonal length

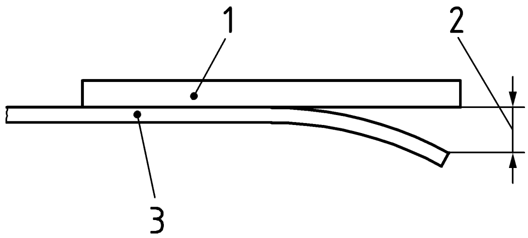
3 thermally toughened soda lime silicate safety glass

Figure 6 — Representation of overall bow

Key

1 thermally toughened soda lime silicate safety glass

Figure 7 — Representation of roller wave distortion



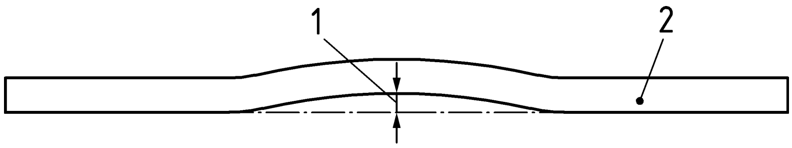
Key

1 straight edge

2 edge lift

3 thermally toughened soda lime silicate safety glass

Figure 8 — Representation of edge lift



Key

1 local distortion

2 thermally toughened soda lime silicate safety glass

Figure 9 — Representation of local distortion

8.3.2 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 10). For glass thinner than 4 mm nominal thickness the support will have an angle between 3 and 7° from the vertical.

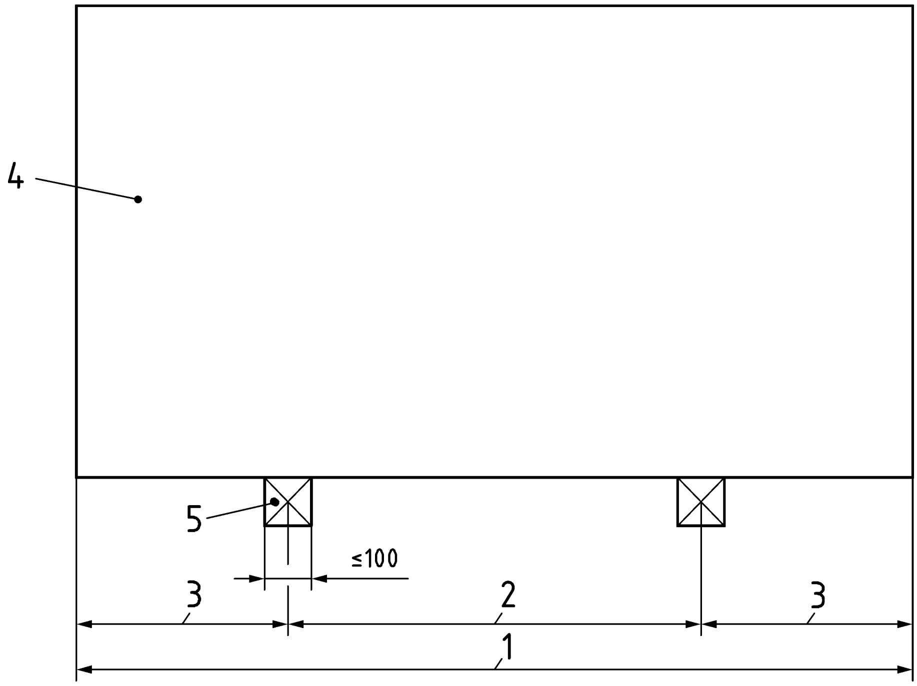
The deformation shall be measured along the edges of the glass and along the diagonals, as the maximum distance between a straight metal ruler, or a stretched wire, and the concave surface of the glass (see Figure 6).

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.

The maximum allowable values for overall bow are given in Table 4 and Table 6.

NOTE Results from this this test method for glasses thinner than 4 mm may be inaccurate.



Key

1 *B* or *H*

2 (*B* or *H*)/2

3 (*B* or *H*)/4

4 thermally toughened soda lime silicate safety glass

5 support

Figure 10 — Support conditions for the measurement of overall distortion

8.3.3 Measurement of wave and roller wave

8.3.3.1 General

The wave or roller wave is measured by means of a straight edge, or equivalent, being placed at right angles to the wave or roller wave and bridging from peak to peak of the waves (see Figure 11).

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

8.3.3.2 Apparatus

A straight edge:

— length of between 300 mm and 400 mm.

The minimal length of the straight edge has to bridge two peaks of the roller waves.

Feeler gauges:

— various thicknesses in units of 0,05 mm.

8.3.3.3 Method

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

Repeat the measurement at several places over the glass surface.

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

8.3.3.4 Limitations

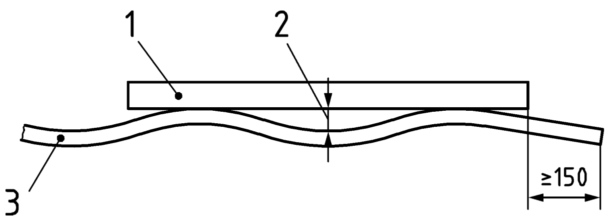
The following limitations apply.

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

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

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

Dimensions in millimetres



Key

1 straight edge

2 wave or roller wave distortion

3 thermally toughened soda lime silicate safety glass

Figure 11 — Measurement of wave or roller wave distortion

8.3.4 Measurement of edge lift (for horizontally toughened glass only)

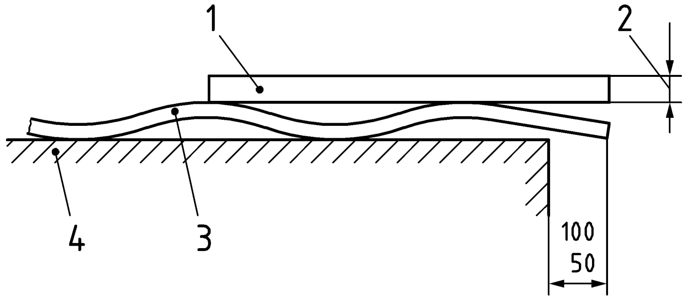
The glass shall be placed on a flat support with the edge lift overhanging the edge of the support by between 50 mm and 100 mm.

The straight edge is placed on the peaks of the roller waves and the gap between the ruler and the glass measured using a feeler gauge (see Figure 12).

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

The values in Table 5 only apply to thermally toughened soda lime silicate safety glass having edgework complying with Figures 15 to Figure 18. For profiled edges or other types of edgework contact the manufacturer.

Dimensions in millimetres



Key

1 straight edge

2 edge lift

3 thermally toughened soda lime silicate safety glass

4 flat support

Figure 12 — Measurement of edge lift

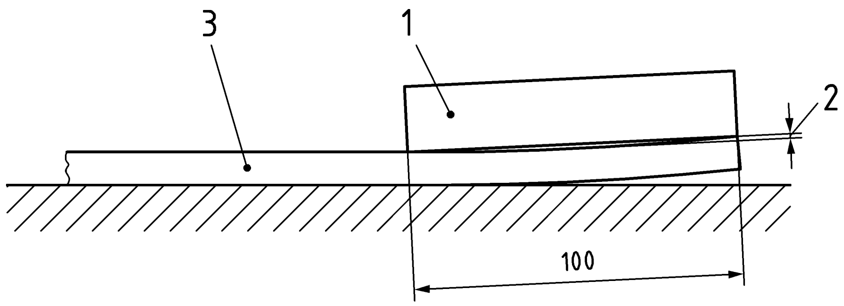
8.3.5 Measurement of perimeter deformation of glass produced by air cushion toughening process

Place the glass on a flat surface with the concave side facing upwards – see Figure 13.

A 100 mm straight edge is laid on the pane at right angles to the edge. The gap between the ruler and the glass is measured using a feeler gauge (see Figure 13). The perimeter deformation is the maximum distance between the surface of the pane and the straight edge.

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

Dimensions in millimetres



Key

1 straight edge

2 perimeter deformation

3 thermally toughened soda lime silicate safety glass

Figure 13 — Measurement of perimeter deformation

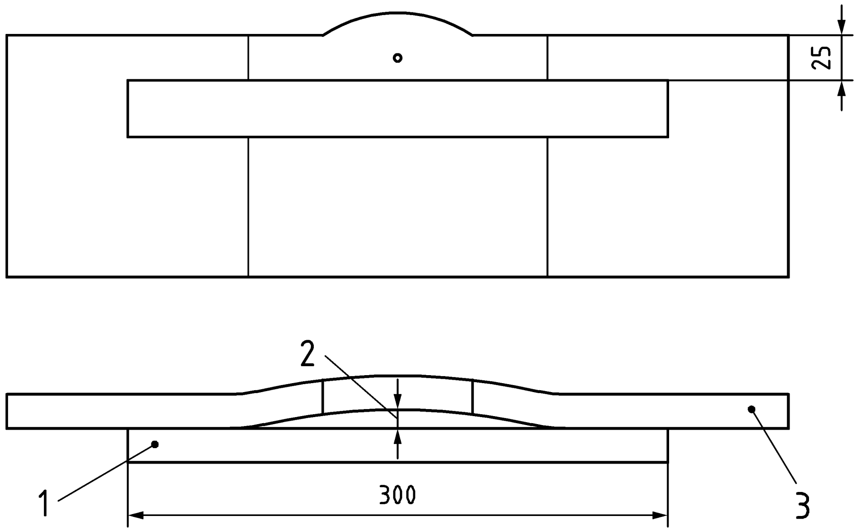
8.3.6 Measurement of local distortion (for vertically toughened glass only)

Local distortion can occur over relatively short distances on the edge of the vertically toughened glass that contains the tong marks (see Figure 5).

Local distortion shall be measured over a limited length of 300 mm by using a straight ruler parallel to the edge at a distance of 25 mm from the edge of the glass (see Figure 14).

Local distortion is expressed as millimetres / 300 mm length.

Dimensions in millimetres



Key

1 straight edge

2 local distortion

3 thermally toughened soda lime silicate safety glass

Figure 14 — Measurement of local distortion

8.3.7 Limitation on overall bow, roller waves and edge lift for horizontally toughened glass

The maximum allowable values for the overall bow, when measured according to 8.3.2, for roller waves, when measured according to 8.3.3 and edge lift, when measured according to 8.3.4 are given in Tables 4 and 5. These values only apply to thermally toughened soda lime silicate safety glass without holes and / or notches and / or cut-outs.

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

Glass Type	**Maximum allowable value for distortion**	
	Overall bow mm / m	**Roller Wave** mm
Uncoated float glass in accordance with EN 572–1 and EN 572–2	3,0	0,3
Others [a]	4,0	0,5
Dependent upon the wavelength of the roller wave an appropriate length of gauge has to be used		
[a] For enamelled glass which is not covered over the whole surface the manufacturer should be consulted.		

Table 5 — Maximum allowable values for edge lift for horizontally toughened glass

Type of glass	Thickness of glass mm	Maximum allowable values mm
Uncoated float glass in accordance with EN 572–1 and EN 572–2	3	0,5
	4 to 5	0,4
	6 to 25	0,3
Others [a]	all	0,5
Dependent upon the wavelength of the roller wave an appropriate length of gauge has to be used For uncoated float glass with a thickness of 2 mm the manufacturer should be consulted		
[a] For enamelled glass which is not covered over the whole surface the manufacturer should be consulted.		

8.3.8 Limitation on overall bow, wave and perimeter deformation for toughened glass manufactured by air cushion process

The maximum allowable values for the overall bow, when measured according to 8.3.2, for waves, when measured according to 8.3.3 and perimeter deformation, when measured according to 8.3.5 are given in Tables 6 and 7. These values only apply to thermally toughened soda lime silicate safety glass without holes and / or notches and / or cut-outs.

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

Glass Type	Maximum allowable value for distortion	
	Overall bow mm / m	Wave mm
Float glass in accordance with EN 572–1 and EN 572–2 and coated float glass in accordance with EN 1096	3,0	0,3
Others [a]	4,0	0,5
For other glass types, the manufacturer should be consulted.		
[a] For enamelled glass which is not covered over the whole surface the manufacturer should be consulted.		

Table 7 — Maximum allowable values for perimeter deformation for toughened glass manufactured by air cushion process

Type of glass	Thickness of glass mm	Maximum allowable values mm
Float glass in accordance with EN 572–1 and EN 572–2 and coated float glass in accordance with EN 1096	2 to12	0,3
Others [a]	2 to 12	0,5

For other glass types, the manufacturer should be consulted.
[a] For enamelled glass which is not covered over the whole surface the manufacturer should be consulted.

8.3.9 Limitation on overall bow and local distortion for vertically toughened glass

The maximum allowable values for the overall bow, when measured according to 8.3.2 and the local distortion, when measured according to 8.3.6 are given in Table 8. These values only apply to toughened glass without holes and / or notches and / or cut-outs.

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

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

8.3.10 Other distortions

The incorporation of holes and / or notches in a plate gives the possibility of distortions being produced during the toughening process as a result of the absence of glass and / or an increase in unsupported edges.

NOTE The magnitude of these distortions will generally be less than edge lift in horizontally toughened glass or local distortion in vertically toughened glass.

9 Edge and / or surface work, holes, notches and cut-outs

9.1 Warning

Heat soaked thermally toughened soda lime silicate safety glass shall not be cut, sawn, drilled, edge worked after toughening or the heat soak process because the risk of breakage is increased or the glass can be destroyed immediately. Surface finished glasses (e.g. sandblasted, acid etched) after toughening or the heat soak process are not covered by this European Standard.

9.2 Edge working of glass for toughening

The simplest type of edge working is the arrissed edge (see Figure 15). Other common types of edge working are shown in Figures 16 to 18. For specialist edge work, such as 'water jet cutting', the manufacturers should be consulted. Corners need not to be treated unless required by the customer.

NOTE The rollers used to convey glass produced by the inclined air cushion process may cause slight marks on the edge of the pane. This applies to polished edges in particular.

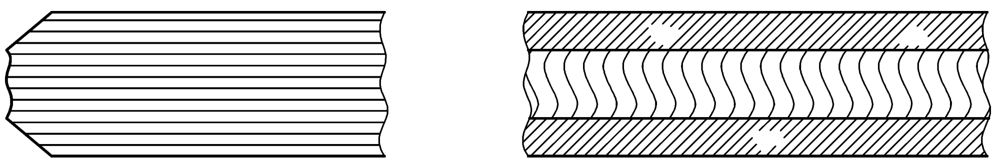


Figure 15 — Arrissed edge (with blank spots)

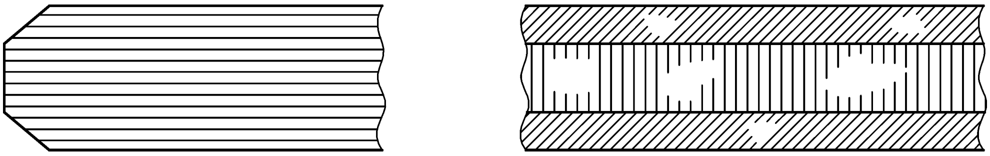


Figure 16 — Ground edge (with blank spots)

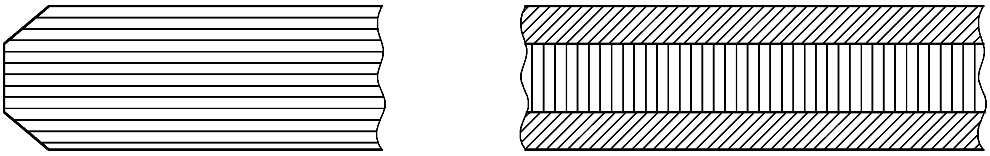


Figure 17 — Smooth ground edge (no blank spots)

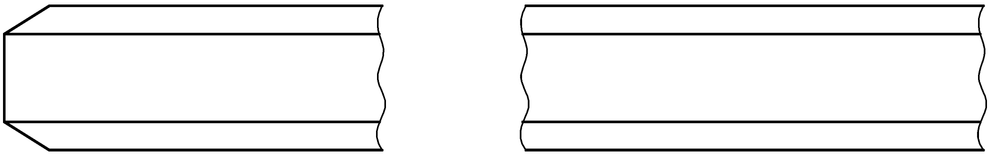


Figure 18 — Polished edge

9.3 Profiled edges

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

9.4 Round holes

9.4.1 General

This European Standard considers only round holes in glass that is not less than 4 mm nominal thickness. The manufacturers should be consulted about edge working of holes. This edge work applies only to the perimeter of the holes.

9.4.2 Diameter of holes

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

9.4.3 Limitations on position of holes

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

— nominal glass thickness (*d*);

— dimensions of the pane (*B, H*);

— hole diameter (Ø);

— shape of the pane;

— number of holes.

The recommendations given below are those which are normally available.

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

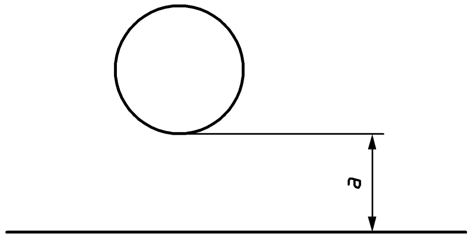


Figure 19 — Relationship between hole and edge of pane

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

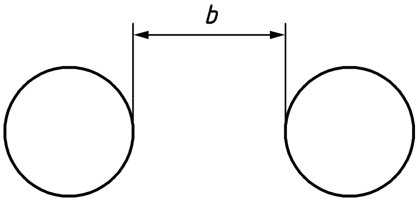


Figure 20 — Relationship between two holes

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

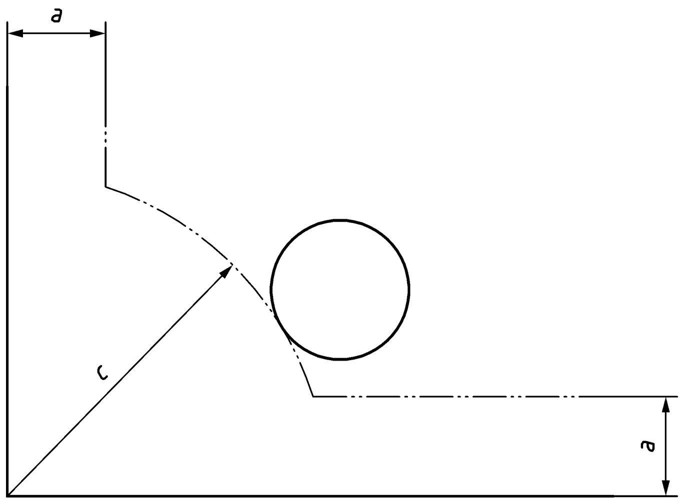


Figure 21 — Relationship between hole and corner of pane

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 comer. The manufacturer should be consulted.

9.4.4 Tolerances on hole diameters

The tolerances on hole diameters are given in Table 9.

Table 9 — Tolerances on hole diameters

Dimensions in millimetres

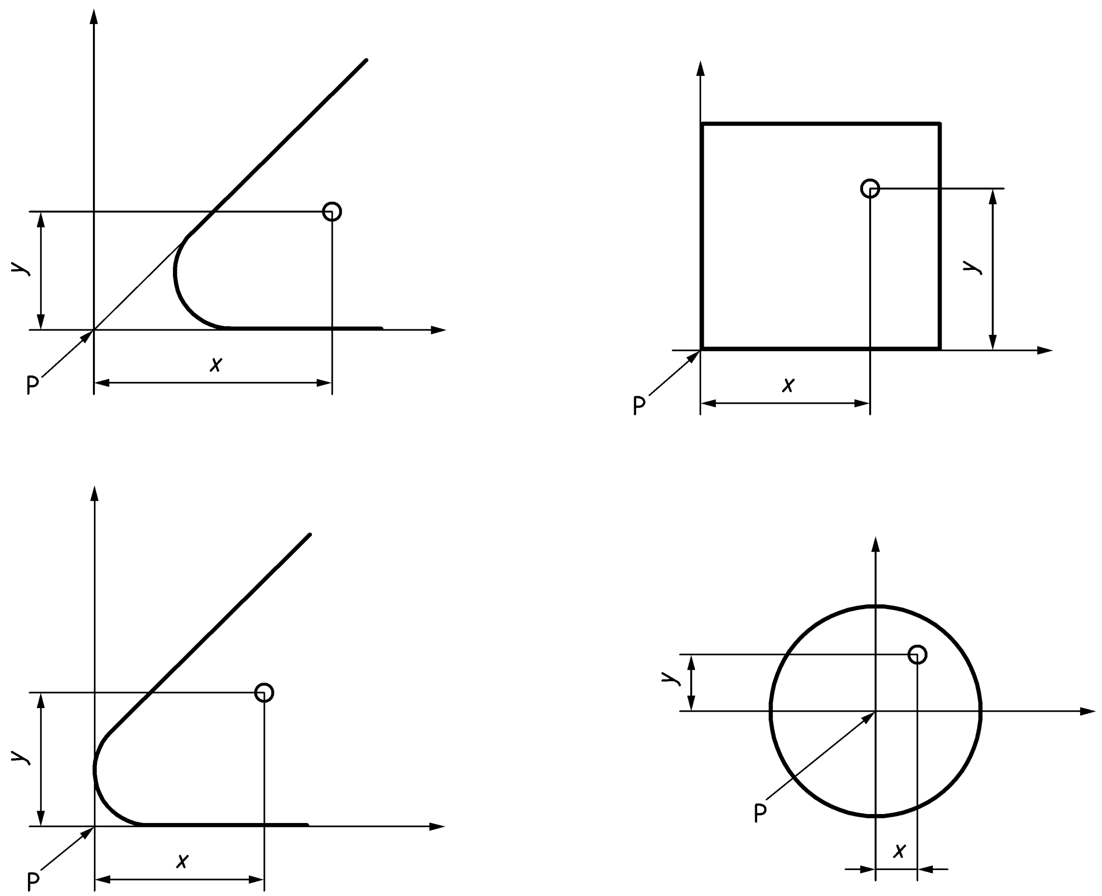
Nominal hole diameter, Ø	Tolerances
4 ≤ Ø ≤ 20	±1,0
20 < Ø ≤ 100	±2,0
100 < Ø	consult the manufacturer

9.4.5 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 22 for examples).

The position of a hole (*X,Y*) *is* (*x* ± *t*, *y* ± *t*), where *x and y* are the required dimensions and *t* is the tolerance from Table *2.*

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



Key

P datum point

Figure 22 — Examples of the positioning of holes relative to the datum point

9.5 Holes / others

There are available countersunk holes, see Figure 23. The manufacturer shall be consulted for the tolerances on hole position, hole shape / dimensions and edge work.

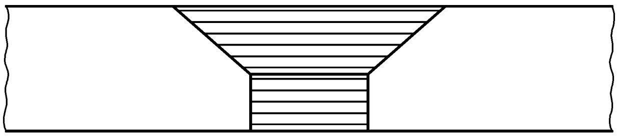


Figure 23 — Countersunk hole

9.6 Notches and cut-outs

Many configurations of notches and cut-outs can be supplied, examples see Figure 24. Corners of notches and cut-outs should be rounded out.

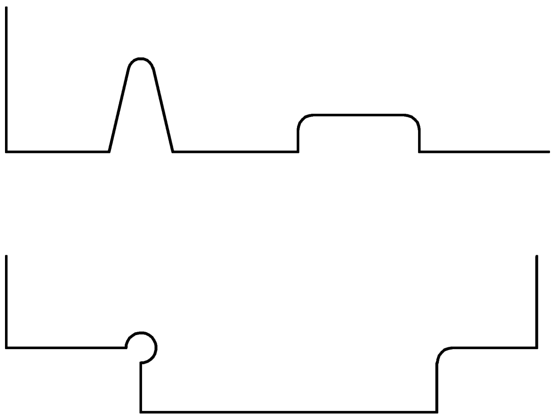


Figure 24 — Examples of notches and cut-outs

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

9.7 Shaped panes

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

10 Fragmentation test

10.1 General

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

10.2 Dimensions and number of test specimens

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

Five specimens shall be tested.

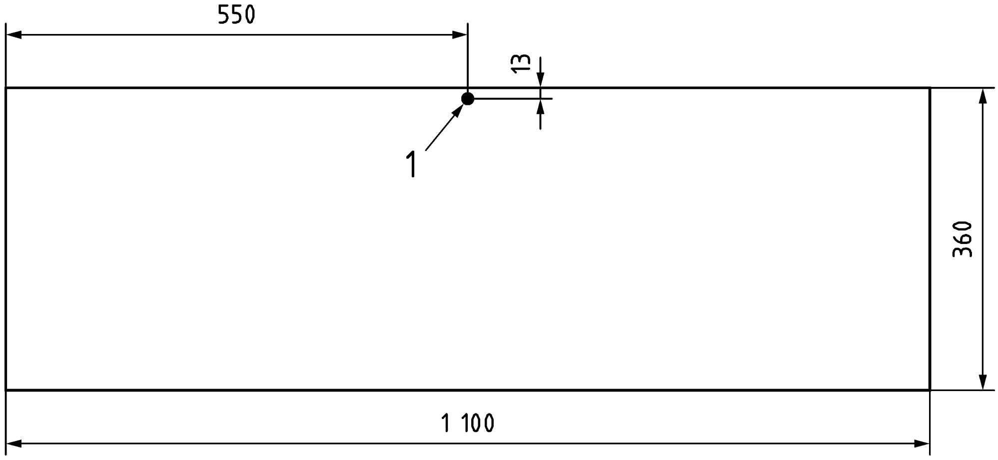
10.3 Test procedure

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 25).

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

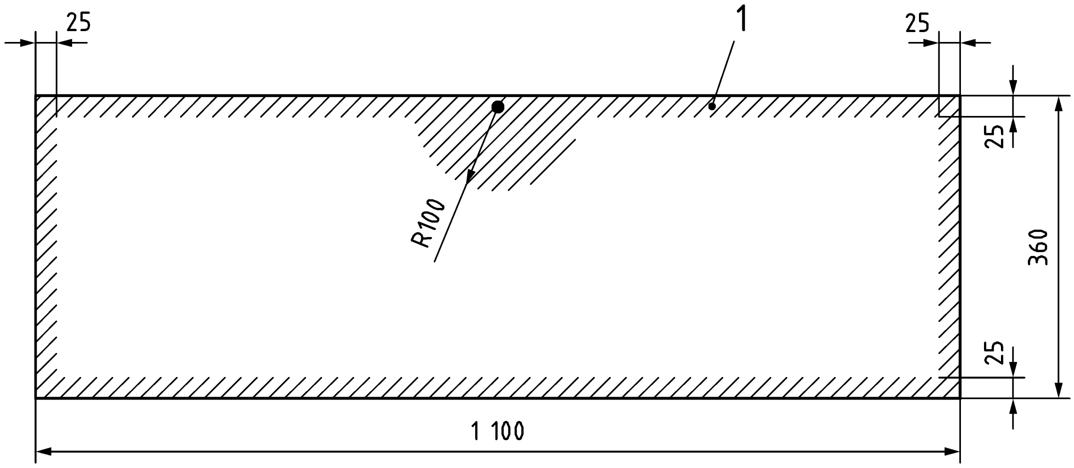
Figure 25 — Position of impact point

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

10.4 Assessment of fragmentation

The particle count and measuring of the dimensions of the largest particle shall be made between 3 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 26), shall be excluded from the assessment.

Dimensions in millimetres



Key

1 excluded area

Figure 26 — Area to be excluded from the particle count determination and largest particle measurement

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 × (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 27).

The examination should be completed within 5 min of fracturing the glass.

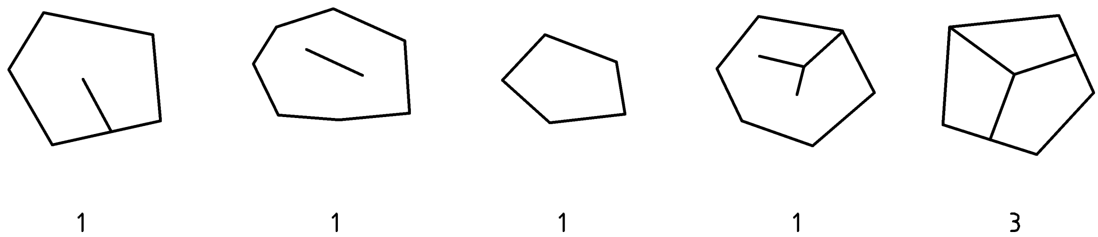


Figure 27 — Examples of crack-free particles and the assessment regarding the number

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 C).

10.5 Minimum values from the particle count

In order to classify a glass as a heat soaked thermally toughened soda lime silicate safety glass, the particle count of each test specimen shall not be less than the values given in Table 10.

Table 10 — Minimum particle count values

Glass type	**Nominal thickness,** *d* mm	**Minimum particle count** number
All glass types	2 to 3	15
All glass types	4 to 12	40
All glass types	15 to 25	30

10.6 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 10.4).

10.7 Maximum length of longest particle

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

11 Other physical characteristics

11.1 Optical distortion

11.1.1 Heat soaked 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 (see Figure 5).

11.1.2 Heat soaked 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 waves create an optical distortion which is generally noticed in reflection. Glass which is thicker than 8 mm can show signs of small imprints in the surface ('roller pick-up').

11.2 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 heat soaked 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.

Anisotropy is not a defect but a visible effect.

11.3 Thermal durability

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

NOTE This property does not have any relationship to the fire resistance performance.

11.4 Mechanical strength

The value of bending strength can only be given as a statistical value associated with a particular probability of breakage and with a particular type of loading. Table 11 gives the minimum characteristic bending strength (5 % Fractile for a confidence level of 95 %) for different types of glass when tested to EN 1288-3.

Table 11 — Minimum values for the characteristic bending strength of heat soaked thermally toughened soda lime silicate safety glass

Type of glass	Minimum characteristic bending strength N/mm^2
Float: Clear Tinted Coated	120
Enamelled glass (based on the enamelled surface in tension)	75
Others (according to Clause 4)	90

NOTE 1 The values in Table 11 represent the strength of heat soaked thermally toughened soda lime silicate safety glass (2 mm and thicker) that meets the requirements of 10.5.

At least 10 specimens of heat soaked thermally toughened soda lime silicate safety glass shall be tested according to EN 1288-3. The 5 % breakage probability, statistically evaluated at the lower limit of the 95 % confidence interval, shall be not less than the value in Table 11.

NOTE 2 Glass with a thicknesses < 3 mm will usually not break under the test conditions of EN 1288–3. A new method is under preparation.

11.5 Classification of performance under accidental human impact

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

12 Marking

Heat soaked thermally toughened soda lime silicate safety glass conforming to this European Standard shall be permanently marked. The marking shall give the following information:

— name or trademark of manufacturer;

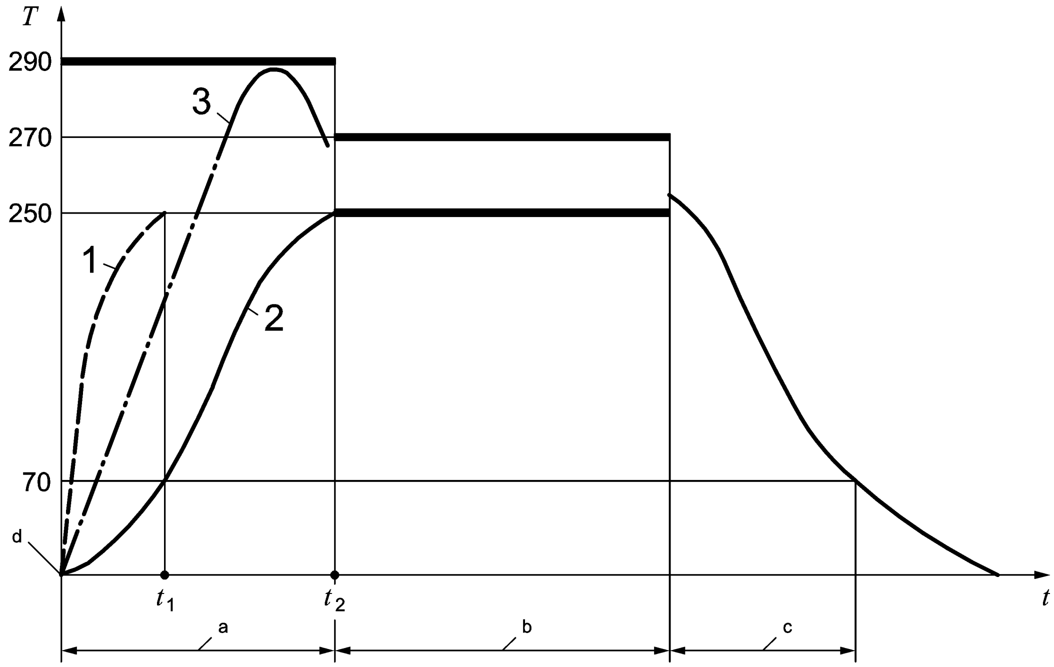
— number of this European Standard: EN 14179-1.

Annex A
(normative)

Heat soak process system calibration test

A.1 Calibration criteria

The heat soak process system shall comply with the time / temperature regime as shown in Figure A.1. The system shall be capable of meeting in the regime at both maximum and minimum load.



Key

T	glass temperature at any point, °C	*3*	glass temperature
t	time, h	*d*	ambient temperature
t1	time for the first glass to reach 250 °C	*a*	heating phase
t2	time for the last glass to reach 250 °C	*b*	holding phase
1	first glass to reach 250 °C	*c*	cooling phase
2	last glass to reach 250 °C		

Figure A.1 — Time / temperature regime as calibration criteria

A.2 Loading of oven and position for glass surface temperature measurement

Figures A.2 to A.9 show the appropriate pattern of stillage(s) loading and thermocouple placements for ovens, which take 1, 2, 6, 8 or 9 stillage(s).

The duration of the heating phase is dependent on the capacity of the oven and the level of load being used.

NOTE Full load will be dependent on glass size, thickness and oven volume. Generally, full load will be defined based on 6 mm or 8 mm thickness.

The separation of the glasses shall be specified as shall also the type, position, material and shape of the separators. The separation of the glasses shall be constant on the stillage(s).

The minimum separation used during calibration is the minimum separation that can be employed during the manufacturing process.

Generally, a minimum separation of 20 mm is recommended.

A.3 Procedure

The measurements of the air temperature in the oven and the glass surface temperatures shall be carried out when the furnace is fully loaded.This maximum load is should be defined by the glass manufacturer and shall not exceed the maximum load as defined by the oven manufacturer.

Depending on the oven construction the air temperature in the oven is monitored by one or more control elements, which are located near the air egress. The measurement of the glass surface temperatures is carried out by thermocouples that are stuck, with good thermal contact, to the glass surfaces.

At the beginning of the calibration, the air temperature in the oven shall not exceed 40 °C.

During the heating phase the oven shall be heated up until the last glass surface temperature reaches 250 °C.

During the heating phase the glass temperature shall not exceed 290 °C at any place.

During the heating phase the following parameters shall be recorded:

T_c temperature of the control element (at any time);

t_1 time for the first thermocouple and a glass to reach a temperature of 250 °C;

T_{c1} temperature of control element at time t_1;

t_2 time for the last thermocouple and a glass to reach a temperature of 250 °C;

T_{cmax} maximum temperature of the control element during the heating phase;

t_{cmax} time at which T_{cmax} occurs;

T_{glass} temperature of the glass surfaces, measured by the thermocouples (at any time) (see Figures A.2 to A.9).

The holding phase starts at time t_2 and shall last for a period of minimum 2 hours. The glass surface temperatures T_{glass} shall remain within the range 260 °C ± 10 °C. The control element temperature T_c shall be recorded.

The cooling phase starts at time t_2 + 2 h. The control element temperature T_c shall be recorded. The oven can be opened when T_c reaches 70 °C.

A.4 Records

The test parameters:

— t_1, T_{c1};

— t_{cmax}, T_{cmax};

— t_2;

— T_c, T_{glass};

— weight of the maximum load as defined by the glass manufacturer;

— glass separation distance;

— separator position, material, shape;

— stillage(s) configuration

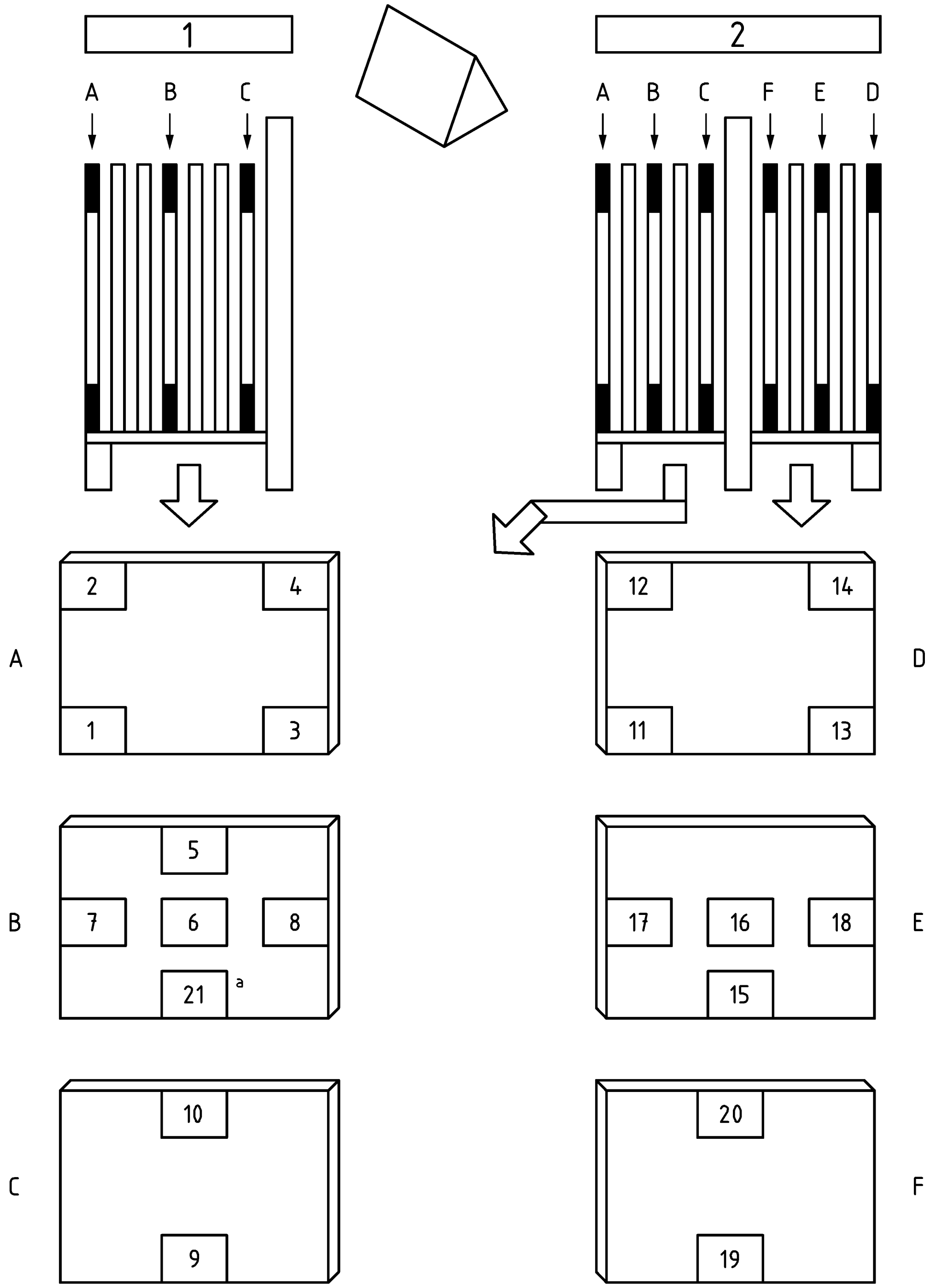
shall be recorded.

A.5 Interpretation of the calibration test

If the conditions for temperatures laid down in A.1 are not met then the oven shall not be regarded as calibrated.

Only ovens, which meet the calibration criteria as laid down in A.1 at full load may be used for the heat soak process cycle during manufacture. The time $t_{2,}$ shall be used for regular production.

The heat soak process system used for manufacture shall comply with the details of the system as calibrated.



Thermocouples should not be fixed nearer to the edge than 25 mm.

Key

[a] is only used for mono side stillages

1 mono side stillage

2 double sided stillage

Figure A.2 — 1st category – 1 stillage – full load

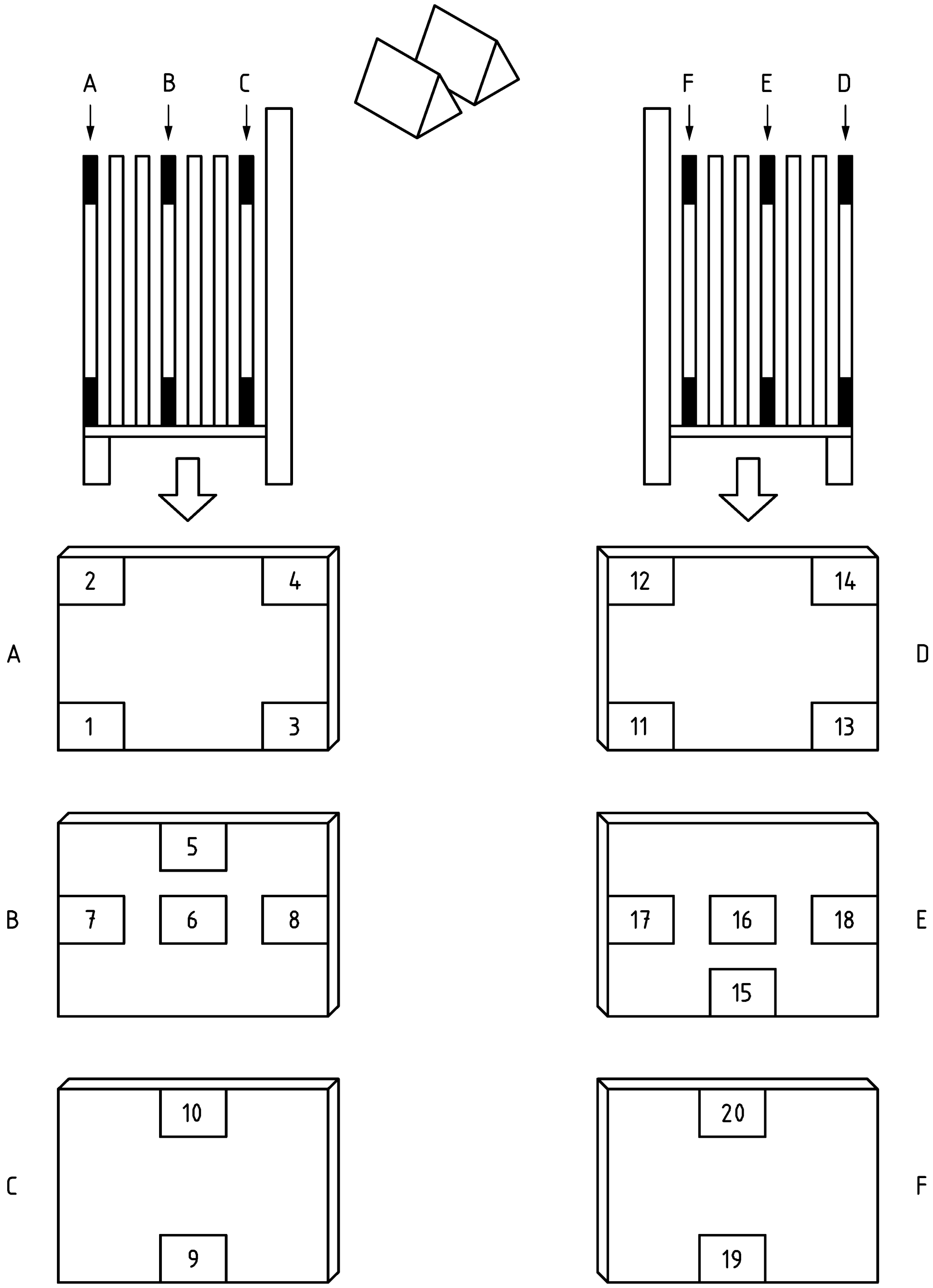
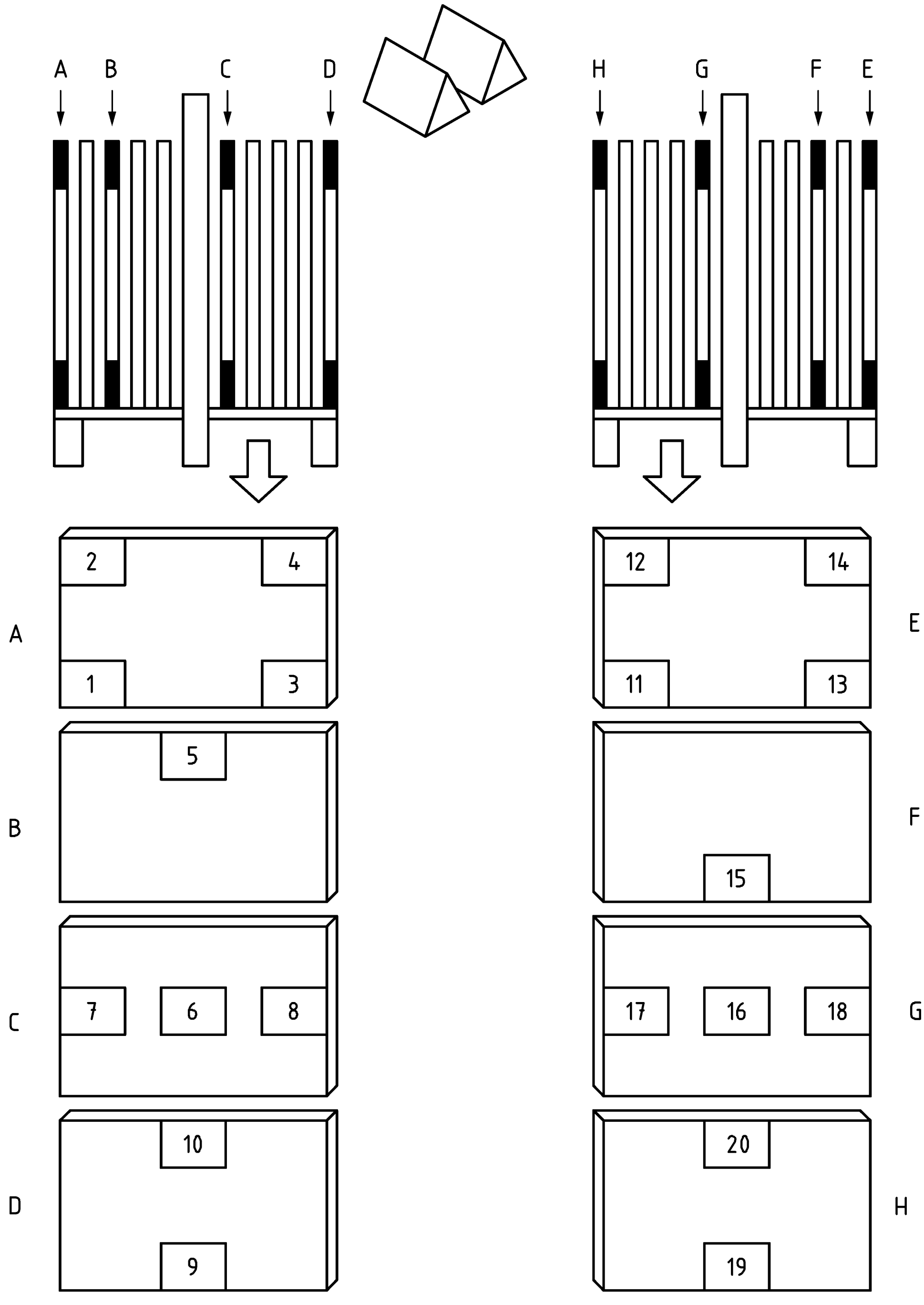
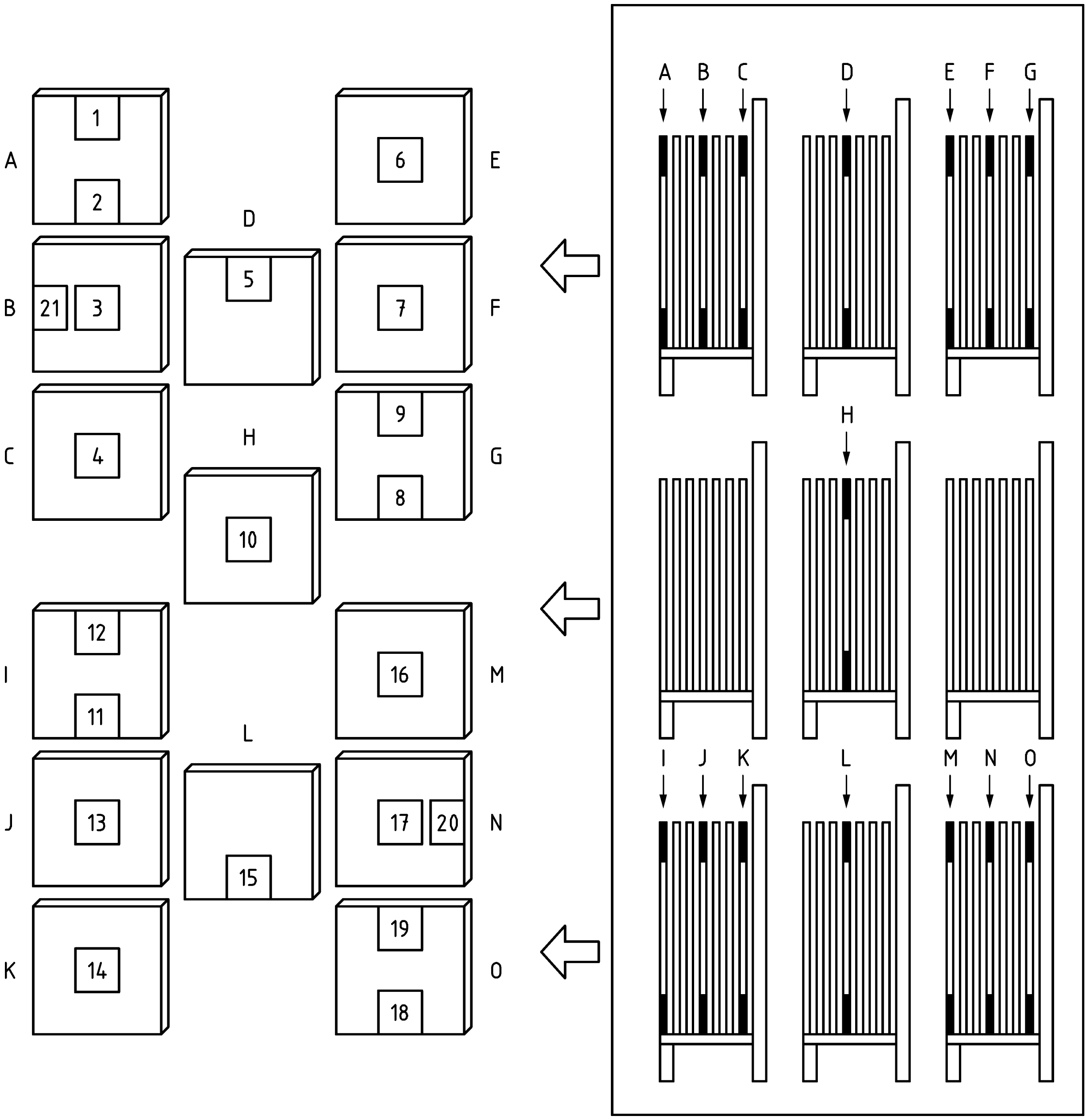


Figure A.3 — 2nd category – 2 mono side stillages – full load



Thermocouples should not be fixed nearer to the edge than 25 mm.

Figure A.4 — 2nd category – 2 double sided stillages – full load



Thermocouples should not be fixed nearer to the edge than 25 mm.

Figure A.5 — 3rd category – 6 or 8 or 9 ... stillages – full load

Annex B
(informative)

Alternative method for the measurement of roller wave distortion

B.1 Apparatus

This is a 350 mm long aluminium channel with a centrally mounted deflection gauge / dial gauge (Figure B.1).

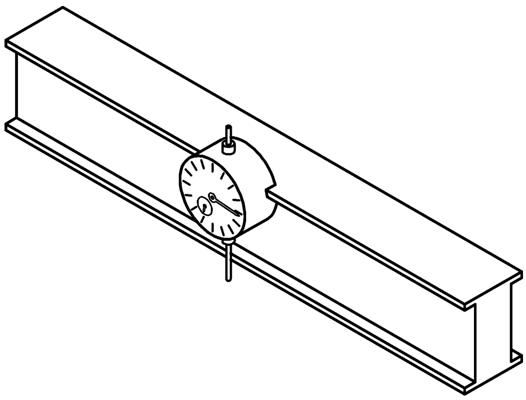


Figure B.1 — Roller wave measurement apparatus

B.2 Method

The apparatus is placed on the glass at right angles to the roller wave, so that it can bridge from peak to peak of the wave (Figure B.2).

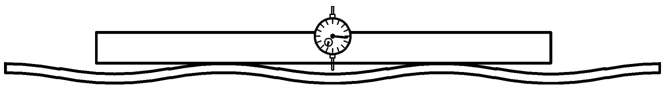


Figure B.2 — Place the apparatus across the roller wave

The apparatus is then moved along its axis until the dial gauge reads the highest value (Figure B.3).

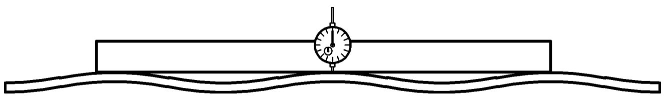


Figure B.3 — Set the zero of the gauge on a peak of the roller wave

At this point, the dial gauge is resting on a peak of the roller wave. The scale of the gauge is positioned (rotated) so that the needle points to 0 (zero) on the scale. The apparatus is then moved again along its axis until the gauge reads the lowest value (Figure B.4). At this point, the dial gauge is resting in the lowest point of the trough. The reading is then taken, and the depth of the roller wave is the difference between the zero point and the reading.

The dial gauge scale is usually arranged so that a positive value is obtained by raising the post. Care should be taken to not misread the depth of the roller wave.

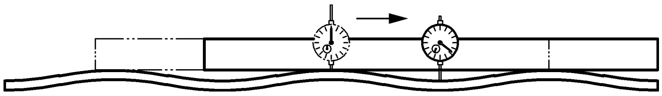


Figure B.4 — Move the gauge to a trough

The roller wave depth is recorded to the nearest 0,05 mm.

The above procedure can be performed several times on the same pane, giving a variety of answers, since the roller waves are unlikely to be consistent. The worst roller wave of those recorded is the value of the pane.

B.3 Limitations

The apparatus should only be used on panes with a dimension larger than 600 mm at right angles to the roller wave. There is an exclusion area, 150 mm from the edge of the pane, where the apparatus should not be used.

The deformation of the edges (up to 150 mm from the edge of the pane) can be different from the deformation of the rollers the surface out of this area of the glass.

A true measurement of roller wave can only be obtained on an otherwise flat pane of glass. If the pane has an overall bow, this will contribute to the value measured by the roller wave and must be taken into account. This can be reduced by laying the pane of glass flat on a table, which will reduce the overall bow in the pane due to the self-weight of the pane, particularly with larger panes.

B.4 Alternative use of apparatus

If the dial gauge is mounted on the end of the aluminium channel rather than at the centre then it may be used for the measurement of edge lift.

Lay the test sample over the end of a table with the edge lift overhanging the edge of the support by between 50 mm and 100 mm so that the edge lift is as shown in Figure 8. Move the apparatus towards the edge of the sample. Measure the maximum deflection of the gauge from when sitting on a peak to touching the edge of the sample.

Annex C
(informative)

Examples of particle count

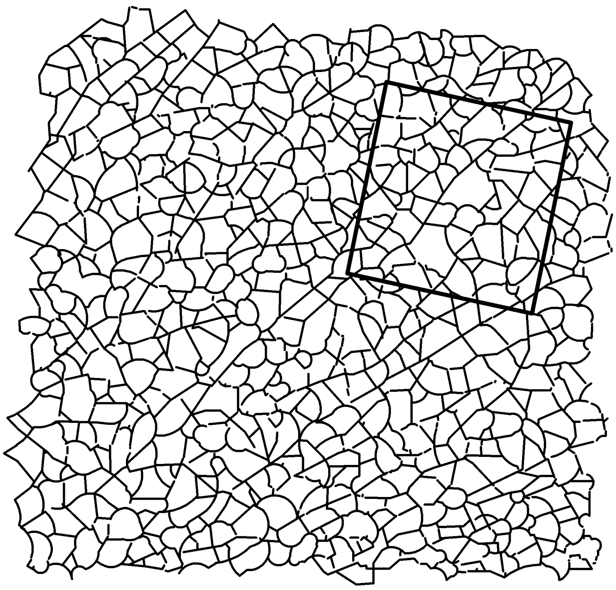
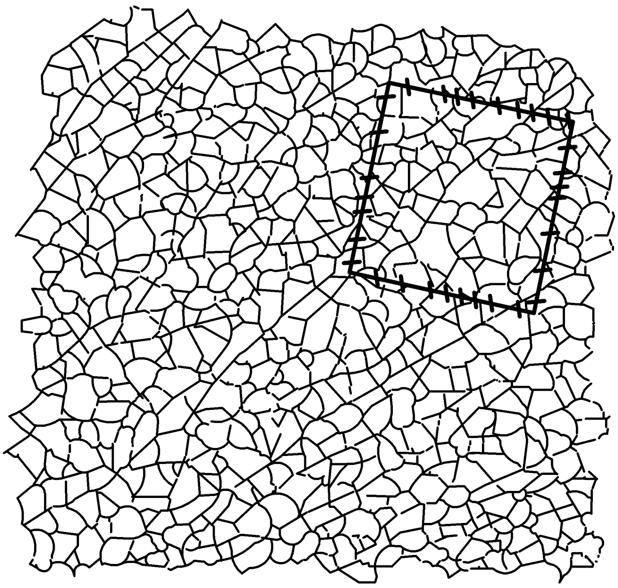


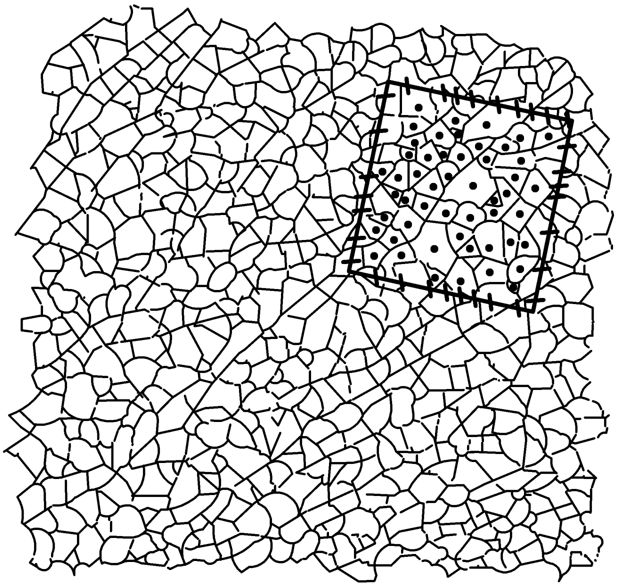
Figure C.1 — Select the area of coarsest fracture, place the template on the test specimen and draw round the template



Key

Number of perimeter particles = 32/2 = 16

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



Key

Number of central particles = 53

Total number of particles = 16 + 53 = 69

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

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