भारतीय मानक
Indian Standard

IS 2553 (Part 1) : 2018

सुरक्षा उपयोगी काँच — विशिष्टि

भाग 1 वास्तुकला, भवन और सामान्य उपयोग

(चौथा पुनरीक्षण)

Safety Glass — Specification

Part 1 Architectural, Building and General Uses

(Fourth Revision)

ICS 81.040.20

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Glass, Glassware and Laboratoryware Sectional Committee, CHD 10

FOREWORD

This Indian Standard (Fourth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Glass, Glassware and Laboratoryware Sectional Committee had been approved by the Chemical Division Council.

This standard was first published in 1963 by adopting BS 857 : 1954 'Specification for safety glass for land transport' and subsequently revised in 1964, 1971 and 1990.

In this revision, the types of safety glass and requirements have been modified keeping in view the technological advancements that have taken place since the last revision; for example, sheet glass is rarely used to manufacture safety glass any more. The title and scope were modified. Terminology has been expanded. Requirements for thickness and dimensional tolerances have been modified. Squareness has been added as a new requirement. A modified sampling methodology has also been incorporated. Other physical characteristics and spontaneous breakage due to nickel sulphide inclusions has been added as informative annexes.

For toughened safety glass, flatness, resistance to human impact, fabrication in glass and edge working has been added as new requirements. Surface compression and mechanical strength (four point bending) has been added as optional requirements.

For laminated safety glass, edge displacement, bake test, resistance to human impact, defects in central area and working on glass after lamination has been added as new requirements. Humidity test has been added as an optional requirement.

In the formulation of this standard, considerable assistance has been derived from the following publications:

a)	ISO 12540 : 2017	Glass in building — Tempered soda lime silicate safety glass
b)	ISO 12543-1 : 2011	Glass in building — Laminated glass and laminated safety glass — Part 1: Definitions and description of components
c)	ISO 12543-2 : 2011	Glass in building — Laminated glass and laminated safety glass — Part 2: Laminated safety glass
d)	ISO 12543-4 : 2011	Glass in building — Laminated glass and laminated safety glass — Part 4: Test methods for durability
e)	ISO 12543-5 : 2011	Glass in building — Laminated glass and laminated safety glass — Part 5: Dimensions and edge finishing
f)	ISO 12543-6 : 2011	Glass in building — Laminated glass and laminated safety glass — Part 6: Appearance
g)	BS EN 12150-1 : 2015	Glass in building — Thermally toughened soda lime silicate safety glass — Part 1: Definition and description
h)	BS EN 14449 : 2005	Glass in building — Laminated glass and laminated safety glass — Evaluation of conformity/product standard

The composition of the Committee responsible for formulation of this standard is given in Annex D.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SAFETY GLASS — SPECIFICATION

PART 1 ARCHITECTURAL, BUILDING AND GENERAL USES

(Fourth Revision)

1 SCOPE

This standard (Part 1) prescribes the requirements, method of sampling and test for safety glass meant for general purposes, such as for use in architectural purposes, furniture, display boards, railway coaches, earth movers, lighting fixtures, parts and components of appliances, equipments and machines etc.

NOTE — Thermal shock test (as per method D of IS 6506) shall additionally be carried out in case of safety glass for appliances, as and when applicable.

2 REFERENCES

The standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
1382 : 1981	Glossary of terms related to glass and glassware (*first revision*)
2835 : 1987	Specification for flat transparent sheet glass (*third revision*)
4905 : 2015	Random sampling and randomization procedures (*first revision*)
6506 : 1972	Methods of thermal shock tests on glassware
14900 : 2018	Transparent float glass — Specification (*first revision*)
17004 : 2018	Testing methods for processed glass

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 1382, in addition to the following shall apply.

3.1 Anisotropy (Iridescence) — A phenomenon of light where strain patterns in tempered glass become visible in polarized light.

3.2 Bubble — Usually a three-dimensional visual effect which is caused by gaseous inclusions in the interlayer or at the interface between glass and interlayer.

3.3 Central Area and Outer area — For glass panes in cut sizes, the central area shall be deemed to be the square or rectangle whose dimensions are 90 percent of the corresponding dimensions of the pane, and shares a common centre with the pane. The remaining area shall be deemed to be the outer area (*see* Fig. 1).

For glass panes in stock and jumbo sizes, the outer area shall be deemed to be a 10 cm border surrounding the entire pane. The central area shall be deemed to be the remaining area of the pane.

3.4 Ceramic Fritted (Enameled) Thermally Toughened Safety Glass — Thermally toughened 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.

3.5 Cloudiness — Local variation in the scattering of incident light by a specimen resulting in a reduction of direct light transmittance and the contrast of objects viewed through the glass

3.6 Creases — Distortions introduced into the interlayer by folds visible after manufacture.

3.7 Delamination — Usually a two-dimensional visual effect which is caused by local loss of adhesion between the glass or plastic glazing material and the interlayer.

3.8 Discoloration — Significant change in colour of a laminated safety glass.Note — In clear interlayers, discoloration is usually perceived as yellowing.

3.9 Encapsulated Material — Non-adhesive material that is encapsulated by an interlayer between the glass and/or plastic glazing sheet material.

NOTE — The non-adhesive material can be plastic, fabric, paper or metal in the form of film, plate, wire, grid, etc.

3.10 Finished Sizes — Sizes which are either manufactured to size or cut from stock sizes and may be further processed.

3.11 Glass Pane (Also Referred to as Glass Component) — One sheet of glass.

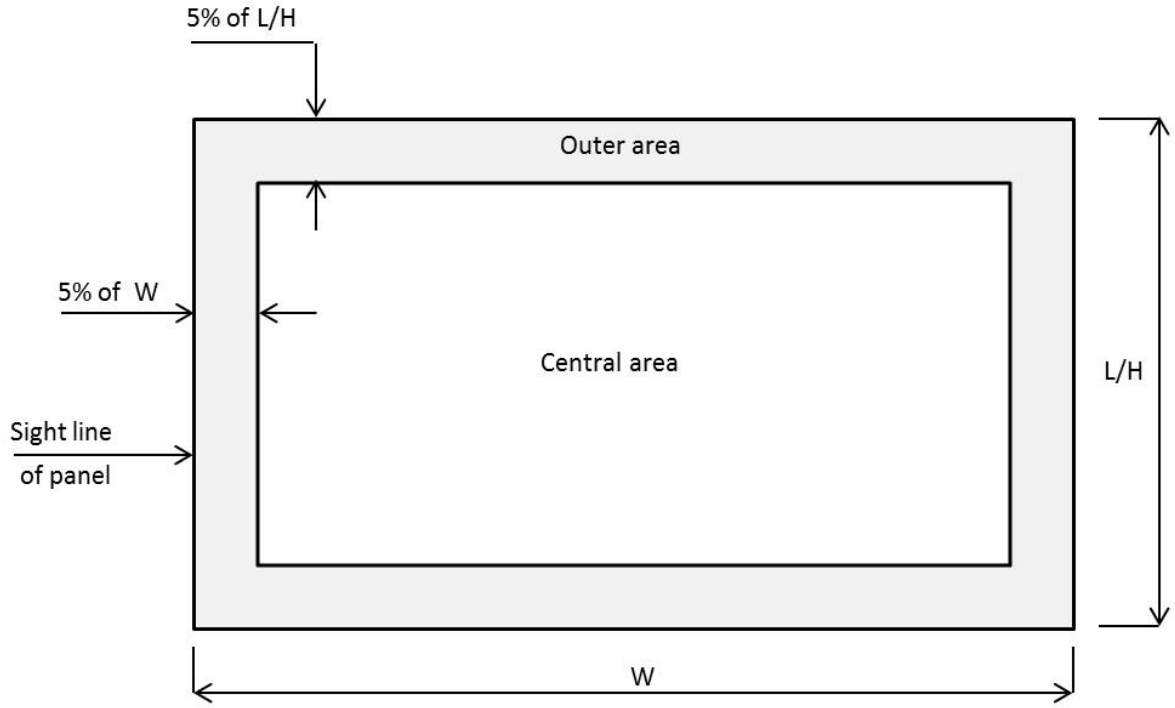


FIG. 1 CENTRAL AND OUTER AREA OF A GLASS PANE

3.12 Haze — Scattering of incident light by a specimen resulting in a reduction of direct light transmittance and the contrast of objects viewed through the glass.

3.13 Horizontal Toughening — Process in which the glass is supported on horizontal rollers when it is undergoing the toughening process.

3.14 Interlayer — One or more layer or material acting as an adhesive and separator between plies of glass and/or plastic glazing sheet material.

NOTE — It can be designed to give additional performance to the finished products for example impact resistance, resistance to fire, solar control, acoustics insulation etc.

3.15 Laminated Safety Glass — Two or more pieces of glass held together by an interleaving layer or layers of plastic sheet material. The laminated safety glass will crack and break under sufficient impact, but the pieces of glass tend to adhere to the plastic and do not fly.

3.16 Spontaneous Breakage Due to Nickel Sulphide Inclusion — Breakage of tempered glass without any form of impact, caused by the expansion of nickel sulphide present in the glass, as it undergoes phase transition.

3.17 Standard Laboratory Conditions — Ambient temperature of 27 ± 2°C and a relative humidity of 65 ± 5 percent.

3.18 Stock Sizes — Sizes which are intended to be re-cut or processed for final use.

3.19 Streaks Due to Interlayer Inhomogeneity — Distortions in the interlayer, caused by manufacturing defects in the interlayer, which are visible after manufacture.

3.20 Toughened (Tempered) Safety Glass — A single piece of specially heat treated glass, with a stress pattern such that the piece when fractured reduces to numerous granular fragments, with no large jagged edges.

3.21 Vents — Sharp tipped fissures or cracks running into the glass from an edge.

3.22 Vertical Toughening — Process in which the glass is suspended by tongs when it is undergoing the toughening process.

4 TYPES

Safety glass shall be of two types as follows:

a) Toughened (tempered) safety glass, or
b) Laminated safety glass.

5 REQUIREMENTS

5.1 General

5.1.1 Safety glass may be flat or curved and may be clear/tinted/coated and in the case of laminated glass, coloured interlayer(s) may be used, as agreed to between the manufacturer and the purchaser.

5.1.2 *Distribution of Allowable Defects*

The allowable defects (spot faults, linear faults, reams, strings, lines, optical faults) in flat glass used in the manufacture of safety glass shall not exceed the limits specified in **4.4** and **4.5** of IS 14900.

5.2 Requirements Specific to Flat Toughened (Tempered) Safety Glass

5.2.1 *Thickness*

When tested in accordance with the method prescribed in **5.1** of IS 17004, toughened safety glass shall be of nominal thickness and range of thickness as specified in Table 2 of IS 14900.

5.2.2 *Dimensions and Squareness*

5.2.2.1 *Dimensions*

When safety glass dimensions are quoted for rectangular panes, the first dimension shall be the width, W, and the second dimension shall be the length, L (or height H in the case of vertical glazing), as shown in Fig. 2. It shall be made clear which dimension is the width, W, and which is the length, L, when related to its installed position.

5.2.2.2 *Squareness*

The nominal dimensions, that is, width (W) and length (L) shall be as agreed to between the purchaser and the supplier. However, the finished pane shall not be larger than a prescribed rectangle of dimensions (W + v, L + v), or smaller than a prescribed rectangle of dimensions (W-v, L-v), where v is the maximum tolerance on nominal dimensions (*see* Table 1). The corresponding sides of the prescribed rectangles shall be parallel to each other and the rectangles shall have a common centre (*see* Fig. 3).

5.2.3 *Fragmentation Test*

It shall pass the fragmentation test when tested as per **6.1** of IS 17004.

Table 1 Deviation on Width and Length

Nominal Thickness → / Nominal Dimension W or L/H	t ≤ 8	t > 8
≤ 2 000	≤ 2	≤ 3
≤ 3 000	≤ 3	≤ 4
> 3 000	≤ 4	≤ 5

All dimensions are in mm.

NOTES

1 For toughened glass manufactured from patterned glass, the direction of the pattern should be specified relative to one of the dimensions.

2 The maximum width and length of laminated glass are dependent on the constituent glass and interlayers used in its composition and the process adopted by the manufacturer.

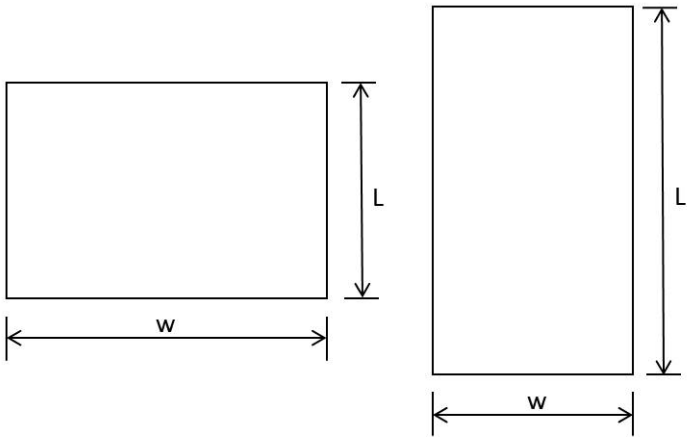


FIG. 2 EXAMPLES OF WIDTH AND LENGTH WITH RESPECT TO PANE SHAPE

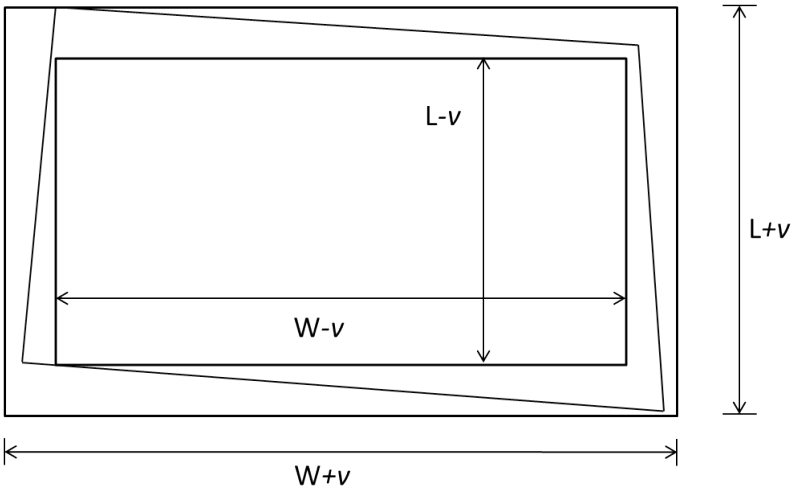


FIG. 3 DEVIATION LIMITS FOR DIMENSIONS OF RECTANGULAR PANES

5.2.4 *Flatness*

By virtue 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 (for example, coated), glass dimensions (that is the nominal thickness, the dimensions and the aspect ratio), and the toughening process employed.

There are four kinds of distortion:

a) Overall bow (*see* Fig. 4);

b) Roller wave distortion (for horizontally toughened glass only) (*see* Fig. 5);

c) Edge lift (for horizontally toughened glass only) (*see* Fig. 6); and

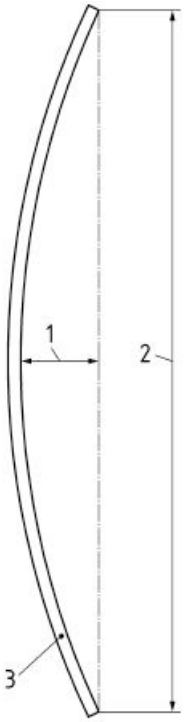
d) Local distortion (for vertically toughened glass only) (*see* fig. 7).

The deformation in toughened safety glass shall not be more than the values prescribed in Tables 2, 3, 4 and 5 when tested as per **5.2**, **5.3**, **5.4** and **5.5** respectively of IS 17004.

NOTES

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

2 Local distortion needs to be allowed for within the glazing materials and the weather seals. For special requirements, it is advised to consult the manufacturer.

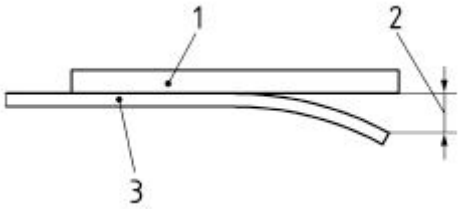


Key	
1	deformation for calculating overall bow
2	W, or L, or diagonal length
3	thermally toughened glass

FIG. 4 REPRESENTATION OF OVERALL BOW

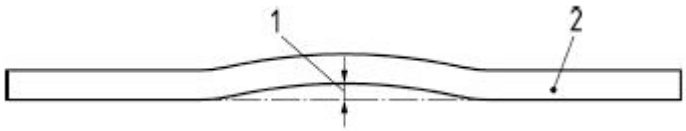
Key	
1	Thermally toughened glass

FIG. 5 REPRESENTATION OF ROLLER WAVE DISTORTION



Key	
1	straight edge
2	edge lift
3	thermally toughened glass

FIG. 6 REPRESENTATION OF EDGE LIFT



Key	
1	Local distortion
2	Thermally toughened glass

FIG. 7 REPRESENTATION OF LOCAL DISTORTION

Table 2 Maximum Deviation Limit for Overall Bend/Bow

Size → / Thickness	Upto 1.2 m	1.2 to 2.5 m	2.5 to 3.05 m	3.05 to 3.66 m	Above 3.66 m
4 mm	4 mm	4 mm	6 mm	Not applicable	Not applicable
5 mm	3 mm	4 mm	5 mm	7 mm	Not applicable
6 mm	3 mm	4 mm	5mm	7 mm	Not applicable
8 mm	3 mm	4 mm	5mm	6 mm	10 mm
10 mm	3 mm	4 mm	4 mm	5 mm	10 mm
12 mm	3 mm	4 mm	4 mm	5 mm	8 mm
15 mm	3 mm	4 mm	4 mm	6 mm	8 mm
19 mm	3 mm	4 mm	4 mm	6 mm	10 mm

NOTE — The limits specified in Table 2 are for aspect ratios limited to 5:1. For glasses outside this aspect ratio and size, the manufacturer should be consulted.

Table 3 Maximum Allowable Value for Roller Wave Distortion

Glass Type	Roller Wave Distortion for Horizontally Toughened Safety Glass
	Roller wave (mm)
Uncoated float glass in accordance with IS 14900	0.3
Others[a)]	0.5
[a)] For enamelled glass which is not covered over the whole surface, the manufacturer should be consulted.	

NOTE — For other glass types, it is advisable to consult the manufacturer.

Table 4 Maximum Allowable Values for Edge Lift for Horizontally Toughened Safety Glass

Type of Glass	Thickness of Glass (mm)	Maximum Allowable Values (mm)
Uncoated float glass in accordance with IS 14900	2 to 4	0.5
	4 to 5	0.4
	6 to 25	0.3
Others [1)]	3 to 19	0.5
[1)] For enamelled glass which is not covered over the whole surface, the manufacturer should be consulted. The values in Table 4 only apply to thermally toughened glass having edgework complying with figures 13 to 16.		

NOTES

1 Dependent upon the wavelength of the roller wave an appropriate length of gauge needs to be used.

2 For uncoated float glass with a thickness of 2 mm it is advised to consult the manufacturer.

Table 5 Maximum Allowable Values for Local Distortion for Vertically Toughened Safety Glass

Glass type	Maximum Allowable Values for Local Distortion, mm/300 mm
All [1)]	1.0
[1)] For enamelled glass which is not covered over the whole surface, the manufacturer should be consulted.	

5.2.4.1 *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.

5.2.5 *Resistance to Impact*

5.2.5.1 *Resistance to shock*

It shall pass the test for resistance to shock as prescribed in **6.2.1** of IS 17004.

NOTE — This test shall apply to toughened safety glasses having a thickness of 5.0 mm and above. For glasses having a thickness of less than 5.0 mm, adoption of the test and interpretation of the results shall be as agreed to between the purchaser and the manufacturer.

5.2.5.2 *Resistance to human impact*

All the test specimens shall conform to Class I of **6.4.5.2** of IS 17004, when tested in accordance with the resistance to human impact test prescribed in **6.4** of IS 17004.

NOTE — Resistance to shock (ball drop test) and resistance to human impact test are completely different tests and should not be matched with each other for safety performance.

5.2.6 *Surface Compression (Optional)*

Toughened safety glass shall be tested for surface compression whenever required by the purchaser. Toughened safety glass shall have a minimum surface compression of 69 MPa (10 000 psi) when tested in accordance with **6.5** of IS 17004.

5.2.7 *Mechanical Strength — Four Point Bending Test (Optional)*

Toughened safety glass shall be subjected to four point bending test whenever required by the purchaser. The glass samples shall meet the minimum values for mechanical strength as prescribed in Table 6, when tested as prescribed in **6.3** of IS 17004.

Table 6 prescribes the minimum characteristic bending strength (5 percent fractile for a confidence level of 95 percent) for different types of glass.

5.2.8 *Fabrication in Glass*

Toughened safety glass shall not be cut, sawed, drilled or edge worked after toughening. Only round holes in glass of nominal thickness 4 mm and above shall be considered. The manufacturer should be consulted about edge working of holes.

5.2.8.1 *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 manufacturer should be consulted.

5.2.8.2 *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:

a) The nominal glass thickness (*t*);
b) The dimensions of the pane (*W*, *L*);
c) The hole diameter (ø);
d) The shape of the pane; and
e) The number of holes.

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

Table 6 Minimum Values for The Mechanical Strength of Thermally Toughened 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 (for example, drawn sheet glass, patterned glass etc.)	90

NOTE — The values in Table 6 represent the strength of thermally toughened safety glass which meets the requirements of fragmentation test.

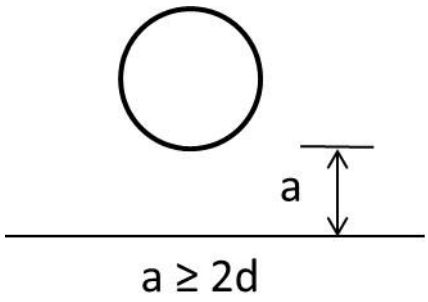


FIG. 8 RELATIONSHIP BETWEEN HOLE AND EDGE OF PANE

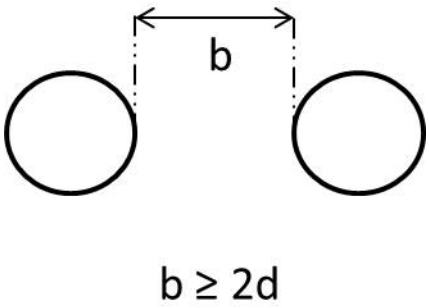


FIG. 9 RELATIONSHIP BETWEEN TWO HOLES

a) The distance, *a*, from the lower edge of a hole to the glass edge shall be not less than 2*t*.

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

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

5.2.8.3 *Deviations on holes and position of holes*

The deviations on positions of holes shall be the same as the deviations on the width (*W*) and the length (*L*/*H*) (*see* Table 1). The positions of holes should be 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* Fig. 11).

The position of a hole (X,Y) is (x – v, y – v), where x and y are the required dimensions and v is the deviation (*see* Table 7).

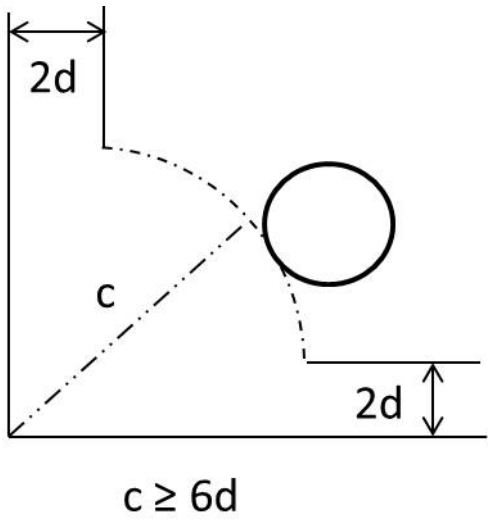


FIG. 10 RELATIONSHIP BETWEEN HOLE AND CORNER OF PANE

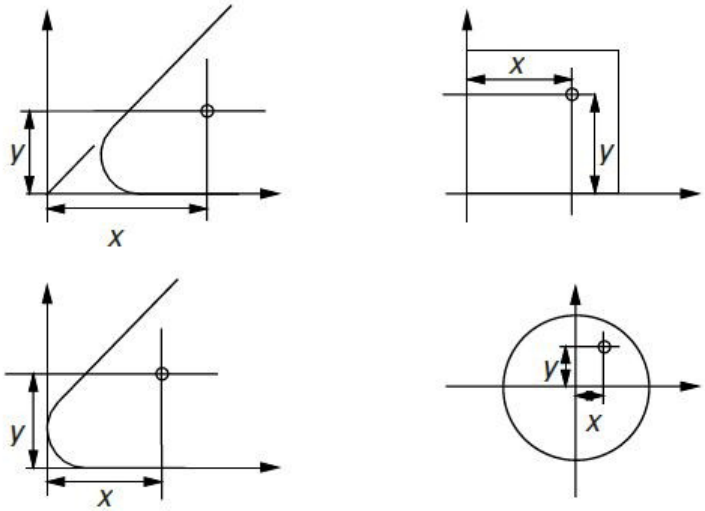


FIG. 11 EXAMPLES OF THE POSITIONING OF HOLES RELATIVE TO THE DATUM POINT

5.2.8.4 *Notches and cut-outs*

Toughened safety glass with many configurations of notches and cut-outs can be supplied. The manufacturer should be consulted about edge working of notches and cut-outs.

5.2.9 *Edge Working of Glass for Toughening*

Toughened safety glass should not be cut, sawed, drilled or edge worked after toughening.

Every glass which is to be thermally toughened has to be edge arrised or edge worked prior to toughening.

The simplest type of edge working is the arrised edge (*see* Fig. 13). Other common types are shown in Fig. 14 to 16. For specialized edge work, such as water jet cutting, the manufacturer should be consulted.

Table 7 Deviation on Hole Diameter

Nominal Hole Diameter, Ø	Deviations
$4 \leq Ø \leq 20$	± 1.0
$20 \leq Ø \leq 100$	± 2.0
$Ø > 100$	Consult the manufacturer

All dimensions are in mm

NOTE — The manufacturer should be consulted if tighter deviations on hole positions are required.

Table 8 Deviations on Hole and Cutouts Location

All Thicknesses	For holes, deviation should be from center of hole	± 1.5 mm
	For cutouts, deviation should be from edge	± 1.5 mm

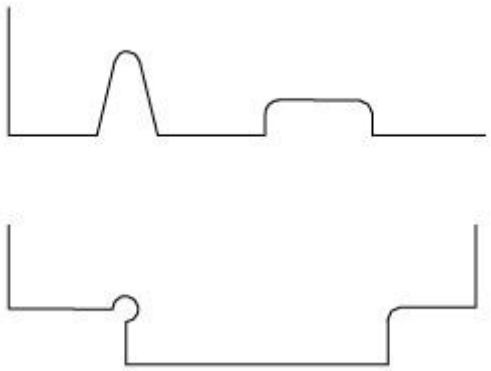


FIG. 12 EXAMPLES OF NOTCHES AND CUT-OUTS

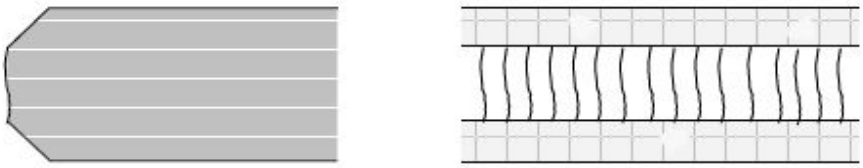


FIG. 13 ARRISED EDGE (WITH BLANK SPOTS)

FIG. 14 GROUND EDGE (WITH BLANK SPOTS)

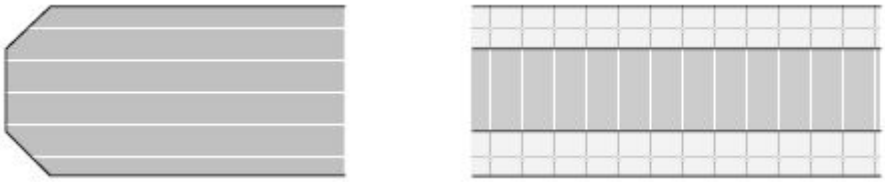


FIG. 15 SMOOTH GROUND EDGE (NO BLANK SPOTS)

FIG. 16 POLISHED EDGE

5.3 Requirements Specific to Laminated Safety Glass

5.3.1 *Thickness*

The thickness of the pane shall be calculated as the mean of measurements taken at the centres of the four sides. The measurements shall be taken according to the method prescribed in **5.1** of IS 17004, to an accuracy of 0.01mm. The individual measurements and the mean shall be rounded to the nearest 0.1 mm. The individual measurements shall also be within the applicable limit deviation as given below.

The nominal thickness of laminated safety glass shall be the sum of the nominal thickness of constituent panes of glass and interlayer material. The limit deviation of the interlayer shall not be taken into account if the total interlayer thickness is < 2 mm.

If the total interlayer thickness is > 2mm, a limit deviation of ± 0.2 mm shall apply. For plastics glazing sheet material, the limit of deviation on thickness shall be the same as applicable to a float glass of the same nominal thickness.

The limit deviations on thickness of laminated glass shall not exceed the sum of the limit deviations of the constituent glass panes as specified in Table 2 of IS 14900.

5.3.2 *Dimensions, Squareness and Edge Displacement*

5.3.2.1 *Dimensions and squareness*

When laminated glass sizes are quoted for rectangular panes, the first dimension shall be the width, W, and the second dimension shall be the length, L (or height H in the case of vertical glazing), as shown in Fig. 2.

The nominal dimensions, that is, width (W) and length (L) shall be as agreed to between the purchaser and the supplier. However, the finished pane shall not be larger than a prescribed rectangle of dimensions (W+v, L+v), or smaller than a prescribed rectangle of dimensions (W-v, L-v), where v is the maximum tolerance on nominal dimensions (*see* table 1). The corresponding sides of the prescribed rectangles shall be parallel to each other and the rectangles shall have a common centre (*see* Fig. 3).

5.3.2.2 *Edge displacement*

The maximum displacement, d, shall be as specified in Table 9. Width (W) and length (L), shall be considered separately.

NOTE — A suitable calibrated equipment, for example, caliper may be used to measure edge displacement.

5.3.3 *Light Stability Test*

Laminated safety glass shall pass the requirements of light stability test as prescribed in **7.6** of IS 17004.

5.3.4 *Boil and Bake Tests*

Laminated safety glass shall be subjected to boil test as prescribed in **7.1.1** of IS 17004 and the bake test as prescribed in **7.1.2** of IS 17004. In both these tests, none of the three samples tested shall show any faults (bubbles, delamination, haziness and clouding). In case only one test specimen develops faults in a particular test, draw another 3 samples from the lot and repeat the concerned test. No sample shall fail this time.

5.3.5 *Fracture and Adhesion Test*

Laminated safety glass shall pass the requirements of fracture and adhesion test, when tested in accordance with either of the methods prescribed in **6.2.2** of IS 17004.

5.3.6 *Defects in the Central Area*

5.3.6.1 *Spot defects in the central area*

When examined according to the test method prescribed in **5.3.6.7**, the admissibility of spot defects (*see* Table 10) depends on the following:

a) Size of the defect;

b) Frequency of the defect;

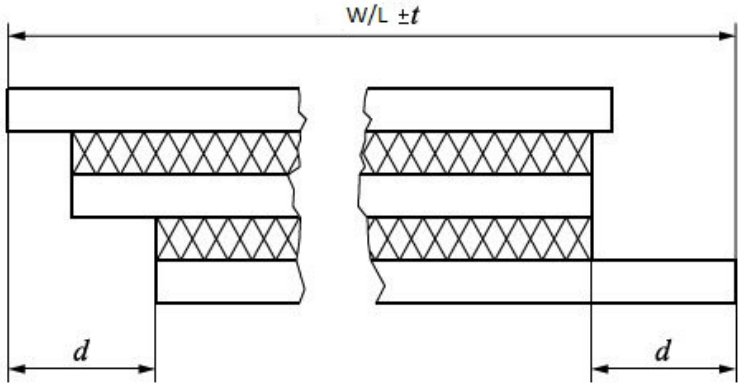


FIG. 17 EDGE DISPLACEMENT

Table 9 Maximum Permissible Displacement for Laminated Safety Glass

Nominal Dimension, W or L	Maximum Permissible Displacement, d
≤ 1 000	2.0
≤ 2 000	3.0
≤ 4 000	4.0
> 4 000	5.0

All dimensions are in mm.

Table 10 Permissible Spot Defects in Laminated Safety Glass in the Central Area

Size of defect, d in mm →		0.5 < d ≤ 1.0	1.0 < d ≤ 3.0			
Size of pane, A in m^2 →		For all sizes	A ≤ 1 (Total number)	1 < A ≤ 2 (Total number)	2 < A ≤ 8 (Number/m^2)	A > 8 (Number/m^2)
Number of permissible defects	2 panes	No limitation, however no accumulation of defects (*see* Note)	1	2	1/m^2	1.2/m^2
	3 panes		2	3	1.5/m^2	1.8/m^2
	4 panes		3	4	2/m^2	2.4/m^2
	≥ 5 panes		4	5	2.5/m^2	3/m^2

NOTE — If four or more defects are at a distance of < 200 mm from each other, it is termed as an accumulation of defects. This distance is reduced to 180 mm for laminated safety glass consisting of three panes, to 150 mm for laminated safety glass consisting of 4 panes and to 100 mm for laminated safety glass consisting of five or more panes.

c) Size of the pane; and

d) Number of panes as components of a laminated safety glass.

Defects less than 0.5 mm are not considered and defects greater than 3 mm are not permitted.

NOTE — Admissibility of spot defects in laminated glass is independent of the individual glass thickness.

The number of permissible defects in Table 10 shall be increased by 1 for each individual interlayer of thickness greater than 2 mm.

5.3.6.2 *Linear defects in the central area*

When inspected according to the test method given in **5.3.6.7**, linear defects shall conform to Table 11.

Linear defects less than 30 mm in length are allowed.

5.3.6.3 *Defects in the outer area for framed edges*

When inspected according to the test method given in **5.3.6.7**, defects less than 5 mm in diameter are permitted in the outer area. If bubbles are present, the bubbled area shall not exceed 5 percent of the outer area.

5.3.6.4 *Vents*

Vents are not permitted.

5.3.6.5 *Creases and streaks*

These are not allowed in the central area.

5.3.6.6 *Defects on edge which will not be framed*

Laminated safety glass is usually installed in frames; when it is unframed, it may have:

a) Ground edges;

b) Polished edges; and

c) Bevelled edges.

In such conditions, shells, bubbles, interlayer defects and retractions are permissible if they do not become apparent when subjected to the test method prescribed in **5.3.6.7**.

5.3.6.7 *Test method*

The laminated safety glass specimen is put in a vertical position, in front of and parallel to a matt grey screen, lit by diffuse daylight or equivalent. The observer shall be at a distance of 2 m from the glass, observing it perpendicularly (the matt screen being on the other side of the glass). Defects that are disturbing when viewed shall be marked.

5.3.7 *Humidity Test – Optional*

Laminated safety glass shall be subjected to humidity test as prescribed in **7.2** of IS 17004. None of the three samples tested shall show any faults (bubbles, delamination, haziness and clouding). In case only one test specimen develops faults in a particular test, draw another 3 specimens from the lot and repeat the concerned test. No fault shall be found on any of these 3 test specimens.

5.3.8 *Resistance to Human Impact Test*

All test specimens shall either conform to Class I of **6.4.5.2** of IS 17004 or break as defined in **6.4.1.2** of IS 17004, when subjected to resistance to human impact test as prescribed at **6.4** of IS 17004.

5.3.9 *Working on Glass after Lamination*

Thermally treated glasses shall not be cut, sawn, drilled or edge worked after lamination.

NOTE — Thermally toughened safety glass, heat-soaked thermally toughened safety glass and heat-strengthened glass shall be individually worked prior to thermal treatment in accordance with an applicable standard procedure. The edges of fire-resistant laminated glass and fire-resistant laminated safety glass can be protected by an adhesive tape.

5.3.9.1 *Cut edge*

These are either originally cut edges of the constituent glass panes not subsequently worked (*see* Fig. 18), or the edges of the laminated glass which have been cut and not subsequently worked (*see* Fig. 19).

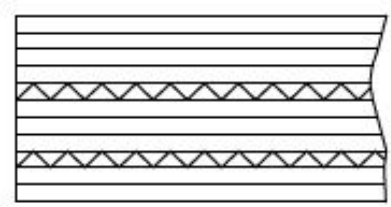


FIG. 18 CUT EDGE PRODUCED BY THE INDIVIDUAL CUT EDGE OF THE CONSTITUENT GLASS PANES WHICH ARE NOT SUBSEQUENTLY WORKED

Table 11 Number of Permissible Defects in the Central Area

Area of Pane	Number of Permissible Defects ≥ 30 mm in Length
≤ 5 m^2	Not allowed
5 to 8 m^2	1
> 8m^2	2

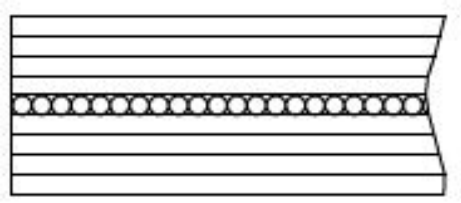


FIG. 19 CUT EDGE OF THE CUT LAMINATED GLASS WHICH IS NOT SUBSEQUENTLY WORKED

5.3.9.2 *Worked edges*

Post cutting a laminated safety glass, grinding the edge is not allowed. Seaming/arrising however is permitted as long as the laminate interlayer does not come in contact with the grinding tool.

5.3.9.3 *Sawn edge*

A sawn edge shall be obtained by cutting with a saw.

NOTE — The appearance is similar to ground edges, but without bright spots and arrising.

5.3.9.4 *Water jet cut edge*

A water jet cut edge shall be obtained by cutting with a water jet.

NOTE — The appearance is similar to ground edges, but without bright spots and arrising.

6 PACKING AND MARKING

6.1 Packing

Safety glass shall be packed as agreed to between the manufacturer and the purchaser.

6.1.1 The packet shall be marked with the following information:

a) Indication of the source of manufacture,
b) Nominal thickness of glass,
c) Code or batch number,
d) Month and year of manufacture, and
e) Type of glass.

6.2 Marking

6.2.1 Each piece of safety glass shall be marked indelibly and distinctly with the following information:

a) In the case of toughened safety glass, it shall be marked with the word ‘Toughened’.
b) In the case of laminated safety glass, it shall be marked with the words ‘Laminated Safety’ or ‘Toughened Laminated Safety’.
c) Indication of the source and year of manufacture.

6.2.2 *BIS Certification Marking*

Each glass may also be marked with the standard mark.

6.2.2.1 The use of the Standard Mark is governed by the provisions of *The Bureau of Indian Standards Act*, 2016 and the Rules and Regulations made thereunder. The details of the conditions under which the licence for use of the Standard Mark may be granted to manufacturers or producers, may be obtained from the Bureau of Indian Standards.

7 SAMPLING

Representative samples of the material shall be drawn as prescribed in Annex A.

ANNEX A

(*Clause* 7)

SAMPLING OF SAFETY GLASS

A-1 TOUGHENED SAFETY GLASS

All the toughened safety glasses of the same nominal thickness which are processed under similar conditions in a day shall be grouped together and constitute a lot. Sample shall be made and tested from each lot to determine its conformity to the requirements of this specification.

In order to ensure the randomness of selection, procedure given in IS 4905 shall be followed.

The sampling plan as described in Table 12 may be followed for the various tests to be performed as per the requirements of this specification.

A-2 LAMINATED SAFETY GLASS

For all the laminated safety glasses of the same nominal thickness manufactured using similar type and thickness of interlayer by the same process under similar conditions in a day, shall constitute one lot.

The sampling plan as described in Table 13 may be followed for the various tests to be performed as per the requirements of this specification. In order to ensure the randomness of selection, procedure given in IS 4905 shall be followed.

Sizes of the test specimen listed in col 4 of Table 13 are recommended in view of the limitation of size of specimen that can be accommodated by the respective test equipment. Test specimen shall be prepared simultaneously along with the product, under similar conditions using similar raw material, that is glass and interlayer as used to manufacture laminated safety glass.

Table 12 Sample Size and Criteria for Conformity

Sl No.	Testing Parameters	No. of Samples	Size of Samples (Recommended)	Acceptance Criteria
1.	Thickness (Clause **5.2.1**)	5 percent of the quantity from each thickness, but not less than five safety glasses.	Actual size of product	All samples shall pass. In case of any single failure, draw another 5 percent and repeat the tests. None of these samples shall fail.
2.	Dimensions and squareness (Clause **5.2.2**)			
3.	Flatness (Clause **5.2.4**)			
4.	Fragmentation test (Clause **5.2.3**)	2	0.36 m^2	All samples shall pass. In case of any single failure, draw another 2 samples from the lot and repeat the test. None of these 2 samples shall fail.
4.	Resistance to shock test (Clause **5.2.5.1**)	2	610 mm × 610 mm	All samples shall pass. In case of any single failure, draw another 2 samples from the lot and repeat the test. None of these 2 samples shall fail.
5.	Resistance to human impact test (Clause **5.2.5.2**)	2	1910 mm × 847 mm	All samples shall pass. In case of any single failure, draw another 2 samples from the lot and repeat the test. None of these 2 samples shall fail.
6.	Surface compression test (Clause **5.2.6**) (Optional)	2	360mm × 1100mm	All samples shall pass. In case of any single failure, draw another 2 samples from the lot and repeat the test. None of these 2 samples shall fail.
7.	Four point bending test (Clause **5.2.7**) (Optional)	2	360 mm × 1100 mm	All samples shall pass. In case of any single failure, draw another 2 samples from the lot and repeat the test. None of these 2 samples shall fail.

Table 13 Sample Size and Criteria for Conformity

Sl No.	Testing Parameter	No. of Samples	Size of Samples (Recommended)	Acceptance Criteria
1.	Thickness (Clause **5.3.1**)	5 percent of the quantity from each size, but not less than five safety glasses.	Actual size of product	All samples shall pass. In case of any single failure, draw another 5 percent and repeat the tests. None of these samples shall fail.
2.	Dimensions and squareness (Clause **5.3.2**)			
3.	Light stability test (Clause **5.3.3**)	3	300 mm × 300 mm	All samples shall pass. In case of any single failure, draw another 3 samples from the lot and repeat the test. None of these 3 samples shall fail.
4.	Boil test (Clause **5.3.4**)	3	300 mm × 300 mm	All samples shall pass. In case of any single failure, draw another 3 samples from the lot and repeat the test. None of these 3 samples shall fail.
5.	Bake test (Clause **5.3.4**)	3	300 mm × 300 mm	All samples shall pass. In case of any single failure, draw another 3 samples from the lot and repeat the test. None of these 3 samples shall fail.
6.	Fracture and adhesion test (Clause **5.3.5**)	3	500 mm × 500 mm or 300 mm × 300 mm, as applicable.	All samples shall pass. In case of any single failure, draw another 3 samples from the lot and repeat the test. None of these 3 samples shall fail.
7.	Defects in the central area (Clause 5.3.6)	3	Actual size of product	All samples shall pass. In case of any single failure, draw another 3 samples from the lot and repeat the test. None of these 3 samples shall fail.
8.	Humidity test (Clause **5.3.7**) (optional)	3 (The test may be carried out either with or without condensation, as applicable).	300 mm × 300 mm	All samples shall pass. In case of any single failure, draw another 3 samples from the lot and repeat the test. None of these 3 samples shall fail.
9.	Resistance to human impact test (Clause **5.3.8**)	2	1910 mm × 847 mm	All samples shall pass. In case of any single failure, draw another 2 samples from the lot and repeat the test. None of these 2 samples shall fail.

ANNEX B

(*Informative*)

OTHER PHYSICAL CHARACTERISTICS

B-1 OPTIONAL DISTORTION

B-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.

B-1.2 Thermally Toughened Soda Lime Silicate Safety Glass Produced by Horizontal Toughening

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).

B-2 ANISOTROPY (IRIDESCENCE)

The thermal 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.

Anisotropy is not a defect but a light effect visible in a stressed glass.

B-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 differential up to 200°C.

ANNEX C

(*Informative*)

RISK OF SPONTANEOUS BREAKAGE OF TOUGHENED GLASS DUE TO NICKEL SULPHIDE INCLUSION

Nickel sulphide is an impurity which is rarely present in glass. Presence of nickel sulphide inclusions may, in certain circumstances, result in spontaneous breakage of thermally toughened glass.

Subjecting thermally toughened glass to heat soaking process would reduce the risk of spontaneous breakage due to nickel sulphide inclusion. The process, which is destructive in nature, involves an additional heat treatment. Heat soaking process does not completely eliminate the risk of breakage, but reduces it significantly.

Heat soaking treatment is recommended for all situations where the stability of the structure and the safety of users may be at risk from breakage of the toughened glass.

ANNEX D

(*Foreword*)

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Amendments Issued Since Publication

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