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IS 709 (1974): Specification for Medium Atrength Aircraft Plywood [CED 20: Wood and other Lignocellulosic products]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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IS:709-1974
(Reaffirmed 2009)

Indian Standard
**SPECIFICATION FOR
MEDIUM STRENGTH AIRCRAFT PLYWOOD**
(First Revision)

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November 1974

Indian Standard
SPECIFICATION FOR
MEDIUM STRENGTH AIRCRAFT PLYWOOD
(First Revision)

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**AMENDMENT NO. 1 MARCH 2001
TO
IS 709 : 1974 SPECIFICATION FOR MEDIUM
STRENGTH AIRCRAFT PLYWOOD**

(First Revision)

(Page 7, clause 4.6) — Substitute the following for the existing:

'4.6 Treatment of Boards — Boards shall be treated with either trichlorophenol dissolved in light organic solvent or sodium pentachlorophenate dissolved in water to a retention level of 8 kg/m³ or 6 kg/m³ respectively.'

(CED 20)

Reprography Unit, BIS, New Delhi, India

**AMENDMENT NO. 2 JANUARY 2005
TO
IS 709 : 1974 SPECIFICATION FOR MEDIUM
STRENGTH AIRCRAFT PLYWOOD**

(First Revision)

(Page 7, clauses 5, 5.1, 5.1.1 and 5.2) — Substitute the following for the existing clauses:

5 DIMENSIONS AND TOLERANCES

5.1 The dimensions of plywood panels shall be as follows:

1 800 mm × 1 200 mm	1 800 mm × 900 mm
1 500 mm × 1 200 mm	1 500 mm × 900 mm
1 200 mm × 1 200 mm	1 200 mm × 900 mm

5.2 Thickness

The thickness shall be 1.0 mm, 1.5 mm, 2.0 mm, 2.5 mm, 3.0 mm, 3.5 mm, 4.0 mm, 4.5 mm, 5.0 mm, 6.0 mm, 7.0 mm, 8.0 mm, 9.0 mm and 10.0 mm.

NOTE — Any other dimensions (length, width and thickness) as agreed to between the manufacturer and the purchaser may also be used.

5.3 Tolerances

Tolerances on the nominal sizes of finished boards shall be as given below:

<i>Dimension</i>	<i>Tolerance</i>
Length	+ 6 - 0 mm
Width	+ 3 - 0 mm
Thickness:	
i) Less than 6 mm	±10 percent
ii) 6 mm and above	± 5 percent
Edge straightness	2 mm per 1 000 mm or 0.2 percent

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Squareness 2 mm per 1 000 mm
or 0.2 percent

NOTE — Edge straightness and squareness shall be tested as per Annex A.

(Page 8, clause 5.3) — Renumber '5.3' as '5.4'.

(Page 9, clause 7.1.5) — Add the following new clause after 7.1.5.3:

7.1.6 Static Bending Strength — Three test specimens taken in each direction from the sample of plywood, when tested in accordance with IS 1734 (Part 11) : 1983 shall have an average and a minimum individual Modulus of Elasticity and Modulus of Rupture not less than the values specified in Table 1.

Table 1 Average and Minimum Individual Values of Modulus of Elasticity (MOE) and Modulus of Rupture (MOR)

Direction	MOE (N/mm ²)		MOR (N/mm ²)	
	Average	Min. Ind.	Average	Min. Ind.
(1)	(2)	(3)	(4)	(5)
Along (Direction parallel to the grain direction of the face veneer)	7 500	6 700	50	45
Across (Direction perpendicular to the grain direction of the face veneer)	4 000	3 600	30	27

(Page 10, clause 10.2.2, third line) — Substitute '7.1.1 to 7.1.6' for '7.1.1 to 7.1.5'.

(Page 10, clause 10) — Insert the following Annex A after clause 10:

ANNEX A (Clause 5.3)

METHOD OF TEST FOR EDGE STRAIGHTNESS AND SQUARENESS

C-1 PROCEDURE FOR EDGE STRAIGHTNESS

C-1.1 The straightness of the edges and ends of plywood shall be verified against a straight edge not less than the full length of the plywood. If the edge on the end of the plywood is convex, it shall be held against the straight edge in

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such a way as to give approximately equal gap at each end. The largest gap between the straight edge and the edge shall be measured to the nearest millimetre and recorded.

C-2 PROCEDURE FOR SQUARENESS

C-2.1 The squareness of plywood shall be checked with a 1 200 mm × 1 200 mm square, by applying one arm of the square to the plywood. The maximum width of the gap shall be recorded.

(*Page 11, Appendix A*) — Rename 'Appendix A' as 'Annex B'.

(*Page 12, Appendix B*) — Rename 'Appendix B' as 'Annex C'.

(CED 20)

Indian Standard
SPECIFICATION FOR
MEDIUM STRENGTH AIRCRAFT PLYWOOD
(*First Revision*)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 15 March 1974, after the draft finalized by the Wood Products Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 This standard, prepared at the instance of the Directorate General of Civil Aviation, deals with medium strength plywood suitable for use mainly in secondary structural parts of aircraft and gliders. The requirements for such plywood are rigid in view of the fact that the parts of the aircraft have to withstand structural stresses often of an undetermined character as well as the rigours of large climatic variations. In the preparation of this standard, the Sectional Committee recognized the need to ensure this quality in the plywood and, therefore, restricted the species of timber which would be used for this type of plywood and in addition has specified the adhesive to be used for bonding.

0.3 This standard was first published in 1957. The first revision is based on the experience gained in the manufacture and use of the medium strength aircraft plywood over these years and the modifications mainly relate to the review of species of timber and the permissible defects in the plywood.

0.3.1 In this revision, details of methods of tests have been omitted and a cross-reference is given to the relevant tests in IS : 1734 (Part I to Part XX)-1972* wherever applicable.

0.4 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

*Methods of tests for plywood (Part I to Part XX) (*first revision*).

0.5 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*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard lays down the requirements for quality, bonding, manufacture and strength of medium strength aircraft plywood suitable for use in the manufacture of secondary structural parts of aircraft and gliders, such as gussets, reinforcing plates, fuselage covering, etc, where medium or low strength plywoods are generally specified.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS: 707-1968† shall apply.

3. MATERIAL

3.1 Timber—Unless otherwise specified by the purchaser (*see* Note) the timber for the manufacture of aircraft plywood shall be from among the species given in Table 1.

NOTE — Other species of timber, such as: (a) rosewood (*Dalbergia latifolia* Roxb.), (b) sissoo (*Dalbergia sissoo* Roxb.), (c) walnut (*Juglans* spp.), (d) padauk (*Pterocarpus dalbergioides* Roxb.), (e) teak (*Tectona grandis* Linn. f.), (f) mullilam (*Fagara budrunga* Roxb.), (g) sandan (*Ougeinia oojenensis* Roxb. Hochreut), (h) padri (*Stereospermum* spp.), (j) debdaru (*Polyalthia* spp.), and (k) hollock (*Terminalia myriocarpa* Heurck et Muell. Arg) may also be used provided that the construction is established to be satisfactory in actual use and in addition the performance specified in this standard is satisfied.

TABLE 1 SPECIES OF TIMBER FOR THE MANUFACTURE OF AIRCRAFT PLYWOOD

BOTANICAL NAME	TRADE NAME	ABBREVIATION FOR MARKING
<i>Dysoxylum malabaricum</i> Bedd	White cedar	WCE
<i>Palaquium ellipticum</i> (Dalz.) Engler	Pali	PAL

*Rules for rounding off numerical values (*revised*).

†Glossary of terms applicable to timber and timber products (*first revision*).

3.1.1 In selecting the species for manufacturing of plywood, it is recommended that, as far as possible, a single specie of timber be used for all plies; where combination of species is used, a single specie of timber should be used for both face and back plies and care shou'd be taken to prevent incompatibility of species.

3.2 Adhesive—Adhesives used in the manufacture of aircraft plywood shall be of the hot press, thermosetting, synthetic resin type and shall conform to BWP Grade of IS:848-1974*. Extenders shall not be added to the adhesive but addition of a dye to check that all parts of the veneer are completely covered by adhesive, shall be permissible.

3.2.1 No alternative adhesive shall be used without the prior approval of the purchaser.

3.2.2 The purchaser may, if he so desires, specify the type of adhesive namely, liquid or film to be used for bonding of the veneers. Unless, specifically mentioned, the manufacturers shall be at liberty to use either of the types.

4. MANUFACTURE

4.1 Veneers

4.1.1 The veneers shall be either rotary-cut or sliced from the timber species specified under **3.1**. Sapwood shall not be permitted in veneers.

4.1.2 The thickness of veneers shall not exceed 3 mm.

4.1.3 The grain in veneers shall be straight and shall run parallel to the edges, except as permitted under **4.1.4**.

4.1.4 The slope of the grain from the edge of the veneer shall be not greater than 1 in 12 nor shall the slope of the grain from the plane of veneer be greater than 1 in 12.

4.1.5 The veneers shall be reasonably free from irregular grain, such as short grain, wavy grain and wild grain.

4.1.6 The veneers shall be conditioned to a moisture content of 8 to 10 percent.

4.1.7 Veneers, when cut, shall be reasonably smooth, so as not to interfere with adhesion.

4.1.8 Veneers shall not have any of the following defects:

- a) Brashwood,
- b) Checks,
- c) Decay,

*Specification for synthetic resin adhesives for plywood (phenolic and amino-plastic) (*first revision*).

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- d) Dote,
- e) Discolouration due to sap stain,
- f) Patches,
- g) Ingrown bark,
- h) Birds eye, and
- j) Filling and inlaying.

4.1.8.1 Harmless discolouration due to chemical action or adhesive stain, not associated with decay, shall be permissible.

4.1.9 Face veneers shall be free from open defects, such as insect holes, splits and pitch pockets. They shall also be free from large, loose or dead knots, but may contain small live knots of diameter not greater than 6 mm provided that the sum of the diameters of the dead knots in any 1 000 cm² does not exceed 10 mm.

4.1.10 The following defects shall be permissible in core veneers:

- a) Live knots not exceeding 12.5 mm in diameter, provided that the sum of the diameters of the knots, in any 1 000 cm² does not exceed 25 mm; and
- b) Closed splits up to a total length of 120 mm/m².

4.2 Joints in Veneers

4.2.1 All joints shall be square cut. Plies may contain edge joints.

4.2.2 All joints in core plies shall be edge glued. Joints in face plies shall be either edge glued or taped and the tape shall be removed from the board before delivery.

4.2.3 End-grain joints, that is, joints running across the width of the veneer at right angles to the grain direction, shall not be permitted.

4.3 Assembly of Veneers

4.3.1 Unless otherwise specified, the grains of adjacent plies in a board shall run at right angles to each other throughout the board.

4.3.2 Unless otherwise specified, the grains of the outer plies in a board shall run parallel to the length of the board.

4.3.3 The construction of the board shall be balanced, that is, corresponding plies on opposite sides of the core ply shall be of the same species, thickness and grain direction. All the veneers of a board shall be cut by the same method, that is, either sliced or rotary-cut.

4.3.4 The thickness of any veneer in multi-ply shall not exceed twice the thickness of any other veneer in the same board.

4.3.5 The thickness of the core veneer in 3-ply shall be neither less than one-third nor greater than five-twelfths of the nominal thickness of the board.

4.4 Bonding

4.4.1 The glue used in the manufacture of plywood shall be as specified under 3.2.

4.4.2 The glueing shall be done in suitable hot platen presses. The manufacturing details shall be controlled so as to produce uniform high quality adhesion throughout.

4.5 Scarf Joints in Boards — There shall be no scarf through the thickness of a board.

4.6 Treatment of Boards — Immediately the boards are taken out of the press and whilst they are still hot, they shall be dipped in a two percent solution of sodium pentachlorophenate in water or two percent solution of pentachlorophenol in a suitable organic solvent at room temperature for 2 minutes and allowed to dry.

NOTE — Sodium pentachlorophenate is likely to precipitate on acidification. It should, therefore, be periodically checked and brought up to proper concentration.

5. SIZE AND THICKNESS OF BOARDS

5.1 Unless otherwise specified, plywood shall be supplied as rectangular boards of the following sizes:

cm	cm
180 × 120	180 × 90
150 × 120	150 × 90
120 × 120	120 × 90

5.1.1 A tolerance of $\begin{matrix} +2 \\ -0 \end{matrix}$ mm may be permitted on the specified dimensions.

5.2 Unless otherwise specified, boards shall be made in thicknesses specified below subject to tolerances as indicated:

mm	mm	mm
1·00 ± 0·10	3·50 ± 0·18	7·00 ± 0·35
1·50 ± 0·15	4·00 ± 0·20	8·00 ± 0·40
2·00 ± 0·20	4·50 ± 0·22	9·00 ± 0·45
2·50 ± 0·25	5·00 ± 0·25	10·00 ± 0·50
3·00 ± 0·30	6·00 ± 0·30	

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5.3 The thickness of any board shall be considered as the average of ten or more measurements taken at random.

6. FINISH

6.1 The edges of the board shall be trimmed square.

6.2 The finished sheets shall be smooth and free from blisters, overlaps and pleats. The surface shall be free from oil, wax, paraffin, tape and any other substance which may prevent adhesion of glue or paint finishes.

6.3 The board shall be sanded on both faces.

7. TESTS

7.1 Test pieces, cut from each of the boards selected as specified under **9.1** shall be subjected to the tests specified under **7.1.1** to **7.1.5**.

7.1.1 *Glue Adhesion in Dry State*

7.1.1.1 *Glue shear strength*— When tested for glue adhesion by the method described in IS: 1734 (Part IV)-1972* the failing load shall be not less than 135 kg and no individual value shall be less than 110 kg.

7.1.1.2 *Adhesion of plies*— The adhesion of plies shall be tested by forcibly separating the layers. The veneers shall offer appreciable resistance to separation and the fractured samples shall show some adherent fibres distributed more or less uniformly. Adhesion may also be tested by knife test method described in IS: 1734 (Part V)-1972†.

NOTE— In case, a definite result is not obtainable by the method described in IS: 1734 (Part V)-1972†, the result of knife test described in IS: 1734 (Part V)-1972† shall be considered as decisive.

7.1.2 *Water Resistance Test*— Six test pieces each approximately 25 × 10 cm shall be cut from any position in the board such that the grain of the face veneer is parallel to the length of the piece. These specimens shall be kept submerged in a pan of boiling water for a period of 72 hours. The period of 72 hours for boiling may be a continuous period or an aggregate of smaller periods of boiling if the test piece is left in cold water between these smaller periods. These test pieces shall then be removed from the boiling water and cooled down to room temperature by plunging them in cold water. These test specimens, while still in wet condition, shall be subjected to tests described under **7.1.2.1** and **7.1.2.2**.

*Methods of tests for plywood: Part IV Determination of glue shear strength (*first revision*).

†Methods of tests for plywood: Part V Test for adhesion of plies (*first revision*).

7.1.2.1 Glue shear strength — When tested for glue shear strength by the method described in IS : 1734 (Part IV)-1972* the average failing load shall be not less than 100 kg and no individual value shall be less than 80 kg.

7.1.2.2 Adhesion of plies — The adhesion of plies shall be tested by forcibly separating the layers. The veneers shall offer appreciable resistance to separation and the fractured samples shall show some adherent fibres distributed more or less uniformly. Adhesion may also be tested by knife test method described in IS : 1734 (Part V)-1972†.

NOTE — In case a definite result is not obtainable by the method described in IS : 1734 (Part IV)-1972*, the result of knife test described in IS : 1734 (Part V)-1972† shall be considered as decisive.

7.1.3 Moisture Content — The moisture content of test pieces cut one from each board, selected as under 7.1 when determined by the method described in IS : 1734 (Part I)-1972‡ shall be between 8 and 12 percent at any time of the year depending on the part of the country where the test is carried out (see IS : 287-1972§).

7.1.4 Bending Test — Plywood up to 5 mm in thickness shall withstand bending around a mandrel when tested in accordance with the method described in Appendix A without showing signs of fracture or separation of the plies.

7.1.5 Cross Sectional Shear Strength

7.1.5.1 Not less than two specimens shall be tested for shear strength from each board selected as under 9.1.

7.1.5.2 The shear strength shall be determined as described in Appendix B.

7.1.5.3 The average of all tests shall be not less than 125 kg/cm². No specimen shall give a test value less than 115 kg/cm².

8. MARKING

8.1 The following particulars shall be legibly stamped on one side of each board:

- a) Name of manufacturer or trade-mark,
- b) Number of this standard,

*Methods of test for plywood: Part IV Determination of glue shear strength (*first revision*).

†Methods of test for plywood: Part V Test for adhesive of plies (*first revision*).

‡Methods of test for plywood: Part I Determination of density and moisture content (*first revision*).

§Recommendations for maximum permissible moisture content of timber used for different purposes in different climatic zones (*second revision*).

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- c) Veneer species (*see* 3.1 for abbreviation),
- d) Date of manufacture,
- e) Thickness of board, and
- f) Batch No. and press-load number.

8.1.1 The board may also be marked with the ISI Certification Mark.

NOTE— The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

9. SAMPLING

9.1 Test Samples — For the purpose of tests, samples shall be drawn at random from each batch as indicated in Table 2.

TABLE 2 NUMBER OF BOARDS TO BE SAMPLED FROM EACH BATCH

SIZE OF BATCH (NO. OF BOARDS OF ANY SIZE)	NO. OF SAMPLES TO BE SELECTED
Less than 50	2
51 to 100	4
101 „ 200	5
201 „ 250	6
251 „ 500	7

9.1.1 The boards selected shall contain joints if any of the boards in the batch represented thereby contains joints.

10. TENDERED SAMPLES AND INSPECTION

10.1 Tendered Samples — The manufacturer shall submit six 3-ply boards of any size (*see* 5.1 for sizes) in each type of plywood in various thicknesses for type tests to the purchaser.

10.1.1 Before any manufacturer's type of plywood is approved for use in aircraft it shall have passed the type tests which shall be conducted at an approved laboratory or testing station.

10.2 Inspection — Veneers shall be inspected individually for conformity to the requirements given under 4.

10.2.1 All joints in veneers shall be inspected individually before assembly into boards.

10.2.2 The board shall be inspected for freedom from warp and conformity to requirements under 5 and 6, and shall be subjected to tests specified under 7.1.1 to 7.1.5.

APPENDIX A

(Clause 7.1.4)

DETERMINATION OF BENDING PROPERTIES

A-1. TEST SPECIMENS

A-1.1 Test specimen shall be cut from each selected board in such a manner that:

- a) the length of the test piece is parallel to the grain direction of the face plies; and
- b) a joint shall run along the axis of the test specimen, if there are such joints in the sheet.

A-1.2 The specimens shall be cut with the minimum slope of grain from the edges.

A-1.3 The test specimen shall be conditioned to a moisture content of 15 ± 1 percent.

A-1.4 The specimen shall be 25 mm wide and of sufficient length, so that when bent over a mandrel of the specified diameter a parallel sided 'U' is formed.

A-2. PROCEDURE

A-2.1 The ratio of the diameter of the mandrel to the thickness of the veneer shall be as specified in Table 3.

TABLE 3 BENDING TEST

PLYWOOD THICKNESS	MANDREL DIAMETER
mm	mm
1.0	100
1.5	150
2.0	200
2.5	250
3.0	300
3.5	350
4.0	400
4.5	450
5.0	500

A-2.2 The specimens shall be bent at the specified radius to a parallel sided 'U' shape without support on the tension side. The specimen shall be bent once and bent again in the reverse directions.

A-3. EXAMINATION

A-3.1 The test specimen shall then be examined visually for fractures and separation of the plies. Breakage shall consist of fractures extending 3 mm or more across the width of the specimen. Tears along the fibre direction that begin at the edge and extend into the specimen along the grain sloping from the edge shall not be considered breakage. It shall be determined whether a specimen breaks before removal from the mandrel. Breakage of more than 20 percent of all the specimens tested shall be considered as the cause for rejection of the whole lot.

A P P E N D I X B

(Clause 7.1.5.2)

DETERMINATION OF SHEAR STRENGTH

B-1. DETAILS

B-1.1 Test specimens shall be cut to a size 15 × 10 cm with the longer edges parallel to the grain direction of the face plies.

B-1.2 Loading blocks *A* and supporting blocks *B* made from any hardwood of moisture content 8 to 12 percent shall be glued to the plywood specimen as shown in Fig. 1. Cross strips *C*, also made of hardwood, shall be glued to supporting blocks *B* only. The dimensions of the blocks and their spacing shall be as shown in Fig. 1.

B-1.3 The assembly shall be placed on the compression table of a standard testing machine such that the supporting blocks rest square on the base and the load shall be applied axially on the loading blocks at a uniform rate of approximately 455 kg per minute. The shear strength is given by the formula:

$$f_s = \frac{P}{2 \times t \times w}$$

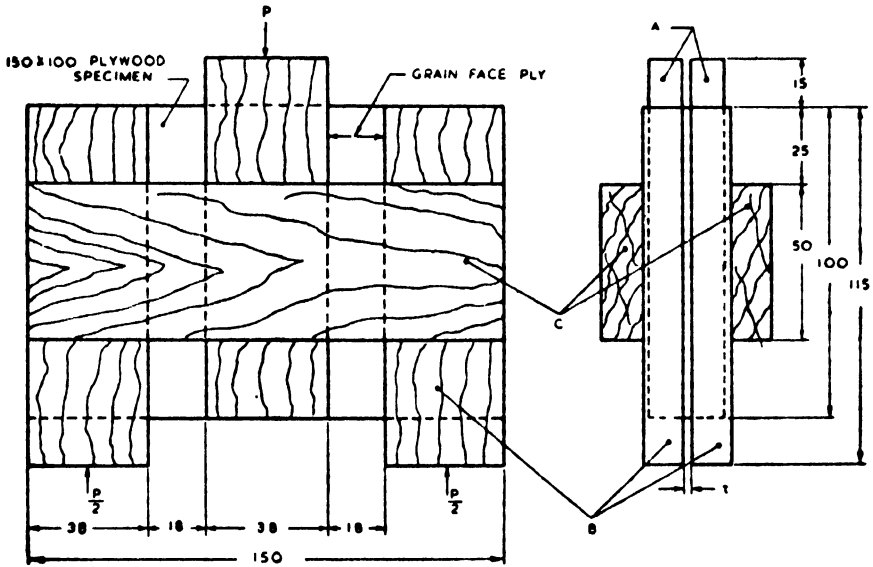
where

f_s = shear strength in kg/cm²,

P = ultimate load in kg,

t = thickness of plywood in cm, and

w = width of specimen in cm.



SIZES OF LOADING BLOCKS

<i>Designation</i>	<i>Length</i>	<i>Width</i>	<i>Thickness</i>
Block A	115	38	13
Block B	115	38	15
Block C	150	50	15

All dimensions in millimetres.

FIG. 1 PLYWOOD SHEAR TEST

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