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मानक

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“Step Out From the Old to the New”

IS 10701 (2012): Specification for Structural Plywood - Specification [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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भारतीय मानक
स्ट्रक्चरल प्लाईवुड — विशिष्टि
(पहला पुनरीक्षण)

Indian Standard

STRUCTURAL PLYWOOD — SPECIFICATION
(*First Revision*)

ICS 79.060.10

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wood and Other Lignocellulosic Products Sectional Committee had been approved by the Civil Engineering Division Council.

Structural plywood is a speciality plywood different from other grades and types of plywood as covered by other Indian Standards. In this plywood, apart from the use of higher grades of adhesives (BWP type), special emphasis is laid on the species of timber to be used, the veneer quality and most importantly on the construction details to be observed in the manufacture of the plywood. This standard covers the general properties of structural plywood, its constructional details for strength and dimensional stability and the testing procedures. The strength characteristics given in this standard represent the basic strength data. The basic design values to be used in structural applications have to be evolved separately from the basic strength values depending upon the type and nature of application.

The standard was first published in 1983. The revision of this standard has been undertaken to incorporate changes based on developments that have taken place and the experience gained in manufacture and use of the product over the years. The following major changes have been incorporated in this revision:

- a) Minimum thickness of face veneer has been specified;
- b) An alternate accelerated method of test for resistance to water has been introduced;
- c) A new test requirement on wet bending strength has been specified and test method have been included;
- d) Requirements for both average value and minimum individual value of modulus of elasticity and modulus of rupture has been specified; and
- e) Sampling requirements have been modified to be in accordance with the provisions in IS 7638 : 1999 'Wood/lignocellulosic based panel products — Methods of sampling (*second revision*)'.

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

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

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

STRUCTURAL PLYWOOD — SPECIFICATION

(*First Revision*)

1 SCOPE

This standard covers the requirements of plywood for structural purposes, used such as in stressed skin panels, plywood web beams, sheathing, silos, rail and ship containers.

2 REFERENCES

The standards listed in Annex A 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 in Annex A.

3 TERMINOLOGY

For the purpose of this standard, definitions given in IS 707 shall apply.

4 MATERIAL**4.1 Timber**

Any species of timber may be used for the manufacture of structural plywood. The species shall be so chosen keeping in view the strength and other characteristics and that the plywood manufactured is able to meet the requirements specified in this standard. A list of species of timber that are suitable for manufacture of structural plywood is given in Annex B for reference.

4.2 Adhesive

Adhesives used for bonding the veneers of structural plywood shall be of the hot press un-extended synthetic resin phenol formaldehyde type and shall conform to BWP type specified in IS 848.

5 PLYWOOD

Structural plywood shall conform to requirements of BWP grade in accordance with IS 848.

6 TREATMENT

Structural plywood panels shall be given preservative

treatment with fixed type of preservatives as specified in IS 5539.

7 MANUFACTURE

7.1 Veneers for the manufacture of structural plywood shall be rotary cut or sliced. Sliced veneers may however be used after splicing. The veneers shall be dried to a moisture content not exceeding 6 percent and shall be smooth to permit an even spread of glue. The glued veneers shall be assembled with the grain direction in alternate layers at right angles to each other and hot pressed under controlled conditions of temperature, pressure and pressing time. The two face veneers shall run in the same direction and the assembly shall be balanced around the central line of the plywood cross-section.

7.1.1 The thickness of all individual veneers shall be uniform within a tolerance of ± 5 percent. The veneer shall be straight grained within a tolerance of $\pm 10^\circ$.

7.1.2 The thickness of face veneers shall not be less than 1.2 mm.

7.1.3 Core gaps, overlaps and warp shall not be permitted.

7.1.4 The quality requirements on veneers used in the manufacture of structural plywood shall be as specified in Table 1.

7.2 Construction Details

7.2.1 Structural plywood shall be constructed symmetrically.

7.3 When panels of size larger than the available press size are required, they may be made by scarf jointing the finished panels.

7.3.1 All scarf joints shall be bonded with adhesive conforming to IS 848 having similar properties to that used for bonding the plywood. Scarf joints shall be made with an inclination not greater than 1 to 10.

7.4 After pressing, the finished plywood boards shall be reconditioned to a moisture content of not less than 5 percent and not more than 15 percent.

Table 1 Quality Requirements of Veneers Used in Manufacture of Plywood for Structural Purposes
(Clause 7.1.4)

Sl No.	Defect	Requirement	
		Face (3)	Core (4)
(1)	(2)		
i)	Blister	Nil	Nil
ii)	Checks	Nil	No restriction
iii)	Discolouration	3 percent of the area, if it does not impair the board properties	6 percent of the area, if it does not impair the board properties
iv)	Dote	Nil	5 cm/m ²
v)	Insect holes	Nil	No restriction
vi)	Knots (dead)	Nil	2 No. up to 12 mm dia/m ²
vii)	Pin knots (dead)	Nil	2 Nos./m ²
viii)	Pin knots (live)	Permitted, provided they do not mar the appearance	No restriction
ix)	Knots (tight)	3 No. up to 25 mm dia/m ²	6 No. up to 25 mm dia/m ²
x)	Split on each panel	One split not more than 0.8 mm wide and length 50 mm provided it is filled with suitable filler	2 splits not more than 6 mm wide and length 200 mm provided it is filled with suitable filler
xi)	Swirl	Up to 4 No./m ² provided they do not mar the appearance	No restriction

8 DIMENSIONS AND TOLERANCES

8.1 The dimensions of structural plywood panels shall be as given below:

2 400 mm × 1 200 mm	2 400 mm × 900 mm
2 100 mm × 1 200 mm	2 100 mm × 900 mm
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
900 mm × 900 mm	

8.2 Thickness

The thickness of the plywood panels shall be 3, 4, 5, 6, 9, 12, 16, 19 and 25 mm.

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

8.3 Tolerances

8.3.1 The tolerances on the nominal sizes of finished panels of the plywood shall be as given below:

Length	: $\begin{matrix} +6 \\ -0 \end{matrix}$ mm
Width	: $\begin{matrix} +3 \\ -0 \end{matrix}$ mm
Thickness:	
a) Less than 6 mm	: ±10 percent
b) 6 mm and above	: ±5 percent
Edge straightness	: 2 mm/1 000 mm or 0.2 percent
Squareness	: 2 mm/1 000 mm or 0.2 percent

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

9 WORKMANSHIP AND FINISH

9.1 Structural plywood panels shall be of uniform thickness within the tolerances specified in **8.3**.

9.2 The faces of the plywood panels shall be smooth. Slight sanding, if required, may be given to rough panels in order to make them smooth, otherwise structural plywood panels are normally unsanded.

10 SAMPLING

10.1 The method of drawing representative samples, sample size and criteria for conformity shall be as prescribed in IS 7638.

10.1.1 The panels selected as samples for tests shall contain joints in case the panels in the batch represented thereby contain joints.

11 TESTS

11.1 Specimens cut from each of the panels selected as specified in **10.1** shall be subjected to the tests specified in **11.2** to **11.9**.

11.2 Moisture Content

The moisture content of one test piece cut from each panel when determined as given in IS 1734 (Part 1) shall not be less than 5 percent and not more than 15 percent.

11.3 Glue Shear Strength in Dry State

The average failing load of a set of six test specimens prepared from each pair of glue lines and tested in accordance with the method given in IS 1734 (Part 4) shall not be less than the corresponding values specified in Table 2.

11.4 Resistance to Water

The specimens shall be subjected to any one of the tests specified in **11.4.1** and **11.4.2**.

Table 2 Minimum Average Failing Load and Percentage Wood Failure Requirements of Structural Plywood
(Clauses 11.3, 11.4.1, 11.4.2 and 11.5)

Sl No.	Average Wood Failure Percent (2)	Average Failing Load, N		
		Dry State (3)	Resistance to Water (4)	Resistance to Micro-organisms (5)
i)	No requirement	≥ 1 350	≥ 1 000	≥ 1 000
ii)	Not less than 60	1 250-1 349	900-999	900-999
iii)	Not less than 80	1 100-1 249	800-899	800-899
iv)	Sample to be considered as failed	< 1 100	< 800	< 800

11.4.1 The average failing load of a set of six test specimens prepared from each pair of glue lines and tested in accordance with the method given in IS 1734 (Part 6) shall not be less than the corresponding values specified in Table 2.

11.4.2 The average failing load of a set of six specimens from each pair of glue lines prepared as given in IS 1734 (Part 4), when subjected to constant steam pressure inside a vacuum steam pressure test apparatus as described in Annex D shall not be less than the corresponding values specified in Table 2.

11.5 Resistance to Micro-organisms

The average failing load of a set of six test specimens prepared from each pair of glue lines and tested in accordance with the method given in IS 1734 (Part 7) shall not be less than the values specified in Table 2.

11.6 Tensile Strength

The average strength of a set of three test specimens prepared and tested in accordance with the method given in IS 1734 (Part 9) shall not be less than the values given in Table 3.

11.7 In addition, the tests specified in **11.7.1** shall also be carried out for testing the structural properties of plywood.

11.7.1 Tests for compressive strength, bending strength (modulus of elasticity and modulus of rupture), panel shear strength, plate shear strength (modulus of rigidity) and rolling shear strength shall be carried out on three test specimens prepared and tested in accordance with IS 1734 (Parts 10, 11, 13 and 14) and Annex E respectively; and the average strength for each of the tests shall not be less than the values given in Table 3 for the respective properties. For bending strength (modulus of elasticity and modulus of rupture), the minimum individual values shall also be not less than that given in Table 3.

Table 3 Minimum Strength Requirements of Structural Plywood
(Clauses 11.6 and 11.7.1)

Sl No.	Property	Strength Requirement N/mm ² (3)
i)	<i>Tensile strength:</i>	
	a) Along the grain	55
	b) Across the grain	35
ii)	<i>Compressive strength:</i>	
	a) Along the grain	35
	b) Across the grain	30
iii)	<i>Modulus of rupture:</i>	
	a) Along the grain	
	1) Average	50
	2) Minimum individual	45
	b) Across the grain	
	1) Average	30
	2) Minimum individual	27
iv)	<i>Modulus of elasticity:</i>	
	a) Along the grain	
	1) Average	7 500
	2) Minimum individual	6 700
	b) Across the grain	
	1) Average	4 000
	2) Minimum individual	3 600
v)	Panel shear strength	12.5
vi)	Modulus of rigidity	588
vii)	Rolling shear strength	3

11.8 Wet Bending Strength

Three test specimen taken in accordance with IS 1734 (Part 11) from each direction of a sample of the plywood, shall be subjected to cyclic test for 3 cycles, each cycle consisting of 4 h boiling in water and 16 h drying in an oven at $65 \pm 2^\circ\text{C}$ or shall be subjected to 72 h of boiling in water. The samples shall be then kept in water at $27 \pm 2^\circ\text{C}$ for 1 h and thereafter tested as per IS 1734 (Part 11). The duration of boiling/drying in oven may be split into shorter intervals by keeping the samples in room temperature at $27 \pm 2^\circ\text{C}$ in water (in case of boiling) or in air (in case of drying). The sample shall have an average and minimum individual modulus of elasticity and modulus of rupture not less than the values specified in Table 4.

Table 4 Minimum Average and Minimum Individual Values of Modulus of Elasticity (MOE) and Modulus of Rupture (MOR) for Wet Bending Strength
(Clause 11.8)

Sl No. (1)	Property (2)	Along the Face Grain (3)	Across the Face Grain (4)
i)	Modulus of elasticity, N/mm^2 :		
	a) Average	3 750	2 000
	b) Minimum individual	3 400	1 800
ii)	Modulus of rupture, N/mm^2 :		
	a) Average	25	15
	b) Minimum individual	22	13

11.9 Retention of Preservative

The retention of the preservative in the structural plywood panel when determined in accordance with the method given in IS 2753 (Part 1) and IS 2753 (Part 2) shall not be less than 12 kg/m^3 for water soluble fixed type. In the case of any other fixed type preservative, the loading shall be sufficient to impart the desired toxicity at the location where structural plywood is used.

12 MARKING

12.1 Each plywood panel shall be legibly and indelibly marked or stamped with the manufacturer's name, his initials or his recognized trade-mark, and the batch number and year of manufacture. The type of plywood shall also be marked.

12.2 All markings shall be done on the face of the panel near one corner.

12.3 BIS Certification Marking

Each plywood panel may also be marked with the Standard Mark.

12.3.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

13 DELIVERY

Unless otherwise specified, the plywood panels shall be delivered in a clean condition and shall be suitably packed according to normal trade practices.

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	Title	IS No.	Title
707 : 1976	Glossary of terms applicable to timber technology and utilization (<i>second revision</i>)	(Part 13) : 1983	Determination of panel shear strength (<i>second revision</i>)
848 : 2006	Specification for synthetic resin adhesives for plywood (phenolic and aminoplastic) (<i>second revision</i>)	(Part 14) : 1983	Determination of plate shear strength (<i>second revision</i>)
1734	Methods of test for plywood:	2753	Methods for estimation of preservatives in treated timber and in treating solutions:
(Part 1) : 1983	Determination of density and moisture content (<i>second revision</i>)	(Part 1) : 1991	Determination of copper, arsenic, chromium, zinc, boron, creosote and fuel oil (<i>first revision</i>)
(Part 4) : 1983	Determination of glue shear strength (<i>second revision</i>)	(Part 2) : 1991	Determination of copper (in copper organic preservative salt) and pentachlorophenol (<i>first revision</i>)
(Part 6) : 1983	Determination of water resistance (<i>second revision</i>)	3629 : 1986	Specification for structural timber in building (<i>first revision</i>)
(Part 7) : 1983	Mycological test (<i>second revision</i>)	5539 : 1969	Specification for preservative treated plywood
(Part 9) : 1983	Determination of tensile strength (<i>second revision</i>)	7638 : 1999	Wood/lignocellulosic based panel products — Methods of sampling (<i>second revision</i>)
(Part 10) : 1983	Determination of compressive strength (<i>second revision</i>)		
(Part 11) : 1983	Determination of static bending strength (<i>second revision</i>)		

ANNEX B
(Clause 4.1)

SPECIES OF TIMBER FOR THE MANUFACTURE OF STRUCTURAL PLYWOOD

B-1 The species have been divided into two groups, that is ordinary and standard as given in IS 3629.

<i>Group — Ordinary</i>			<i>Group — Standard</i>		
<i>Botanical Name</i>	<i>Standard Trade Name</i>	<i>Abbreviated Symbols</i>	<i>Botanical Name</i>	<i>Standard Trade Name</i>	<i>Abbreviated Symbols</i>
<i>Anthocephalus cadamba</i>	Kadam	KAD	<i>Vateria indica</i>	Vellapine	VEL
<i>Artocarpus chaplasha</i>	Chaplash	CHP	<i>Acrocarpus fraxinifolius</i>	Mundani	MUN
<i>Bischofia javanica</i>	Uriam	URI	<i>Albizia lebbek</i>	Kokko	KOK
<i>Boswellia serrata</i>	Salai	SAA	<i>Amoora</i> spp.	Amari	AMA
<i>Calophyllum</i> spp.	Poon	POO	<i>Xylocarpus molluccensis</i>	Pussur	PUS
<i>Cedrela toona</i> spp.	Toon	TOO	<i>Carallia brachiata</i>	Carallia	CAR
<i>Chukrasia tabularis</i>	Chickrassy	CHI	<i>Chloroxylon swietenia</i>	Satinwood	SAT
<i>Holoptelea integrifolia</i>	Kanju	KAN	<i>Cinnamomum</i> spp.	Cinnamon	CIN
<i>Lannea grandis</i>	Jhingan	JHI	<i>Dipterocarpus macrocarpus</i>	Hollong	HON
<i>Machilus</i> spp.	Machilus	MAC	<i>Dipterocarpus indicus</i>	Gurjan	GUR
<i>Mangifera</i> spp.	Mango	MAN	<i>Dysoxylum malabaricum</i>	White cedar	WCE
<i>Michalia</i> spp.	Champ	CHM	<i>Kingiodendron pinnatum</i>	Piney	PIN
<i>Shorea assamica</i>	Makai	MAK	<i>Paiaquium ellipticum</i>	Pali	PAL
<i>Terminalia myriocarpa</i>	Hollock	HOL	<i>Terminalia bellerica</i>	Bahera	BAH
			<i>Terminalia paniculata</i>	Kindal	KIN
			<i>Terminalia tomentosa</i>	Laurel	LAU

ANNEX C
(Clause 8.3.1)

METHOD OF TEST FOR EDGE STRAIGHTNESS AND SQUARENESS

C-1 PROCEDURE FOR EDGE STRAIGHTNESS

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 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

The squareness of plywood shall be checked with a square with arms 500 mm long, by applying one arm of the square to the plywood. The maximum width of the gap shall be recorded.

ANNEX D
(Clause 11.4.2)

ALTERNATE METHOD FOR WATER RESISTANCE TEST

D-1 Pure water shall be filled in boiler of the vacuum steam pressure test (VPT) apparatus as shown in Fig. 1 to the marking of minimum water level on glass water level indicator and the boiler shall be switched on with the valve connecting the boiler and main chamber in closed condition. The test specimens shall be placed in the working (main) chamber and shall be closed air tight with cover. The vacuum pump shall then be switched on and vacuum inlet valve shall be kept in open condition. The steam release valve shall be kept in closed condition. After the required vacuum of 110 ± 10 kPa has been created inside the main chamber, the vacuum pump shall be switched off, the vacuum

inlet valve closed and boiler valve connected to main chamber opened. The time shall be noted the moment the steam pressure in the main chamber reaches 220^{+10}_{-0} kPa and same pressure shall be maintained for 6 h. The system and boiler then shall be switched off. The steam release valve and vacuum release valve shall slowly be opened until the steam in the chamber is completely evacuated. The samples shall then be kept in water for 1 h at $27 \pm 2^\circ\text{C}$. The samples shall thereafter be tested for glue shear strength according to the method laid down in IS 1734 (Part 4) and meet the requirement specified in **11.4.2**.

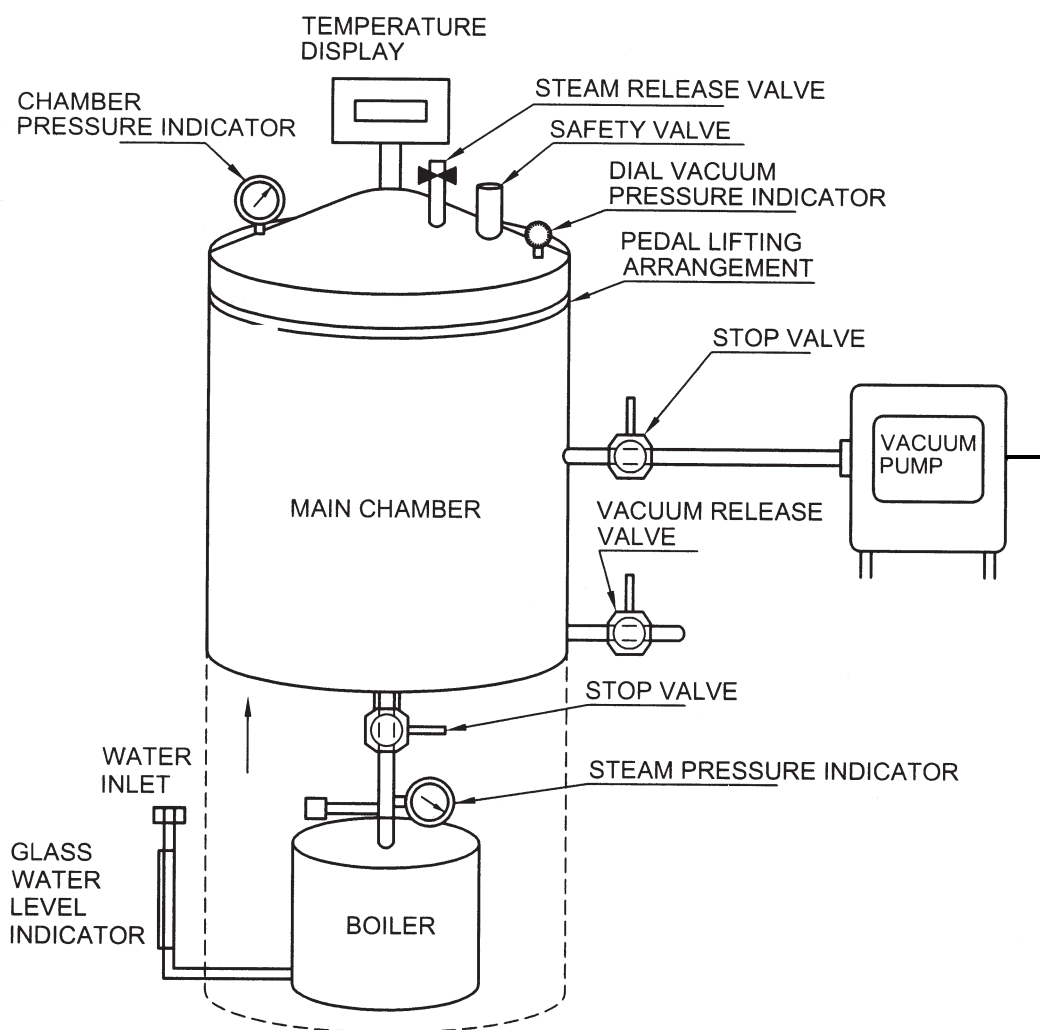


FIG. 1 VACUUM STEAM PRESSURE TEST (VPT) APPARATUS

ANNEX E

(Clause 11.7.1)

METHOD TO DETERMINE THE ROLLING SHEAR STRENGTH OF PLYWOOD FOR STRUCTURAL PURPOSES

E-1 INTRODUCTION

E-1.1 There are two types of shear failures, namely, normal shear and the rolling shear. The rolling shear is the term applied to a failure in wood veneers glued together, which fail in tensile shear in such a manner that in the failed specimen the veneer appears to have rolled over itself. Rolling shear failure occurs in such a way that a square element in a plane perpendicular to the grain direction of the stressed veneer distorts itself into a rhombus from under the applied shear stress. Rolling shear stress is of critical importance for application of structural plywood in box beams, I- beams, stiffened panels, etc.

E-1.2 The test suggested below for the determination of the rolling shear strength is only for comparative purposes because the apparent failing stress of a joint between plywood and wood or plywood and plywood will ultimately depend upon the exact geometry of the joint.

E-2 TEST SPECIMEN

The test is carried out on the double lap tension specimen as shown in Fig. 2. The specimen comprises of two 25 mm wide central strips of plywood to which two 25 mm wide cover plates having the face grain perpendicular to their length are glued. The cover plates are positioned so that there is a 25 mm double lap joint at one end and a 50 mm double lap joint at the other, the gap between the ends of the central strips is 6 mm.

The centre strips both have the face grain parallel to their lengths. The plywood strips are conditioned to a constant mass at a humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$ before assembly and the assembled specimens are again conditioned to a moisture content of 10 percent before testing.

NOTE — Constant mass is considered to be reached when the results of two successive weighing operations (at an interval of 2 h) carried out after 24 h do not differ by more than 0.1 percent of the mass of the test specimen.

E-3 TEST PROCEDURE

The specimen is positioned in the testing machine and held with wedge action grips. The load is applied with a movable head of the testing machine moving at 0.05 cm/min and the load at failure is recorded.

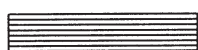
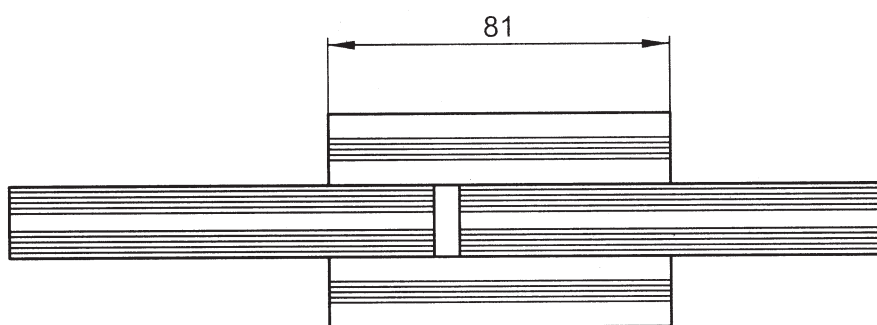
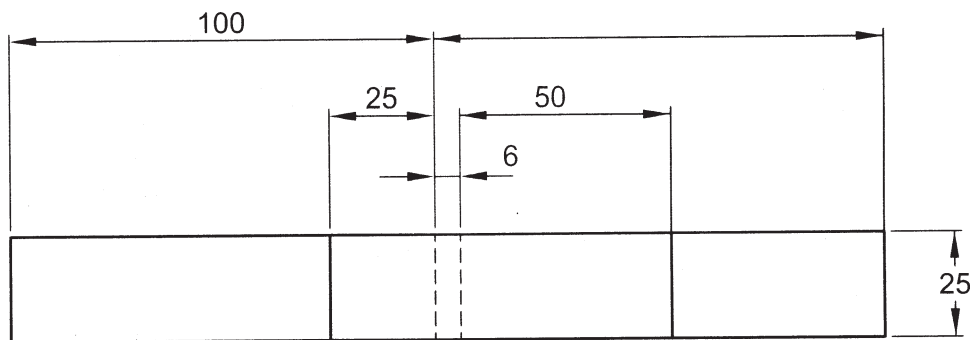
E-4 CALCULATION

Failing load of the specimen which fail in a manner other than in rolling shear in the shorter lap shall be discarded for the purpose of averaging. The rolling shear stress S at failure is given by:

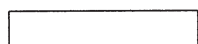
$$S = \frac{P}{2.A} \text{ kg/cm}^2$$

where

- P = load at failure, in kg; and
 A = smaller area of overlap (6.25 cm^2).



Grain Parallel to Length



Grain Perpendicular to Length

All dimensions in millimetres.

FIG. 2 ROLLING SHEAR TEST SPECIMEN

ANNEX F (Foreword)

COMMITTEE COMPOSITION

Wood and Other Lignocellulosic Products Sectional Committee, CED 20

<i>Organization</i>	<i>Representative(s)</i>
Indian Plywood Industries Research & Training Institute, Bangalore	DR C. N. PANDEY (Chairman)
Bamboo Society of India, Bangalore	SHRI N. S. ADKOLI SHRI A. S. SADASHIVAIAH (<i>Alternate</i>)
Building Materials & Technology Promotion Council, New Delhi	SHRI J. K. PRASAD SHRI A. K. TIWARI (<i>Alternate</i>)
Central Building Research Institute, Roorkee	DR S. P. AGARWAL DR B. S. RAWAT (<i>Alternate</i>)
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Century Plyboard India Ltd, Kolkata	SHRI AJAY BALDAWA SHRI NIKHILESH ROY CHOWDHURY (<i>Alternate</i>)
Coir Board, Bangalore	SHRI M. SUDHAKARAN PILLAI SHRI R. VASUDEV (<i>Alternate</i>)
Directorate General of Supplies & Disposals, Hyderabad	SHRI M. GANGARAJU
Directorate of Standardization, New Delhi	DR (SHRIMATI) INDU GUPTA SHRI G. K. SHARMA (<i>Alternate</i>)
Engineer-in-Chief's Branch, New Delhi	SHRI N. B. SHELAR SHRI SANJAY MITTAL (<i>Alternate</i>)
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Kutty Flush Door & Furniture Co Pvt Limited, Chennai	COL. G. KRISHNAN SHRI K. SHANKARKRISHNAN (<i>Alternate</i>)
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