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Mazdoor Kisan Shakti Sangathan

“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 2553-2 (1992): Safety Glass, Part 2: For Road Transport
[CHD 10: Glassware]



“ज्ञान से एक नये भारत का निर्माण”

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“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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IS 2553 (Part 2) : 1992

भारतीय मानक

सुरक्षा काँच — विशिष्ट

भाग 2 सड़क परिवहन के लिए

Indian Standard

SAFETY GLASS — SPECIFICATION

PART 2 FOR ROAD TRANSPORT

(Second Reprint JUNE 2001)

UDC 666.155

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BUREAU OF INDIAN STANDARDS

MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

April 1992

Price Group 9

FOREWORD

This Indian Standard (Part 2) was adopted by the Bureau of Indian Standards, after the draft finalized by the Glassware Sectional Committee had been approved by the Chemical Division Council.

The standard on safety glass was first published in 1963 and was subsequently revised in 1964. During the second revision in 1971, optical requirements were added and nominal thickness and tolerance were modified in accordance with IS 2835 : 1971 'Specification for flat transparent sheet glass'. In the light of the experience gained over the years, the Committee decided to further split this standard in two parts: Part 1 Safety glass for general purposes, and Part 2 Safety glass for road transport to cater to the needs of the road transport.

Part 1 of this standard was published in 1990. In Part 2 of this standard the use of float glass has been permitted. Use of zone toughened safety glass has been permitted for windscreen of cars. Warp for toughened safety glass for windows and windshield, and head form impact test for laminated and zone toughened safety glass have been included. Penetration resistance test has been introduced for laminated safety glass for windscreen. The uniformity test has been deleted as the quality of toughening is tested by fragmentation test which has been modified. Nominal thickness and tolerance on cut sizes for laminated safety glass has been rationalized taking into view the thickness of the foil and tolerance of nominal thickness of sheet glass. Detailed tolerance on dimensions, cross bend and various types of defects have been included. The optical distortion test has also been modified.

The Committee, while finalizing this standard, was of the opinion that uniformly toughened safety glasses even though being substantially used at present should be phased out as early as possible. This has already been done elsewhere with a view to further improve safety of windscreen glasses. The Committee therefore decided that the use of uniformly toughened safety glass for windscreen in road transport vehicles shall be discontinued from 1 April 1993 and accordingly necessary amendment shall be issued.

In preparing this standard considerable assistance has been derived from the following:

JIS R 3211-1985	Safety glass for road vehicles. Japanese Industrial Standard Committee.
JIS R 3212-1985	Test methods for safety glass for road vehicles. Japanese Industrial Standard Committee.
JASO M 501-1989	Safety glass for automobiles. Japanese Automobile Standards Organization.
BS AU 178 : 1976	Road vehicle safety glass. British Standards Institution.
Regulation No. 43	Uniform provisions concerning the approval of safety glazing and glazing materials for installation on power driven vehicles and their trailers. Economic Commission for Europe, United Nations.
ISO 3536-1 : 1975	Road vehicles - Safety glasses — Vocabulary — Part 1. International Organization for Standardization.
ISO 3537 : 1975	Road vehicles — Safety glasses — Test methods for mechanical properties. International Organization for Standardization.
ISO 3538 : 1978	Road vehicles — Safety glasses — Test methods for optical properties. International Organization for Standardization.
ISO 3917 : 1975	Road vehicles — Safety glasses — Test methods for resistance to radiation, high temperature, humidity and fire. International Organization for Standardization.

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)'.

**AMENDMENT NO. 2 MAY 2008
TO
IS 2553 (PART 2) : 1992 SAFETY GLASS —
SPECIFICATION
PART 2 FOR ROAD TRANSPORT**

(Page 1, clause 1) — Substitute following for the existing matter:

This standard prescribes requirements and methods of sampling and test for safety glass glazing and glazing materials intended for installation as windscreen or other panes, or as partitioning in power driven vehicles and their trailers, to the exclusion, however, of glass panes for lighting and light signalling devices and instrument panels, of special bullet-proof and aggression-resistance glass panes and materials other than glass.

This standard does not concern the installation of safety glazing and glazing materials on power driven vehicles and their trailers or double windows.

(TED 6)

AMENDMENT NO. 1 APRIL 1994
TO
IS 2553 (Part 2) : 1992 SAFETY GLASS —
SPECIFICATION
PART 2 FOR ROAD TRANSPORT

(*Page 5, Table 1, Note*) — Substitute the existing note with the following:

'NOTE — The use of uniformly toughened safety glass for windscreen shall be in accordance with the provisions of the Rule 100 of the Central Motor Vehicles (Amendment) Rules, 1993 and as amended from time to time.'

(CHD 010)

Printed at Simco Printing Press, Delhi

Indian Standard

SAFETY GLASS — SPECIFICATION

PART 2 FOR ROAD TRANSPORT

1 SCOPE

This standard prescribes requirements and methods of sampling and test for safety glass meant for use in automobile windscreen, back-light and side window glasses.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

<i>IS No.</i>	<i>Title</i>
1382 : 1981	Glossary of terms relating to glass and glassware (<i>second revision</i>)
2553 (Part 1) : 1990	Safety glass: Part 1 For general purposes (<i>third revision</i>)
2835 : 1987	Flat transparent sheet glass (<i>second revision</i>)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 1382 : 1981, IS 2553 (Part 1) : 1990 and the following shall apply.

3.1 Uniformly Toughened Safety Glass

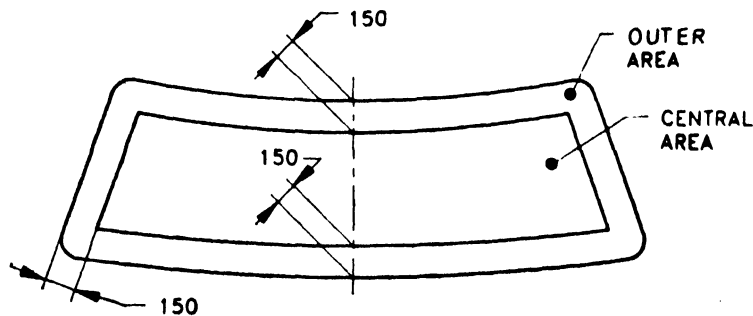
A glasspane consisting a single layer of glass which has been subjected to special treatment to increase its mechanical strength and to condition its fragmentation after shattering.

3.2 Zone Toughened Safety Glass

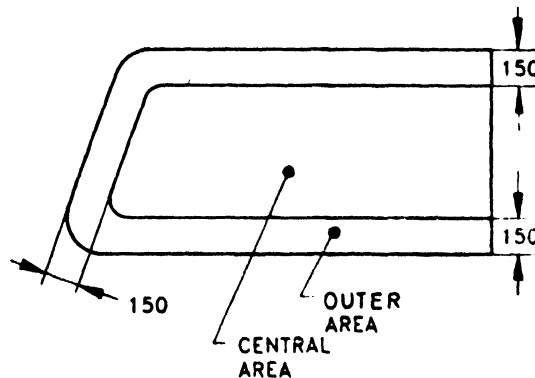
A single piece of specially heat-treated glass with a stress pattern such that the piece when fractured, a desired portion of the glass may shatter into somewhat larger fragments while the rest may shatter into granular fragments to secure field of vision necessary for driving.

3.3 Central Area and Outer Area of Windscreen

That part of the windscreen through which the principal field of view is obtained (*see* Fig. 1A and 1B) is called the central area of windscreen. It is also called the primary vision area of the windscreen. The remaining area is considered as outer area.



1A Central Area and Outer Area of Windscreen



1B Central Area and Outer Area of Divided Windscreen
All dimensions in millimetres.

FIG. 1 CENTRAL VISION AREA FOR OPTICAL TESTS FOR WINDSCREEN

3.4 Central Area and Outer Area of Safety Glasses Other than Windscreen

The area enclosed by an ellipse or a circle whose major or minor axis or diameter do not exceed half the length or width of safety glass is considered as central area. The remaining area is considered as outer area.

3.5 Secondary Image

The secondary or 'ghost' image is a spurious image, usually seen at night when the object viewed is very bright in relation to its surroundings, for example, the headlights of an approaching vehicle.

3.6 Dimensions and Shape of Safety Glass

3.6.1 Corner Sections

R sections shown in Fig. 2 are corner sections (points of tangency shown in Fig. 2 are included in corner sections).

3.6.2 Design Line

A reference line on inspection fixture (see Fig. 2).

3.6.3 Basic Line

A reference line on an inspection fixture adjacent to stopper (S). It does not include corner sections (see Fig. 2).

3.6.4 Allowable Size Tolerance Along Basic Line

The deviation between the design line and the periphery of the glass (see A in Fig. 2).

3.6.5 Allowable Size Tolerance for Height

The deviation between the design line and the periphery of the glass (see B in Fig. 2).

3.6.6 Allowable Size Tolerance for Width

The deviation between the design line and the periphery of the glass (see C in Fig. 2).

3.6.7 Allowable Size Tolerance for Corner Sections

The deviation between the design line and the periphery of the glass (see D in Fig. 2).

3.6.8 Curvature Tolerance

The deviation between the design curve and that of the glass product (see Fig. 3).

3.6.9 Cross Bend

A phenomenon occurring in the manufacture of curved glass (see Fig. 4).

3.6.10 Deep Bend

A curved surface containing a bend radius less than 300 mm and a depth of bend greater than 100 mm.

3.6.11 Shallow Bend

A curved surface containing a bend radius greater than 300 mm and a depth of bend less than 100 mm.

3.6.12 Long Side

The longer of either 'L' or 'H' in Fig. 5.

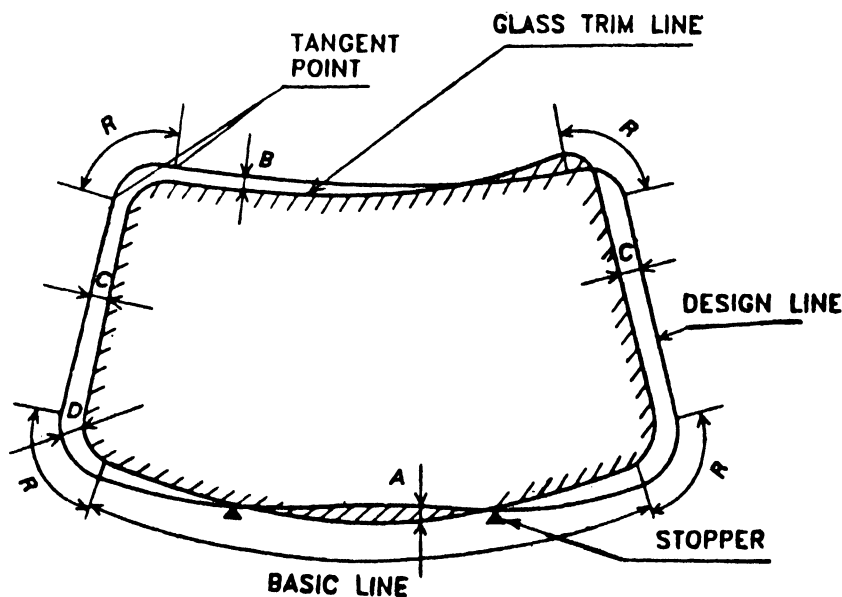


FIG. 2 CORNER SECTION OF SAFETY GLASS

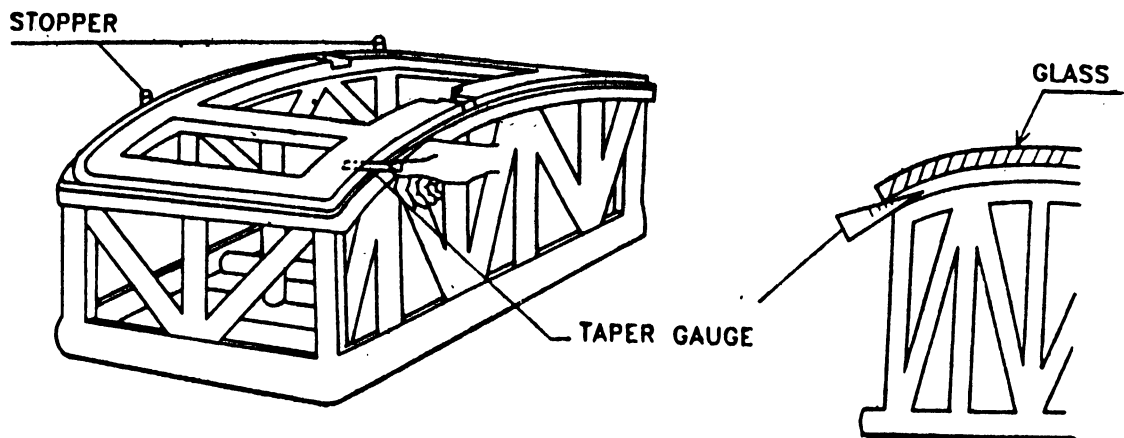


FIG. 3 CURVATURE TOLERANCE OF SAFETY GLASS

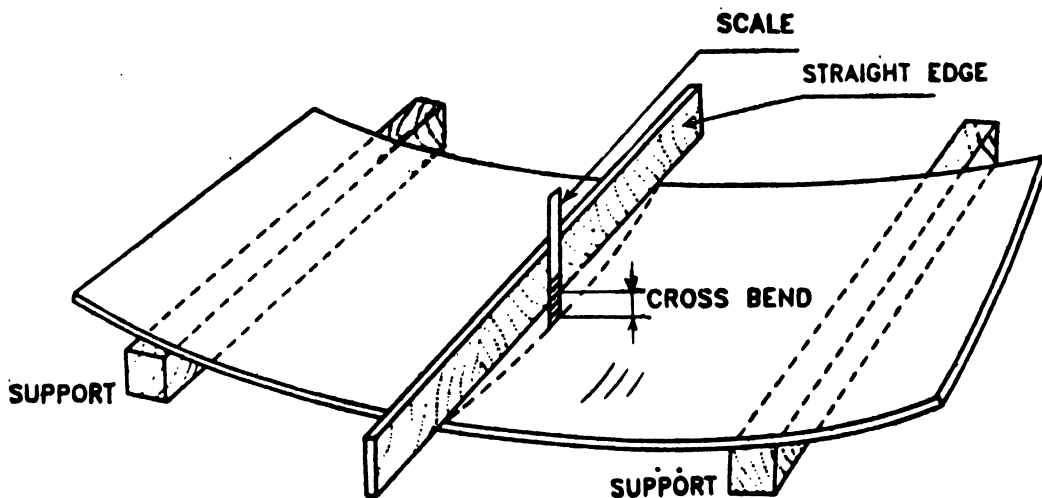


FIG. 4 CROSS BEND ON SAFETY GLASS

3.6.13 Area per Piece (s)

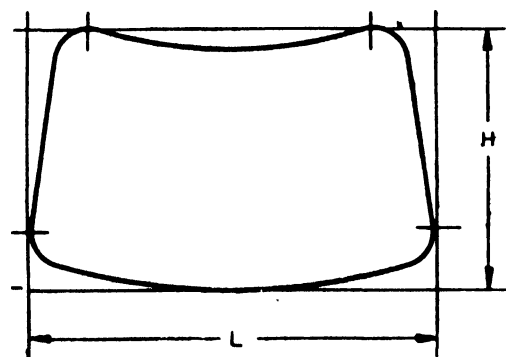
The area per piece is the area of the minimum rectangle externally tangent to the developed shape expressed in square metres (see Fig. 5).

3.7 Body Defects of Safety Glass

These include the following defects other than those present in parent glass as covered in IS 2835 : 1987.

3.7.1 Handling Scratches

Scratches made on the surface of the glass during processing or handling. According to the extent of scratches, the scratches are defined as heavy or medium. The heavy scratches are those which can be readily detected by fingernails and the medium scratches are those which cannot be readily detected by fingernails.



SAMPLE CALCULATION

$$L = 1\,234 \text{ mm}$$

$$H = 456 \text{ mm}$$

$$S = 1\,234 \times 456 \times 10^{-6}$$

$$= 0.562\,7 \text{ m}^2$$

FIG. 5 AREA PER PIECE OF SAFETY GLASS

3.7.2 Lint

Fibres of yarn, fabric or hair on the surface of the plastic interlayer of laminated safety glass.

3.7.3 Black Spot

Coloured portions adhered in spots onto the plastic interlayer.

3.7.4 Edge Delamination

The state in which the plastic interlayer is not bonded to the glass along the periphery of laminated glass.

3.7.5 Slip

The state in which the two sheets of laminated glass are not perfectly positioned.

3.7.6 Interlayer Dirt

The so-called 'dirt' adhered to the plastic interlayer of laminated glass and grouped as fine particles on the surface of the plastic interlayer.

3.7.7 Interlayer Bubbles

Transparent air bubbles on or in the plastic interlayer of laminated glass.

3.7.8 Short Plastic

The state in which the end of the plastic interlayer of laminated glass withdraws inward from the edge of the glass.

3.7.9 Shell Chips

The shell shaped, lost portions on the surface or edges of the glass (see Fig. 6).

3.7.10 Vents and Chill Cracks

Small cracks formed on the surface of the glass.

3.7.11 Fused Chips

Small pieces of glass adhered to the surface of the glass.

3.7.12 Bull's Eye

Optical distortion caused by scratch polishing.

3.7.13 Polished Edge

The state in which the periphery is polished to a semi-cylindrical shape (see Fig. 6).

3.7.14 Shiner

Unpolished portion of a polished edge (see Fig. 6).

3.7.15 Seamed Edge

The edges of the periphery seamed lightly at an oblique angle (see Fig. 6).

3.7.16 Lack of Seam

Unseamed raw edge portion (see Fig. 6).

3.7.17 Mold Mark

A mark from bending tooling near the periphery of curved glass (see Fig. 7).

3.7.18 Tong Mark

A mark formed along one edge by hangers used during vertical tempering of glass (see Fig. 8).

4 TYPES, NOTATIONS AND APPLICATIONS

The types, notations and applications of the safety glass shall be in accordance with Table 1.

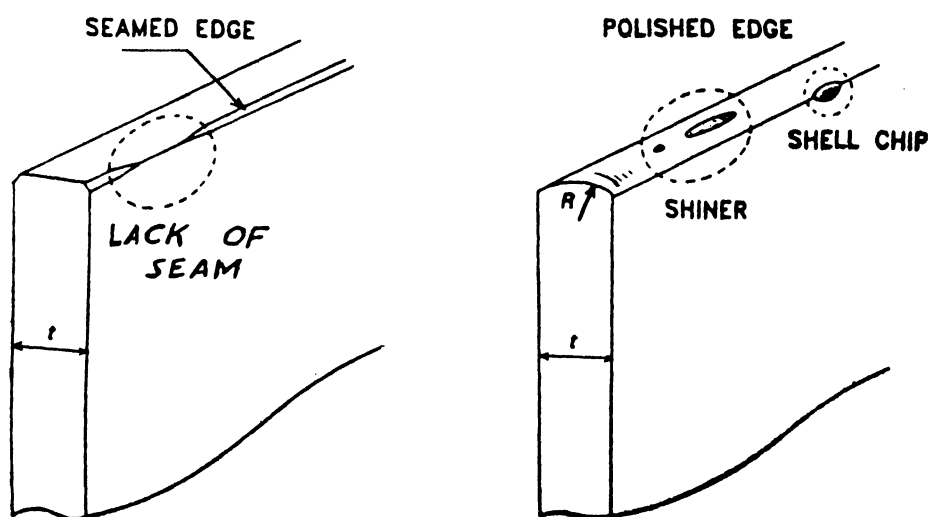


FIG. 6 TYPE OF EDGEWORK

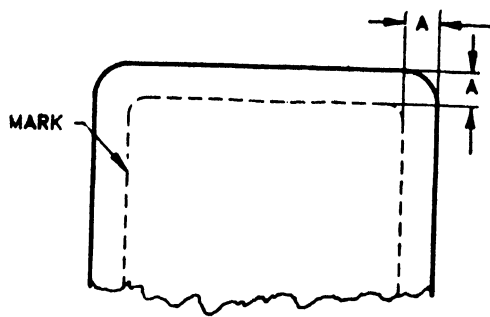


FIG. 7 MOLD MARK

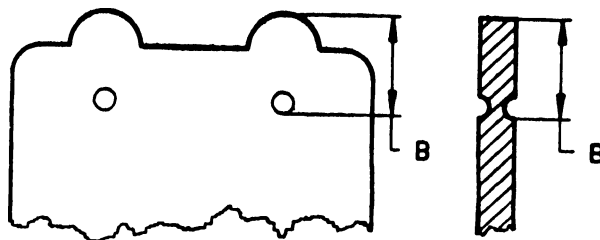


FIG. 8 TONG MARK

Table 1 Types, Notations and Applications of Safety Glass
(Clause 4)

Sl No.	Type	Notation	Application
(1)	(2)	(3)	(4)
i)	Laminated safety glass	LW	In windscreen
ii)	Laminated safety glass	L	Other than wind-screen
iii)	a) Uniformly toughened safety glass	T	Other than wind-screen
	b) Uniformly toughened safety glass	TW	In windscreen
iv)	Zone toughened safety glass	Z	In windscreen

NOTE — The use of uniformly toughened safety glass for windscreen (TW) is intended to be discontinued with effect from 1 April 1993 for which necessary amendment shall be issued.

5 REQUIREMENTS

5.1 General

5.1.1 Material

Safety glass shall be made of 'AA' and 'A' quality flat transparent sheet glass conforming to IS 2835 : 1987. Safety glass may also be made from float glass.

5.1.1.1 Safety glass may be flat or curved as agreed to between the purchaser and the supplier.

5.1.1.2 Safety glass may itself be tinted or tinted by providing tint interlayers as agreed to between the purchaser and the supplier provided it conforms to minimum visible light transmission specified in 5.1.7.

5.1.2 Dimensional Tolerance for Height, Width and Corner Sections of Safety Glass

Tolerance for height, width and corner sections of safety glass shall be in accordance with Tables 2 and 3.

5.1.3 Curvature Tolerance and Cross Bend of Bent Safety Glass

Curvature tolerance and cross bend of bent safety glass shall be in accordance with Tables 4, 5 and 5A.

5.1.4 Warpage for Flat Safety Glass

5.1.4.1 The warpage measurement will be made separately for bow and corrugation.

5.1.4.2 The bow shall be measured by keeping the specimen vertical without any external force so as to deform it and by attaching a scale horizontally along the length of the glass. The measurement (see Fig. 10A) of the height (h) of the arc for the length (l) of the cord shall give the bow (b) when calculated as follows:

$$\text{Bow } (b), \text{ percent} = \frac{h}{l} \times 100$$

Bow (b) should not exceed 0.5 percent.

Table 2 Allowable Size Tolerance in mm of Flat and Cylindrically Bent Safety Glass
(Clause 5.1.2)

Sl No.	Type	Basic Line	Total Size Tolerance for Height and/or Width			Corner Sections Area/ Piece (sq m)	
			Less than 600	600 to 1 200	More than 1 200	Less than 0.300	Equal to or more than 0.300
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	L and LW	±0.5	2.0	3.0	3.5	3.0	4.0
ii)	T, TW and Z	±0.5	2.0	3.0	4.0	3.0	4.0

NOTE — These size tolerances can be made stricter subject to agreement between the purchaser and the supplier.

Table 3 Total Size Tolerance in mm of Compound Bent Safety Glass
(Clause 5.1.2)

Sl No.	Type	Basic Line	Total Size Tolerance for Height and Width, mm						Corner Sections Length of Longest Side		
			Length of Longest Side						Length of Longest Side		
			Less than 1 200		1 200 to 1 800		More than 1 800		Less than 1 200	1 200 to 1 800	More than 1 800
			H	W	H	W	H	W	(10)	(11)	(12)
i)	L and LW	± 1.0	(4)	(5)	(6)	(7)	(8)	(9)	2.5	4.0	4.5
ii)	T, TW and Z	± 1.0	2.0	2.0	2.5	2.5	3.0	4.0	2.5	4.0	4.5
			2.5	2.0	3.0	3.0	3.5	4.0			

NOTES

1 These tolerances can be made stricter subject to agreement between purchaser and supplier.

2 For parts with longest side length less than 1 200 mm and the areas per sheet greater than 0.700 sq. m, use size tolerance as for the 1 200 mm -1 800 mm case.

3 Total tolerance 6 mm, applicable to corner sections, are shown in Fig. 9. Continuous line shows design line and dotted line shows periphery of glass.

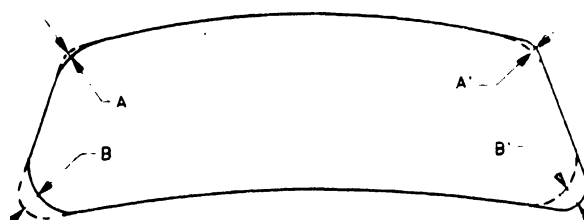
Table 4 Curvature Tolerance in mm of Compound Bent Safety Glass
(Clause 5.1.3)

Length of Longest Side in mm					
Less than 1 200		1 200 to 1 800		More than 1 800	
Shallow	Deep	Shallow	Deep	Shallow	Deep
(1)	(2)	(3)	(4)	(5)	(6)
3.0	3.5	3.5	4.0	4.0	4.0

5.1.4.3 The corrugation shall be measured by keeping the glass on a flat surface and attaching a scale along the length of the glass. The depth (h) of the trough (see Fig. 10B) and the distance (l) from crest to crest or trough to trough are to be measured. The corrugation when

calculated as follows shall not exceed 0.3 percent:

$$\text{Corrugation, (c) percent} = \frac{h}{l} \times 100$$



$$1A1 \pm 1A'1 \leq 0.0 \text{ mm}$$

$$1B1 \pm 1B'1 \leq 6.0 \text{ mm}$$

FIG. 9 TOLERANCE FOR CORNER SECTIONS

Table 5 Cross Bend on Curved Glass
(Clause 5.1.3)

Sl No.	Type	Height	Width						Unit : mm
			Shallow Bend			Deep Bend			
			Less than 1 200	1 200 to 1 800	More than 1 800	Less than 1 200	1 200 to 1 800	More than 1 800	
			(4)	(5)	(6)	(7)	(8)	(9)	
(1)	(2)	(3)							
i)	Land LW	Less than 600	7.0	9.0	11.0	9.0	11.0	13.0	
		600 to 750	9.0	12.0	15.0	12.0	14.0	16.0	
		More than 750	11.0	15.0	19.0	15.0	17.0	19.0	
ii)	Z, T and TW	Less than 600	10.0	12.0	14.0	12.0	16.0	20.0	
		600 to 750	12.0	15.0	18.0	15.0	18.0	21.0	
		More than 750	14.0	18.0	22.0	18.0	20.0	22.0	

NOTE — For parts with special shape, cross bends shall be as agreed between the purchaser and the supplier if depths are known.

Table 5A Cross Bend on Single-R Bend Glass
(Clause 5.1.3)

Type	Thickness	Length of Longest Edge				Unit : mm
		Less than 600	600 to 899	900 to 1 200	More than 1 200	
T and TW	$e \geq 4$	1.5	2.0	2.5	3.0	
	$e < 4$	2.0	2.5	3.0	3.5	

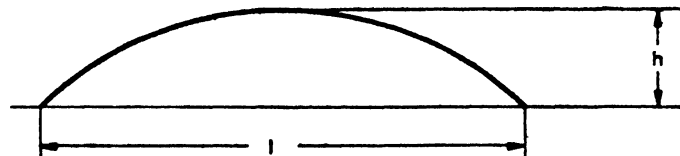


FIG. 10A BOW MEASUREMENT

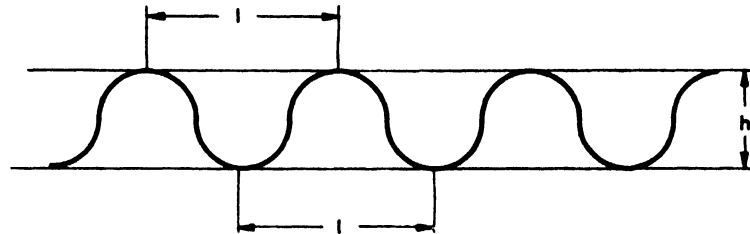


FIG. 10B CORRUGATION MEASUREMENT FOR FLAT SAFETY GLASS

5.1.5 Limits of Allowable Defects

The limit of allowable defects in safety glass shall be in accordance with Table 2 of IS 2835 : 1987 for AA and A quality sheet glass for the following defects:

- | | |
|------------------------------|-------------------------------|
| a) Gaseous Inclusion (clear) | b) Gaseous Inclusion (opaque) |
| | c) Stone, Knots |
| | d) Dirt |

For other type of defects it shall be in accordance with Table 6.

Table 6 Limit of Allowable Defects in Safety Glass

SI No.	Defects	Windscreen		Other than Windscreen (Whole Area)
		Central Area	Outer Area	
(1)	(2)	(3)	(4)	(5)
i)	Heavy Scratch, <i>Max</i> , mm	5.0	10.0	15.0
ii)	Medium Scratch <i>Max</i> , mm	10.0	20.0	30.0
iii)	Lint, <i>Max</i> , mm	15.0	30.0	30.0
iv)	Black Spot, dia in mm, <i>Max</i> 1.5		2.5	2.5
v)	Edge Examination (For L and LW)	—	Not allowed on exposed edges Other peripheral sections 5 mm, <i>Max</i>	
vi)	Slip (For L and LW)	—	Not allowed on exposed edges Other peripheral sections 1.5 mm, <i>Max</i>	
vii)	Interlayer Dirt (For L and LW)	←—————Should not affect vision————→		
viii)	Interlayer Bubbles (For L and LW)	←—————Not allowed on exposed edges————→		
ix)	Short Interlayer (For L and LW)	←—————Less than 3 mm from the edge————→		
x)	Position of Mold Mark (see A of Fig. 7.)	←—————Less than 12 mm from edge for curved glass————→		
xi)	Position of Tong Mark (see B of Fig. 8)	←—————Less than 12 mm from the edge————→		
xii)	Cracks	←—————None————→		

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5.1.5.1 Allowable number of defects per piece

The sums of the number of defects per piece of safety glass shall not be more than three when the area of the piece is less than 0.100 sq m. If the area of a piece is more than 0.100 sq m, (the first digit after the decimal point is rounded off to an integer), it shall be calculated by the following formula:

$$\text{Defects per piece} = 3 + \frac{\text{Area in sq m} - 0.1 \text{ sq m}}{0.1 \text{ sq m}}$$

5.1.6 Allowable Cluster of Defects

Allowable cluster of defects mentioned in 5.1.5 in safety glass shall be as follows:

In the central area of windscreen, maximum three defects are permissible in any circle with a diameter of 300 mm, but only one is permissible for major defects like gaseous inclusion, opaque gaseous inclusion, knots, stones and heavy handling scratches.

In the outer area of windscreen and for glasses other than windscreen, maximum five defects are permissible in any rectangle of 150 mm × 500 mm, but only one is permissible for major defects like gaseous inclusion, opaque gaseous inclusion, knots, stones and heavy handling scratches.

5.1.7 Visual Light Transmission

Visual light transmission of safety glass shall be 70 percent *Min* for windscreen and 50 percent *Min* for glasses other than windscreen, when tested in accordance with Annex C of IS 2553 (Part 1) : 1990.

5.2 Requirements Specific to Laminated Safety Glass (L and LW)

5.2.1 Thickness

The nominal thickness of laminated safety glass shall be the combined thickness of sheet glass and interlayer and the thickness range shall be the nominal thickness $\pm 0.2n$ where 'n' is the number of glass sheets constituting the product. The thickness shall be measured by the method prescribed in Annex B of IS 2835 : 1987.

5.2.2 Edge Matching

For matching the edges of laminates in laminated safety glass, the tolerance limit within which overlapping of edges shall be maintained, shall not exceed ± 1.5 mm.

5.2.3 Impact Resistance Test

Laminated safety glass shall pass the requirements of Impact Resistance Test as prescribed in Annex A.

5.2.4 Boil Test

Laminated safety glass shall pass the requirements of boil test as prescribed in IS 2553 (Part 1) : 1990.

5.2.5 Light Stability Test

Laminated safety glass shall pass the requirements of light stability test as prescribed in IS 2553 (Part 1) : 1990.

5.2.6 Test Specific to Laminated Windscreen (LW)

5.2.6.1 Penetration resistance test

Laminated safety glass used for windscreen shall pass the penetration resistance test when tested in accordance with Annex B.

NOTE — This test shall be applicable from 1 April, 1993.

5.2.6.2 Head-form (human head maniquinn) impact test

Windscreen made of laminated safety glass shall pass the head-form impact test as prescribed in Annex C.

5.3 Requirements Specific to Toughened Safety Glass (T and TW)

5.3.1 Thickness

The thickness of uniformly toughened safety glass and tolerance thereof shall conform to the requirements given in Table 7. The thickness of glass shall be measured by the method prescribed in Appendix B of IS 2835 : 1987.

Table 7 Nominal Thickness and Thickness Tolerance of Toughened Safety Glass

Type	Nominal Thickness mm	Thickness Tolerance mm
(1)	(2)	(3)
T and TW	3.5	± 0.2
	4.0	± 0.2
	5.0	± 0.3
	5.5	± 0.3
	6.0	± 0.3

5.3.2 Impact Resistance Test

Toughened safety glass shall pass the impact resistance test as given in Annex A.

5.3.3 Fragmentation Test

Toughened safety glass shall pass the fragmentation test as prescribed in Annex D.

5.4 Requirement Specific to Zone Toughened Safety (Z)

5.4.1 Thickness

The thickness of zone toughened safety glass and tolerance thereof shall conform to the requirements given in Table 8. The thickness of glass shall be measured by the method prescribed in Appendix B of IS 2835 : 1987.

Table 8 Nominal Thickness and Thickness Tolerance of Zone Toughened Safety Glass
(Clause 5.4.1)

Type	Nominal Thickness mm	Thickness Tolerance mm
(1)	(2)	(3)
Zone toughened (Z)	5.0	± 0.3
	5.5	± 0.3
	6.0	± 0.3

5.4.2 Fragmentation Test

Zone toughened safety glass shall pass the fragmentation test as prescribed in Annex D.

5.4.3 Head-Form (Human Head Maniquinn) Impact Test for Windscreen

Zone toughened glass (Z) shall pass the head-form impact test for windscreen as prescribed in Annex C.

5.5 Optical Requirements for Safety Glass Used as Windscreen

5.5.1 General

The optical requirements given in 5.5.2 and 5.5.3 shall apply to both central area and outer area of the windscreen. Since this area necessarily varies with different models of road transport vehicles according to the rake angle of the windscreen, seated height, distance from the windscreen and lateral placement of the driver, the vehicle manufacturer should define for each model the 'eye position' to which the primary vision area is related.

5.5.2 Secondary Image Test

The test shall be carried out with the test piece at the designed angle of rake from the vertical in a dark room so that secondary image and the white circle shall be distinctly visible.

5.5.2.1 Apparatus

The apparatus shall consist of a box 30 cm × 30 cm × 15 cm as shown in Fig. 11. The front of

the box shall have either a central hole of 12.7 mm diameter and a concentric slit of inside diameter 7.92 cm and width 1.6 mm forming a 'ring and spot' target or a circular slit of inside diameter 3.33 cm and width 1.6 mm forming a ring target. This front panel may be of glass masked with opaque black paper or of metal sheet painted matt black; in the latter case, the spiders bridging the slit should be small and disposed at 45° to the vertical and horizontal axes. The box shall be illuminated by a 15 or 25 watt pearl bulb and the central hole shall be covered by a yellow-red filter, for example, 'Ilford red 608'. The inside of the box shall be painted white.

5.5.2.2 Procedure

Place the light box so that the centre of the target lies on a horizontal line passing through the centre of the windscreen placed at a distance of 7.6 m from the light box, either set at the designed rake angle or in a vehicle standing on a level surface facing the light box. View the light box through each part of the primary vision area in order to detect the presence of any secondary image associated with the illuminated target. The windscreen may be moved laterally across the projection line, being rotated as necessary to maintain normality of vision in the horizontal plane, still maintaining a distance of 7.6 m from light box to windscreen, and the designed rake angle. A monocular (× 2) will assist in viewing and decrease eye strain.

5.5.2.3 Interpretation of the result

- Using the 'ring and spot' target, there shall be no displacement of the secondary image beyond the point of tangency of the central spot image with the inside edge of the circle. This limits the secondary image separation to a maximum of 15 minutes of arc.
- Alternatively, using the 'ring' target the primary and secondary images of the circle shall either overlap or touch. This also limits the secondary image separation to a maximum of 15 minutes of arc.

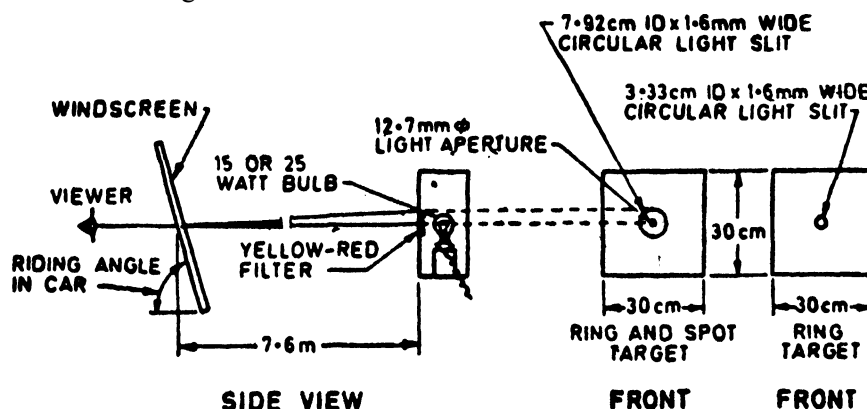


FIG. 11 SECONDARY IMAGE TEST

- c) There shall not be more than one secondary image.
- d) From point to point in the test area, there shall be no abrupt change in the displacement of the secondary image.

5.5.3 Optical Distortion Test

The test shall be carried out with the test piece at the designed angle of rake from the vertical in a dark room.

5.5.3.1 Apparatus

The apparatus shall consist of the following:

- a) *Projector* — The projector shall have a light source of 150 to 250 W halogen lamp and an objective lens of focal length of 90 mm

or more. A diaphragm to obtain sharp image may be attached as required (see Fig. 12).

- b) *Slide* — The slide shall be capable of obtaining the image as shown in Fig. 13.
- c) *Screen* — The screen shall be white and flat.
- d) *Supporting fixture* — The supporting fixture shall be capable of mounting a specimen at the rake angle of a real car, and also of rotating and shifting in horizontal or vertical direction.
- e) *Measuring instrument* — The measuring instrument shall be capable of measuring the distortion of the shape of the bright circle projected on the screen after passing through the specimen. The checking template as shown in Fig. 14 may be used.

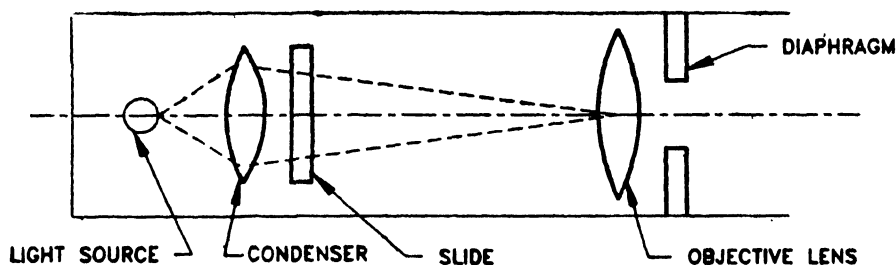
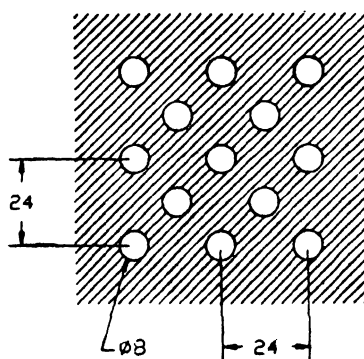


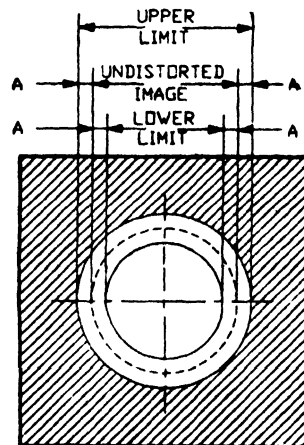
FIG. 12 PROJECTOR FOR OPTICAL DISTORTION TEST



$$D = \frac{R_1 + R_2}{R_1} \times 4$$

- where D : the diameter of circles projected on the screen (unit : mm)
 ($D = 8$ For $R_1 = R_2 = 4$ m)
 R_1 : the distance from the projector to the specimen (see Fig. 14)
 R_2 : the distance from the specimen to the screen (see Fig. 14)

FIG. 13 IMAGE PROJECTED ON THE SCREEN



Remark : A is determined by the formula:

$$A \text{ (mm) } = 0.145 \Delta \alpha L \times R_2,$$

where

$\Delta \alpha L$: The maximum value of the change in deviation (minutes of arc),

R_2 : 2 to 4 (m)

FIG. 14 CHECKING TEMPALTE

5.5.3.2 Procedure

Arrange the projector, the supporting fixture and the screen as shown in Fig 15. In the absence of the test piece, ascertain that the circular shaped part projected on the screen is D mm in diameter (for example in the case of $R_1 = R_2 = 4$ m, $D = 8$ mm is led by the formula described in Fig. 14). Place the test piece midway between the projector and the screen. Mount the test piece on the supporting fixture at the designed rake angle.

Rotating or moving the specimen horizontally and moving it vertically, while maintaining the distance at R_2 measure the maximum value of the change in diameter. Calculate the maximum value of the angular deviation by the following formula:

$$\Delta = \frac{\Delta d}{0.29 \times R_2}$$

where

- Δ = the angular deviation (minutes of arc),
- Δd = the change in diameter of the projected image (mm), and
- R_2 = the distance from the specimen to the screen (m).

5.5.3.3 Interpretation of result

The maximum angular deviation for windscreens made of sheet glass shall not be more than 8 minutes of arc for central area and 10 minutes of arc for outer area. For windscreens made of float glass the deviation shall not be more than 4 minutes of arc for central area and 6 minutes of arc for outer area.

6 PACKING AND MARKING

6.1 Packing

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

6.2 Marking

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

In the case of laminated safety glass used for windscreen, it shall be marked with 'LW' and for other than windscreen, it shall be marked with 'L';

In the case of toughened (uniformly) safety glass used for windscreen, it shall be marked with 'TW' and for zone toughened safety glass it shall be marked with 'Z', for safety glass other than windscreen, it shall be marked with 'T'; and

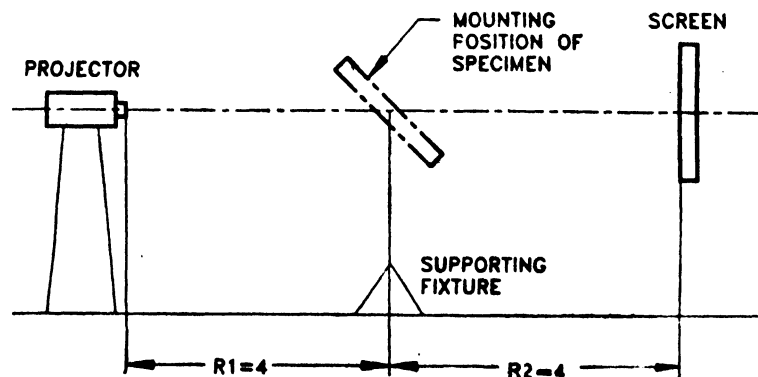
Indication of the source of manufacture.

6.2.2 Each packet shall be marked with the following information:

- a) Indication of the source of manufacture,
- b) Nominal thickness,
- c) Month and year of manufacture, and
- d) Type.

7 SAMPLING

7.1 Representative samples of safety glass shall be drawn as prescribed in Annex E.



All dimensions in millimetres.

FIG. 15 ARRANGEMENT FOR PROJECTOR SUPPORTING FIXTURE AND SPRING

ANNEX A
(*Clauses 5.2.3 and 5.3.2*)

IMPACT RESISTANCE TEST

A-1 PRINCIPLE

Safety glass is given a sudden impact and the fragments from the undersurface is collected and weighed.

A-2 APPARATUS

A-2.1 A hardened steel ball with a diameter of 38 mm and weighing 227 ± 2 g shall be used for the test.

A-2.2 A square frame having dimensions approximate to those shown in Fig. 16 so constructed that when the test specimen rests symmetrically on the frame 260 mm \times 260 mm of the specimen shall remain unsupported.

A-3 SPECIMEN

The specimen shall be a laminated or uniformly toughened safety glass measuring approx.

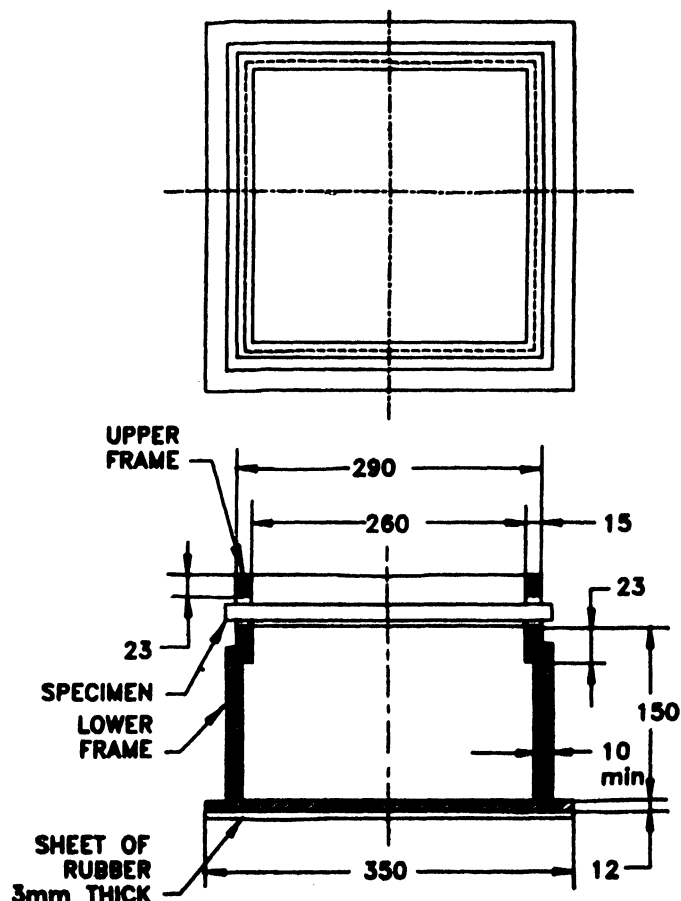
300 mm \times 300 mm manufactured by the same process as that of the product.

A-4 DROPPING DEVICE FOR THE BALL

A means of dropping the ball freely from the specified height so as to strike the ball within 50 mm from its centre. An electromagnet may conveniently be used for this purpose.

A-5 PROCEDURE

Condition the test piece for at least 4 hours immediately preceding the test at the temperatures $40 \pm 2^\circ\text{C}$ and $-20 \pm 2^\circ\text{C}$ for laminated glass of LW type; at $40 \pm 2^\circ\text{C}$ for laminated glass of L type. The test should be done within 5 minutes of taking the specimen out of the conditioning chamber.



All dimensions in millimetres.

FIG. 16 SUPPORTING FRAME FOR IMPACT RESISTANCE TEST

Place the specimen in the supporting frame supported horizontally so that the face which represents the outer face on the real vehicle faces upwards. Drop the steel ball from a standstill, without any impetus, from a height given in Table 9 on to the centre of the specimen.

The point of impact shall be within 50 mm of the centre of the specimen for windscreens. For glasses other than windscreens, the point shall be within 25 mm of the centre of the specimen for a height not more than 6 m, within 50 mm for a height more than 6 m. The impact given onto one specimen shall be limited to only once.

Table 9 Drop Height for Impact Resistance Test

Sl No.	Type	Nominal Thickness (mm)	Height of Drop in m at Test Temp		
			40±2°C	20±2°C	Room temp
(1)	(2)	(3)	(4)	(5)	(6)
i)	LW	$e \leq 4.5$	9	8.5	—
		$4.5 < e \leq 5.5$	10	9	—
		$5.5 < e \leq 6.5$	11	9.5	—
		$6.5 < e$	12	10	—
ii)	L	$e \leq 5.5$	5	—	—
		$5.5 < e \leq 6.5$	6	—	—
		$6.5 < e$	7	—	—
iii)	T & TW	$e \leq 3.5$	—	—	2
		$3.5 < e$	—	—	2.5

A-6 INTERPRETATION OF RESULT

A-6.1 The safety glass shall pass the requirements given in Table 10.

A-6.2 For LW type of glass, ten specimens shall be tested at $40 \pm 2^\circ\text{C}$ and further ten specimens at $-20 \pm 2^\circ\text{C}$. If eight or more specimens of each set satisfy the requirements mentioned in Tables 10 and 11 the safety glass shall be acceptable. If six or less specimens satisfy the requirements, the glass shall be rejected.

Table 10 Condition of Safety Glass After Impact
(Clause A-6.1)

Sl No.	Type	Condition After Impact
(1)	(2)	(3)
i)	LW	a) The steel ball shall not pass through the specimen
		b) The total mass of the fragments detached from the undersurface shall not exceed the value mentioned in Table 11
ii)	L	The steel ball shall not pass through the specimen

Table 11 Mass of Fragments After Impact
(Table 10)

Sl No.	Nominal Thickness (mm)	Maximum Permitted Mass (g)
(1)	(2)	(3)
i)	$e \leq 4.5$	12
ii)	$4.5 < e \leq 5.5$	15
iii)	$5.5 < e \leq 6.5$	20
iv)	$6.5 < e$	25

If seven specimens satisfy the requirements mentioned above, further ten specimens shall be tested and if all the new specimens satisfy the requirements, the glass shall be acceptable.

A-6.3 For L, T and TW type of glass, six specimens shall be tested. If five or more specimens satisfy the requirements mentioned in Table 10, the safety glass shall be acceptable. If three or less specimens satisfy the requirements, the glass shall be rejected.

If four specimens satisfy the requirements mentioned above, further six specimens shall be tested and if all the new specimens satisfy the requirements, the glass shall be acceptable.

PENETRATION RESISTANCE TEST

B-1 GENERAL

The objective of this test is to determine whether laminated safety glass for windscreen has a certain penetration resistance.

B-2 APPARATUS

B-2.1 A hardened steel ball with a diameter of approximate 82 mm and weighing $2\,260 \pm 20$ g shall be used for the test.

B-2.2 A steel frame having dimensions similar to those shown in Fig. 16 shall be used as the supporting fixture.

B-3 SPECIMEN

The specimen shall be a flat laminated glass measuring approx. $300\text{ mm} \times 300\text{ mm}$ manufactured by the same process as that of the product or that of approx $300\text{ mm} \times 300\text{ mm}$ cut from the product.

B-4 DROPPING DEVICE FOR THE BALL

A means of dropping the ball freely from the specified height so as to strike the ball within 25 mm from its centre. An electromagnet may conveniently be used for this purpose.

B-5 PROCEDURE

Condition the test piece for at least 4 hours immediately preceding the test at the temperature $27 \pm 2^\circ\text{C}$ and do the test within 5 minutes of taking the specimen out of the conditioning chamber.

Each specimen in turn shall be supported on the wooden frame in such a way so that the plane of the test specimen when in the frame shall be substantially horizontal. Drop the steel ball from a standstill position, without any impetus,

from a height of 4 m onto the centre of the specimen.

The point of impact shall be within 25 mm of the centre of the specimen, the impact given onto one specimen shall be limited to only once. The steel ball shall not pass through the specimen within 5 seconds of the moment of impact.

B-6 INTERPRETATION OF RESULT

B-6.1 Six specimens shall be tested by the penetration resistance test. If all specimens satisfy the requirements as specified below, the safety glass shall be acceptable. If four or less specimens satisfy, the glass shall be rejected.

If five specimens pass, further six specimens shall be re-tested and if all the specimens satisfy the conditions given above, the safety glass shall be acceptable, otherwise not.

ANNEX C

(Clauses 5.2.6.2 and 5.4.3)

HEAD-FORM (HUMAN HEAD MANIQUINN) IMPACT TEST FOR WINDSCREEN

C-1 APPARATUS USED

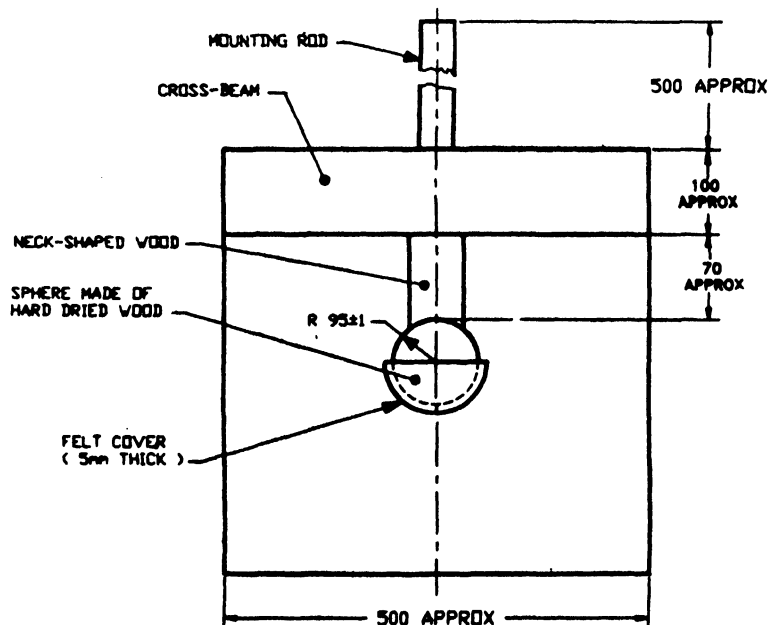
C-1.1 Head-Form

The head-form shall be 10 ± 0.2 kg in mass and shall be so constructed as shown in Fig. 17.

C-1.2 Supporting Fixture for Specimen

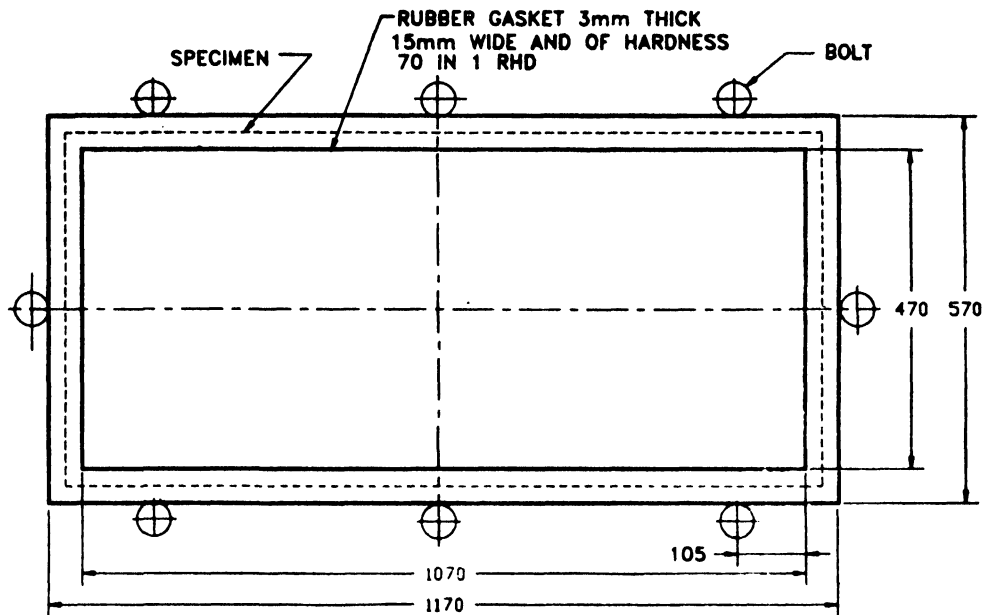
The supporting fixture for the specimen shall be made of 2 steel frames, with machined edges,

50 mm wide, fitting one over the other and faced with rubber gaskets about 3 mm thick and 15 ± 1 mm wide, of hardness 70 IRHD. The upper frame is pressed against the lower frame by at least eight bolts (see Fig. 18). The size of the specimen shall be approximately 1 100 mm \times 500 mm or actual windscreen.



All dimensions in millimetres.

FIG. 17 HEAD-FORM (HUMAN HEAD MANIQUINN)



All dimensions in millimetres.

FIG. 18 SUPPORTING FIXTURE FOR SPECIMEN IN HEAD-FORM TEST

C-2 DROPPING DEVICE

The device shall be capable of dropping the head-form freely from a specified height as given below:

Type of Glass	Drop Height of Head-Form in m	
	Product (2)	Test Piece (3)
(1) LW	1.5	4.0
Z	1.5	1.5

NOTE — The height specified is from the upper face of the specimen to the lowermost point of the head-form.

C-3 PROCEDURE

For the laminated glass of LW type keep the specimen at a temperature of $27 \pm 3^\circ\text{C}$ for at least 4 hours preceding the test.

C-3.1 Place the specimen such that its periphery is supported uniformly with interposition of the rubber gasket on the supporting fixture placed horizontally and put the pressing frame with rubber gasket upon it. The specimen shall be placed so that its side which will be the interior part when set on the motor vehicle faces upwards.

C-3.2 Fasten the pressing frame and supporting fixture with the bolts to prevent the specimen from being dislocated out of the frames at the time of impact of the head-form.

C-3.3 Make the head-form as it is at a stand still, without being subjected to any impetus, to

drop from the specified height onto the centre of the specimen face. The point of impact shall be within 50 mm from the centre of the specimen face. The impact given onto the specimen shall be limited to only once.

C-4 INTERPRETATION OF THE RESULTS

C-4.1 For the safety glass used for windscreens, if one of the following two conditions (a) and (b) is met, the safety glass shall be acceptable.

a) Where a Complete Product is Used as the Test Specimen

Four specimens shall be tested by the head-form test. If all four specimens satisfy the requirements as specified in **C-4.1.1**, the safety glass shall be acceptable. If two or less specimens satisfy, the glass shall be rejected.

If three specimens pass, further four specimens shall be re-tested and if all the specimens satisfy the conditions given in **C-4.1.1**, the safety glass shall be acceptable, otherwise not.

b) In Case a Test Piece is Used as Test Specimen

Six specimens shall be tested by the head-form test. If all specimens satisfy the requirements as specified in **C-4.1.1**, the safety glass shall be acceptable. If four or less specimens satisfy, the glass shall be rejected.

If five specimens pass, further six specimens shall be re-tested and if all the specimens satisfy the conditions given in C-4.1.1, the safety glass shall be acceptable, otherwise not.

C-4.1.1 Condition After Impact

Type	Condition After Impact	Type	Condition After Impact
(1)	(2)	(1)	(2)
Laminated Glass, LW	i) The specimen breaks, displaying numerous circular cracks centered on the point of impact, the cracks nearest to the point of impact being less than or equal to 80 mm from it.	iii)	On the impact side, the interlayer must not be laid bare over an area of not more than 20 cm ² .
	ii) The glass fragments remain adhering to the interlayer.	iv)	A tear in the interlayer up to 35 cm is allowed.
	Zone Toughened Glass, Z		The specimen shall fracture by the head-form impact.

ANNEX D

(Clauses 5.3.3 and 5.5.2)

FRAGMENTATION TEST

D-1 PRINCIPLE

Uniformly toughened or zone toughened glass is broken by giving it a sudden punch and number of broken particles per unit area are counted.

D-2 PROCEDURE

D-2.1 Test specimens from each lot having the same thickness for this purpose. Support the specimen as far as possible over its whole area, means being provided to prevent any substantial spreading of the fragments (*see Note*). Break the test pieces by giving a severe blow by means of a centre punch of 0.2 ± 0.05 mm radius of curvature at its tip to cause fracture.

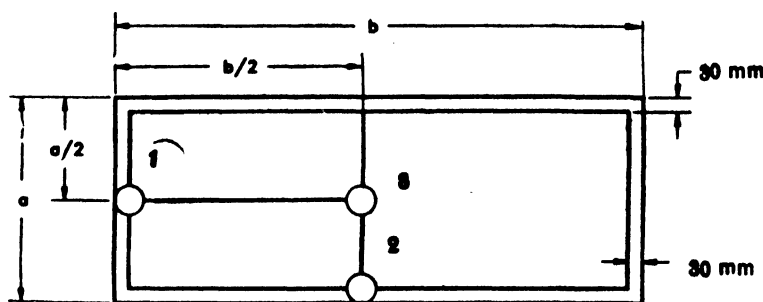
NOTE — In the case of a flat glass, the specimen may be laid on any convenient flat surface and spreading of the particles prevented by a loose wooden frame. In the case of curved glass the specimen may be wrapped in a sheet of paper, and sealed in such a manner that the package may be readily opened from one side and placed for breaking on a suitable supporting frame.

D-2.1.1 Complete the particle count determination on any one piece of glass sheet within 3 minutes of the fracture of that glass. Alternately, a photograph of the specimen immediately after the impact may be taken for counting of the fragments. No magnifying lens or other aid to vision (except spectacles, if normally worn) shall be used when making the particle count as described in Table 12 for uniformly toughened safety glass and Table 13 for zone toughened safety glass.

D-2.2 Points of Impact

D-2.2.1 Uniformly Toughened Glass

The points of impact for uniformly toughened safety glass of 3.5 and 4.0 mm thickness shall be as shown in Fig. 19A and that of 5.0 and 6.0 mm thickness as shown in Fig. 19B.



19A POINTS OF IMPACT FOR TOUGHENED SAFETY GLASS

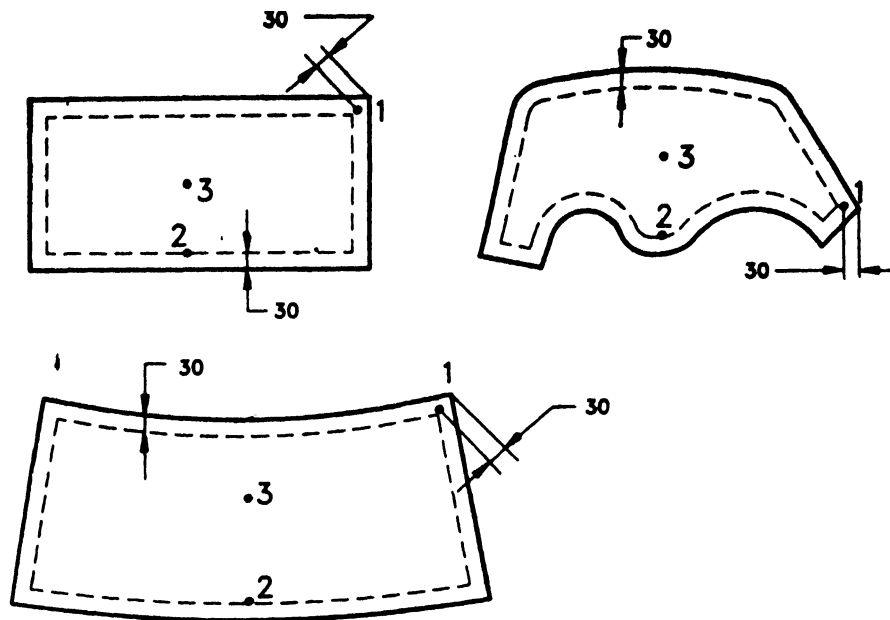


FIG. 19B POINTS OF IMPACT FOR TOUGHENED SAFETY GLASS

Remarks

Point 1 : 30 mm distance from the centre of the smallest angle on its bisecting line.

Point 2 : 30 mm distance from the centre of the longer side on a line passing through the centre.

Point 3 : Approximately central point of the specimen.

D-2.2.2 Zone Toughened Safety Glass

The test specimen shall be divided into three areas as shown in Fig. 20A.

D-2.2.2.1 Surrounding area

The surrounding area shall be such that 70 mm or more apart from the periphery of the seeing through area of glass.

D-2.2.2.2 Seeing through area

The seeing through area shall be that which locates approximately front of the driver's seat

and consists of a rectangular shape of horizontal side 500 mm or more and vertical side 200 mm or more.

D-2.2.2.3 Intermediate area

The intermediate area shall be that which is within 50 mm from the periphery of the seeing through area.

D-2.2.2.4 The points of impact for zone toughened safety glass shall be as specified in Fig. 20B.

D-3 INTERPRETATION OF RESULTS**D-3.1 Uniformly Toughened Safety Glass**

D-3.1.1 Count the particles in a square of side 50 mm when broken as described above (see D-2.1). A fragment on the side line of the square, shall be counted as half. Make the particle count in the region of coarsest and the finest fracture excluding the areas, within 20 mm from the periphery of the glass and within 75 mm in radius from the point of impact.

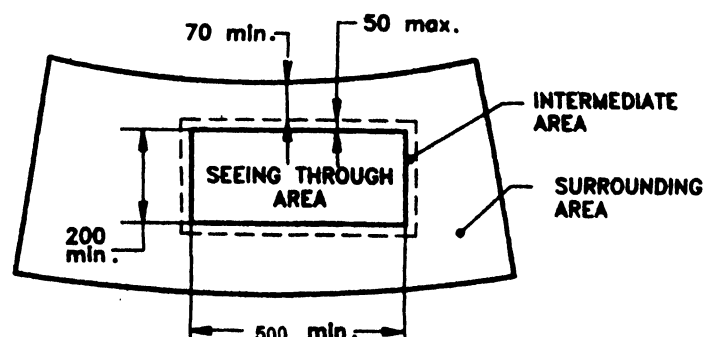


FIG. 20A DIVIDED AREA OF SPECIMEN FOR ZONE TOUGHENED SAFETY GLASS

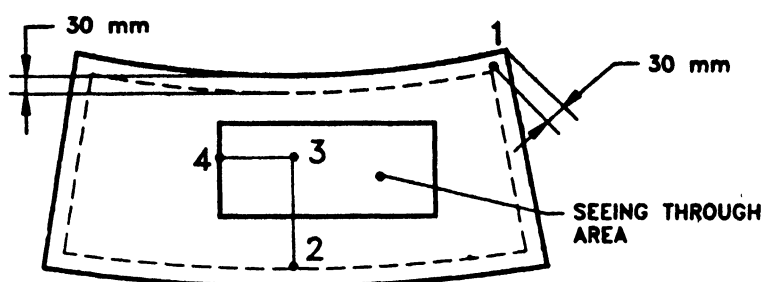


FIG. 20B POINTS OF IMPACT FOR ZONE TOUGHENED SAFETY GLASS

D-3.1.2 For flat or cylindrically bend toughened glass, three specimens shall be tested. The material shall be taken as having satisfied the requirement of the test if all the specimens satisfy the requirements given in Table 12.

If two specimens satisfy, further one specimen shall newly be retested at the same point of impact as that of the failed specimen. And if it satisfies the requirements, the safety glass shall be acceptable, otherwise not.

If one or no specimen satisfies the requirements, further three specimens shall be re-tested. If all three new specimens satisfy the requirements given in Table 12, the material shall be taken as having satisfied the requirements of this test, otherwise not.

D-3.1.3 For compound bend toughened glass, four specimens shall be tested. The material shall be taken as having satisfied the requirement of the test if all the specimens satisfy the requirements given in Table 12.

Table 12 Condition of Fragments of Toughened Glass

(Clauses D-3.1.1, D-3.1.2 and D-3.1.3)

Type	Condition of Fragments
(1)	(2)
T and TW	<p>i) The number of fragments shall not be less than 40 nor more than 400. In the case of specimens not more than 3.5 mm in thickness, even if the number is less than 40 in any area of 50 mm × 50 mm it shall be allowed only if the number of fragments is not less than 160 in any area of 100 mm × 100 mm including the former area.</p> <p>ii) The number of fragments exceeding 3 cm² but not more than 5 cm² shall not be more than 2.</p> <p>iii) The number of fragments of elongated shape exceeding 75 mm length but not more than 150 mm length shall not be more than 5.</p> <p>iv) If the elongated fragment extending the edge of the specimen forms an angle not less than 45° with it, its length shall be less than 60 mm.</p>

If three specimens satisfy, further one specimen shall newly be retested at the same point of impact as that of the failed specimen. And if it satisfies the requirements, the safety glass shall be acceptable, otherwise not.

If one or two specimens satisfy, further four specimens shall be re-tested. If all the new specimens satisfy the requirements given in Table 12, the material shall be taken as having satisfied the requirements of this test, otherwise not.

D-3.2 Zone Toughened Safety Glass

D-3.2.1 Measuring Method of Fragments

D-3.2.1.1 Surrounding area

Selecting two portions where the fragments are the coarsest and the finest in size, count the particles in a square of side 50 mm when broken as described above (see D-2.1). A fragment on the side line of the square, shall be counted as half.

Count the number of fragments with an area exceeding 3 cm², and measure each of their areas.

Count the number of elongated shape fragments exceeding 75 mm long and measure each of their lengths.

Measure each of angles which the elongated shaped shape fragments extending to the edge of glass make with that edge, and each of their lengths.

Exclude the areas within 20 mm from the periphery of the glass and within 75 mm in radius from the point of impact from the measurement.

D-3.2.1.2 Seeing through area

Calculate the aggregated area of fragments not less than 2 cm² in the rectangle for assessment (see Table 13). If a fragment lies on the periphery of the rectangle and its area within the rectangle is not less than 2 cm², the part area of the fragment within the rectangle shall be included in the calculation of the aggregate area.

Count the number of fragments with an area exceeding 16 cm^2 and measure each of their areas.

Count the number of fragments with a length exceeding 100 mm, and measure each of their lengths.

Count the number of fragments with an area exceeding 2 cm^2 and with one or more sharp edges not being embraced by a circle of diameter 50 mm in an area of $500 \text{ mm} \times 200 \text{ mm}$.

D-3.2.1.3 Intermediate area

Compare the condition of the fragments in the intermediate area with that of the surrounding area and area and seeing through area.

D-3.2.2 For zone toughened glass, six specimens shall be tested. The material shall be taken as having satisfied the requirement of the test if all the specimens satisfy the requirements given in Table 13, and if three specimens or less satisfy, it shall be rejected.

If five specimens satisfy, further one specimen shall newly be re-tested at the same point of impact as that of the failed specimen. And if it satisfies the requirements, the safety glass shall be acceptable, otherwise not.

If four specimens satisfy the requirements, further six specimens shall be re-tested. If all three new specimens satisfy the requirements given in Table 13, the material shall be taken as having satisfied the requirements of this test, otherwise not.

Table 13 Condition of Fragment in Zone Toughened Glass

Sl No.	Area of Specimen	Condition of Fragments
(1)	(2)	(3)
i)	Surrounding Area	<p>(1) The number of fragments in any square of side 50 mm shall not be less than 40 or more than 400.</p> <p>(2) The number of fragments of an area exceeding 3 cm^2 but not more than 5 cm^2 shall not exceed 2.</p> <p>(3) The number of fragments of elongated-shape exceeding 75 mm length but less than 150 mm length shall not exceed 5.</p> <p>(4) If the elongated fragments extending to the edge of the specimen form an angle of more than 45° with it, their length shall be less than 60 mm.</p>
ii)	Seeing Through Area	<p>(1) The aggregate surface area of the fragments of not less than 2 cm^2 shall represent not less than 15% of the area of $500 \text{ mm} \times 200 \text{ mm}$. If the height dimension of the specimen is less than 440 mm, the percentage shall be assessed by the area of $500 \text{ mm} \times 150 \text{ mm}$.</p> <p>(2) The number of fragments exceeding 16 cm^2 but less than 25 cm^2 shall not be more than 3 within a radius of 100 mm of the point of impact, and not more than 8' in the whole seeing through area.</p> <p>(3) The number of fragments of elongated-shape exceeding 100 mm length but not more than 200 mm length shall not be more than 5.</p> <p>(4) The number of sharp-edged fragments exceeding 2 cm^2 and extending across a circle of diameter 50 mm shall not be more than 15 in any area of $500 \text{ mm} \times 200 \text{ mm}$.</p>
iii)	Intermediate Area	The fragmentation in this area shall have characteristics intermediate between the respective characteristics of the fragmentations allowed for the peripheral and the seeing through area.

ANNEX E

(Clause 7.1)

SAMPLING OF SAFETY GLASS

E-0 LOT SIZE

The lot size shall be not more than 500 sq m (irrespective of thickness).

E-1 TOUGHENED SAFETY GLASS (T)

E-1.1 Five percent, but not less than five safety glasses shall be selected at random from each lot.

E-1.2 Each of the glasses selected under **E-1.1** shall be inspected for dimensional tolerances (**5.1.2**), curvature tolerance and cross bend (**5.1.3**) in case of bent glass, for warpage (**5.1.4**) in case of flat glass, limits of allowable defects (**5.1.5**), allowable cluster of defects (**5.1.6**), thickness (**5.3.1**), and shall satisfy all the requirements.

E-1.3 Three glasses from each lot as selected under **E-1.1** shall be tested for fragmentation (**5.3.3**).

E-1.4 Three glasses from each lot as selected under **E-1.1** shall be tested for visual light transmission (**5.1.7**).

E-2 TOUGHENED WINDSCREEN (BOTH TW AND Z)

E-2.1 Five percent, but not less than eleven windscreens shall be selected at random from each lot.

E-2.2 Each of the glasses selected under **E-2.1**, shall be inspected for dimensional tolerances (**5.1.2**), curvature tolerance and cross bend (**5.1.3**), limits of allowable defects (**5.1.5**), allowable cluster of defects (**5.1.5**), thickness (**5.3.1**) for TW type or thickness (**5.4.1**) for Z type and shall satisfy all the requirements.

E-2.3 Three glasses from each lot as selected under **E-2.1** shall be tested for fragmentation (**5.3.3**) and three glasses for optical requirements (**5.5**) and visual light transmission (**5.1.7**).

NOTE — In the case of zone toughened glass (Z) six more samples shall be subjected to head-form impact test (**5.4.3**). It shall also pass the fragmentation test (**5.4.2**).

E-3 LAMINATED SAFETY GLASS (L)

E-3.1 Draw by random selection, minimum number of sheets from each lot separately, so that thirteen samples of approximately 300 mm × 300 mm may be taken out.

E-3.2 Each of the glasses selected under **E-3.1** shall be inspected for dimensional tolerances (**5.1.2**), curvature tolerance and cross bend (**5.1.3**) in case of bent glass or warpage (**5.1.4**), in case of flat glass, limits of allowable defects (**5.1.5**), allowable cluster of defects (**5.1.6**), thickness (**5.2.1**), and edge matching (**5.2.2**) shall satisfy all the requirements.

E-3.3 Three out of the thirteen specimens (*see* **E-3.1**) from each lot shall be inspected (samples of apprx 300 mm × 300 mm only) for light stability test (**5.2.5**) and boil test (**5.2.4**) and ten specimens shall undergo impact resistance test (**5.2.5**).

NOTE — Separate test specimens may also be used for boil test and light stability test.

E-4 FOR LAMINATED WINDSCREEN (LW)

E-4.1 One percent, but not less than six windscreens shall be selected at random from each lot.

E-4.2 Each of the glasses selected under **E-4.1** shall be inspected for dimensional tolerance (**5.1.2**), distribution of allowable defects (**5.1.3**), allowable cluster of defects (**5.1.4**), thickness (**5.2.1**) and edge matching (**5.2.2**).

E-4.3 Three (*see* **E-4.1**) from each lot shall be inspected for light stability test (**5.2.5**) and boil test (**5.2.4**) and ten specimens shall undergo impact resistance test (**5.2.5**). Six specimens shall be tested for penetration resistance test (**5.2.6.1**), five specimens for head-form impact test (**5.2.6.2**), and three glasses for optical requirements (**5.5**) and visual light transmission (**5.1.7**).

NOTE — Separate test specimens may also be used for boil and light stability tests.

SUMMARY**Tests to be Performed on Safety Glass for Road Transport at a Glance**

Test	Clause Reference for Each Type of Glass				
	For Windscreen			Other Than Windscreen	
	Laminated (LW)	Uniformly toughened (TW)	Zone toughened (Z)	Laminated (L)	Toughened (T)
(1)	(2)	(3)	(4)	(5)	(6)
Visual light trans- mission	5.1.7	5.1.7	5.1.7	5.1.7	5.1.7
Impact resistance test	5.2.3	5.3.2	—	5.2.3	5.3.2
Boil test	5.2.4	—	—	5.2.4	—
Light stability test	5.2.5	—	—	5.2.5	—
Penetration resistance test	5.2.6.1	—	—	—	—
Head-form impact test	5.2.6.2	—	5.4.3	—	—
Fragmentation test	—	5.3.3	5.4.2	—	5.3.3
Secondary image test	5.5.2	5.5.2	5.5.2	—	—
Optical distortion test	5.5.3	5.5.3	5.5.3	—	—

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This Indian Standard has been developed from Doc : No. CHD 010 (0079)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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