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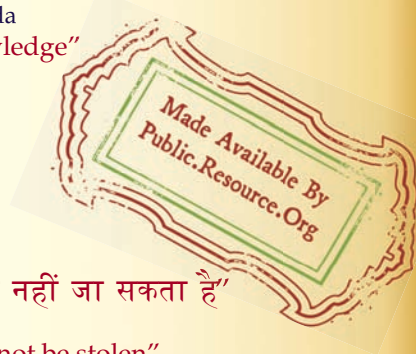
IS 1734-1 to 20 (1983): Methods of test for plywood [CED
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IS : 1734 (Parts 1 to 20) - 1983
(Reaffirmed 2003)

Indian Standard
METHODS OF TEST FOR PLYWOOD
(Second Revision)

UDC 674-419.32

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

Price Group 13

Indian Standard

METHODS OF TEST FOR PLYWOOD

(Second Revision)

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IS : 1734 Methods of test for plywood

- Part 1 Determination of density and moisture content (*second revision*)
- Part 2 Determination of resistance to dry heat (*second revision*)
- Part 3 Determination of fire resistance (*second revision*)
- Part 4 Determination of glue shear strength (*second revision*)
- Part 5 Test for adhesion of plies (*second revision*)
- Part 6 Determination of water resistance (*second revision*)
- Part 7 Mycological test (*second revision*)
- Part 8 Determination of pH value (*second revision*)
- Part 9 Determination of tensile strength (*second revision*)
- Part 10 Determination of compressive strength (*second revision*)
- Part 11 Determination of static bending strength (*second revision*)
- Part 12 Determination of scarf joint strength (*second revision*)
- Part 13 Determination of panel shear strength (*second revision*)
- Part 14 Determination of plate shear strength (*second revision*)
- Part 15 Central loading of plate test (*second revision*)
- Part 16 Vibration of plywood plate test (*second revision*)
- Part 17 Long time loading test of plywood strips (*second revision*)
- Part 18 Impact resistance test (*second revision*)
- Part 19 Determination of nails and screw holding power (*second revision*)
- Part 20 Acidity and alkalinity resistance test (*second revision*)

Indian Standard

METHODS OF TEST FOR PLYWOOD

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Parts 1 to 20) (Second Revision) was adopted by the Indian Standards Institution on 28 November 1983, after the draft finalized by the Wood Products Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Methods of test for evaluating physical and mechanical properties of plywood, from the viewpoint of its use as an engineering material, were first published in 1960. These were revised in 1972, when, for the sake of convenience and as well as for keeping them up-to-date, these were published as separate parts of the standard. Besides, a few more methods were included. As a result of the experience gained by their usage, over a decade, it was considered necessary to update them. As such, the second revision has been prepared, wherein, while reviewing these tests in general, major changes have been effected in tests for density and moisture content, glue shear strength, compressive strength, and long time loading test.

0.3 This edition incorporates Amendments issued to various parts, details of which are indicated in each part as well as in the last cover page. Side bar indicates modification of the text as the result of incorporation of these amendments.

0.4 In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

*Rules for rounding off numerical values (revised).

Indian Standard

METHODS OF TEST FOR PLYWOOD

**PART I DETERMINATION OF DENSITY AND
MOISTURE CONTENT**

(Second Revision)

UDC 674-419.32 : 531.754 + 543.812

1. SCOPE

1.1 This standard (Part 1) covers the method of test for the determination of density and moisture content of plywood by oven dry method.

2. OBJECT

2.1 The object of this test is to determine the density of plywood which is an indicator of the properties of timber species. The determination of moisture content is necessary since it has a bearing on several important mechanical properties of plywood.

3. TEST SPECIMEN

3.1 Each test specimen shall be of the full thickness of the material and 75 mm wide and 150 mm long. Smaller specimens may be used when deemed necessary. The dimensions of the test specimens shall be measured to an accuracy of not less than ± 0.3 percent.

4. APPARATUS

4.1 Oven — An oven that can be maintained at a temperature of $103 \pm 2^\circ\text{C}$ through the drying chamber for the time required to dry the specimen to constant mass. It may require forced air circulation to maintain uniform temperature. Oven shall be vented to allow the evaporated moisture to escape.

4.2 Balance — A balance to weigh a specimen within ± 0.2 percent. The accuracy and sensitivity of the weighing balance shall be checked frequently.

5. PROCEDURE

5.1 The test specimen shall be weighed. The specimen shall then be dried in an oven at a temperature of $103 \pm 2^\circ\text{C}$ until approximately constant mass is obtained. The specimen shall be weighed to an accuracy of not less than ± 0.2 percent.

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6. CALCULATION

6.1 The density shall be calculated as follows:

$$\text{Density, in g/cm}^3 = \frac{M_o}{L w t}$$

where

- M_o = oven dry mass of specimen in g,
- L = length of the specimen in cm,
- w = width of the specimen in cm, and
- t = thickness of the specimen in cm.

6.2 Moisture Content — The moisture content shall be calculated as follows:

$$\text{Moisture content, percent} = \frac{M_1 - M_o}{M_o} \times 100$$

where

- M_1 = initial mass of specimen, and
- M_o = oven-dry mass of specimen.

7. PRECAUTIONS

7.1 Care shall be taken to prevent any change in moisture content between the cutting of the sample and first weighing and also between the removal from the oven and subsequent weighings. The specimen may be wrapped in an aluminium foil or polyethylene film to prevent moisture changes after cutting between consecutive weighings.

NOTE 1 — The moisture content and density, as determined by this method, are the average values for the entire specimen. In plywood made up of thin veneers, that is, less than 0.8 mm in thickness, the glue may constitute a significant part of the total mass and as a result the calculated density and moisture content may vary substantially from the true values for the veneers. In some instances, it may be desirable to take this into account.

NOTE 2 — The density so obtained is based on the volume at test and mass when oven-dry. If desired, the density may be obtained on an oven-dry mass and volume basis. In each instance, the basis of the density value with respect to volume and moisture conditions shall be stated.

8. REPORT

8.1 The density and moisture content of the specimen shall be reported.

Indian Standard

METHODS OF TEST FOR PLYWOOD

**PART 2 DETERMINATION OF RESISTANCE TO
DRY HEAT**

(Second Revision)

UDC 674-419.32 : 620.193.5

1. SCOPE

1.1 This standard (Part 2) covers the method of test for the determination of resistance of plywood to dry heat.

2. OBJECT

2.1 This test is intended to evaluate the resistance of plywood to delamination in storage under dry heat conditions.

3. TEST SPECIMEN

3.1 Each test specimen shall be of the full thickness of the material and approximately 225×100 mm.

4. PROCEDURE

4.1 The test specimens shall be dried in an oven maintained at a temperature of $103 \pm 2^\circ\text{C}$ for a period of 3 hours for boards up to 8 mm in thickness. Boards over 8 mm in thickness shall be dried for additional half-an hour for every additional 1.5 mm thickness. The test specimens shall then be allowed to cool to room temperature and then examined for signs of delamination at the edges of the veneers or formation of blisters. The test specimens shall also be tested by forcibly separating the veneers.

5. INTERPRETATION OF TEST RESULTS

5.1 The test specimens shall be considered to have failed if they show positive signs of delamination, that is, delamination not less than 6.5 mm in depth and not less than 50 mm in length or fail entirely in the glue line on forcible separation of the veneers. The test specimens shall also be considered to have failed if blisters appear on the surface.

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METHODS OF TEST FOR PLYWOOD

PART 3 DETERMINATION OF FIRE RESISTANCE

(Second Revision)

(Incorporating Amendment Nos. 1 & 2)

UDC 674-419.32 : 620.193.5

1. SCOPE

1.1 This standard (Part 3) covers the method of test for the determination of fire resistance of plywood.

2. OBJECT

2.1 The following three fire resistance tests are intended to evaluate the efficacy of the fire-proofing treatments accorded to plywood:

- a) Flammability test,
- b) Flame penetration test, and
- c) Rate of burning test.

3. FLAMMABILITY TEST

3.1 Test Specimen — Each test specimen shall be of the full thickness of the material and approximately 125×125 mm. The specimen shall be preconditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$.

3.2 Procedure — The test specimens are held vertical 15 mm apart, one specimen being held 40 mm higher than the other (see Fig. 1). An ordinary bunsen burner having 3 mm bore is fixed horizontally so that the flame plays against the lower end of the inner face of the lower specimen. The axis of the burner is centrally disposed 22 mm above the lower edge of the lower specimen, the end of the burner being 12 mm away from the face of this specimen. Coal gas or LPG is fed to the burner resulting in a blue flame which when unobstructed is 50 mm long. The flame ignites the face of the lower specimen which in turn ignites the opposite face of the higher specimen. The time taken for the

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higher specimen to be ignited after the ignition of the lower specimen is recorded. This ignition is usually very distinct and capable of being timed to a few seconds.

NOTE — The specimen is deemed to be ignited if the burning is uninterrupted for not less than 50 seconds.

4. FLAME PENETRATION TEST

4.1 Test Specimen — Dimensions and details of the test specimen shall be the same as for the flammability test (*see 3.1*).

4.2 Procedure — The test specimen is held horizontally 50 mm above the nozzle of a blow-pipe flame (*see Fig.2*). The test specimen is rotated in a horizontal plane at 75 rev/min in such a way that the centre of the flame describes a circle of 25 mm diameter. The time taken for the flame to penetrate the thickness of the plywood is recorded.

5. RATE OF BURNING TEST

5.1 Test Specimen — Each test specimen shall be of the full thickness of the material and approximately 100×12.5 mm. The specimen shall be preconditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$.

5.2 Procedure — The test specimen is suspended in a fire tube and adjusted at a height of 30 mm from the flame of the burner (*see Fig. 3*). The test specimen is ignited by a blue flame and time taken for each 10 percent loss in mass is recorded. The time taken from 30 to 70 percent loss in mass is taken for the purpose of comparison.

6. INTERPRETATION OF TEST RESULTS

6.1 The test panel shall be rated on the basis of combined test result of all the three tests keeping in view the end use of the plywood.

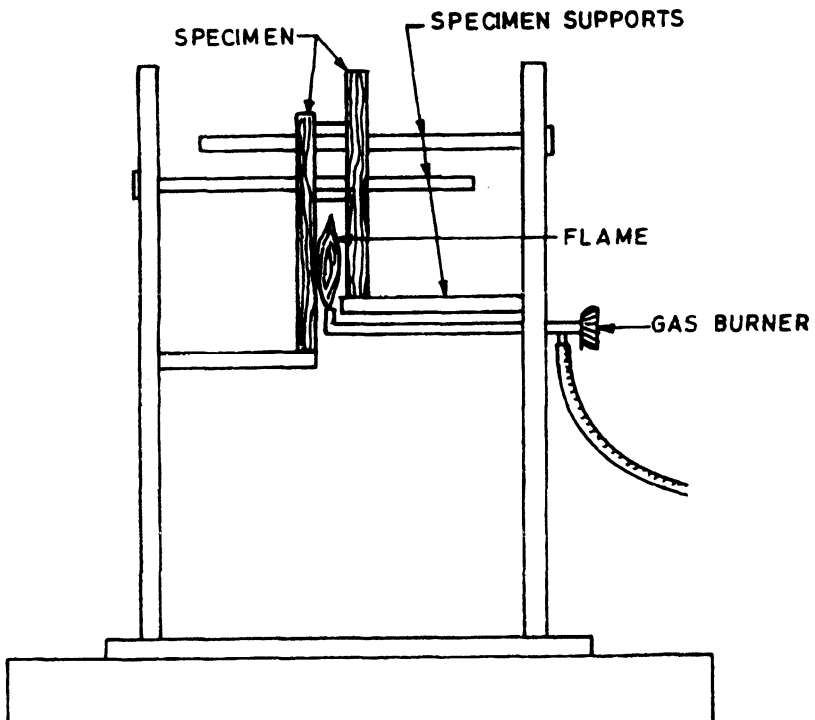


FIG. 1 SCHEMATIC DIAGRAM FOR FLAMMABILITY TEST

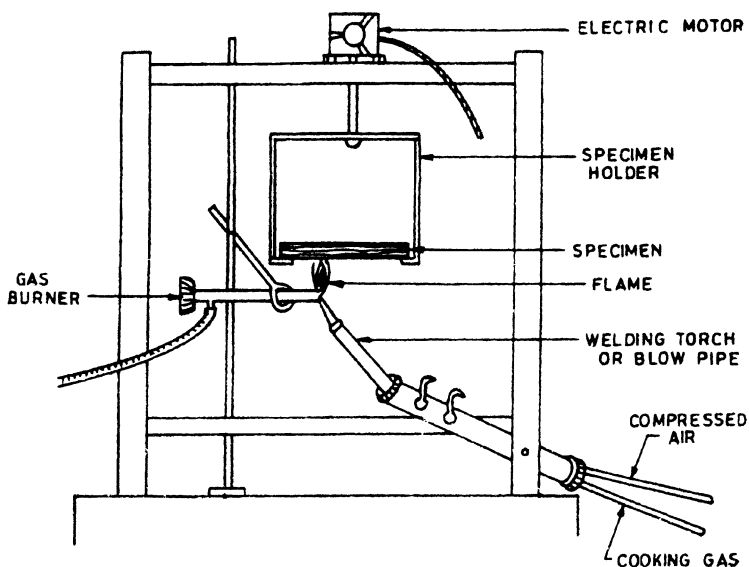


FIG. 2 SCHEMATIC DIAGRAM FOR FLAME PENETRATION TEST

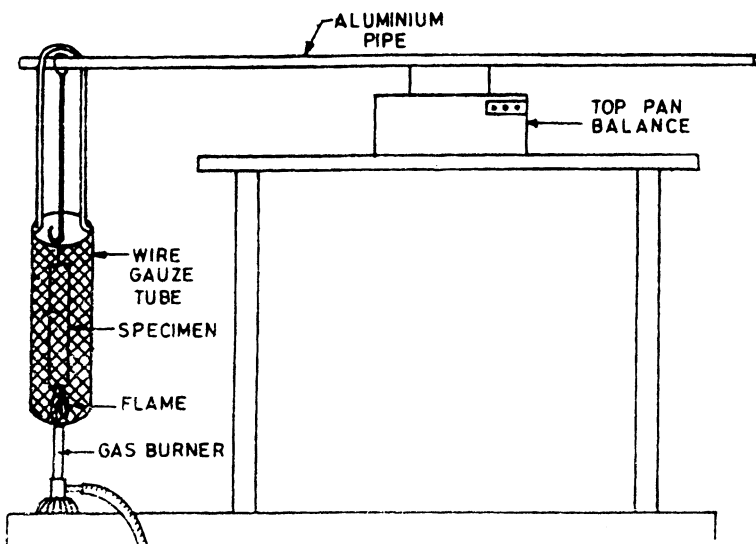


FIG. 3 SCHEMATIC DIAGRAM FOR RATE OF BURNING TEST

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 4 DETERMINATION OF GLUE SHEAR STRENGTH

(Second Revision)

(Incorporating Amendment Nos. 1, 2 & 3)

UDC 674-419.32 : 668.3 : 620.176.2

1. SCOPE

1.1 This standard (Part 4) covers the method of test for the determination of glue shear strength of plywood.

2. OBJECT

2.1 This test is intended to estimate the tenacity with which the bonding material holds the veneers together.

3. TEST SPECIMEN

3.1 At least six specimens for each pair of glue lines shall be cut from the panel from different locations.

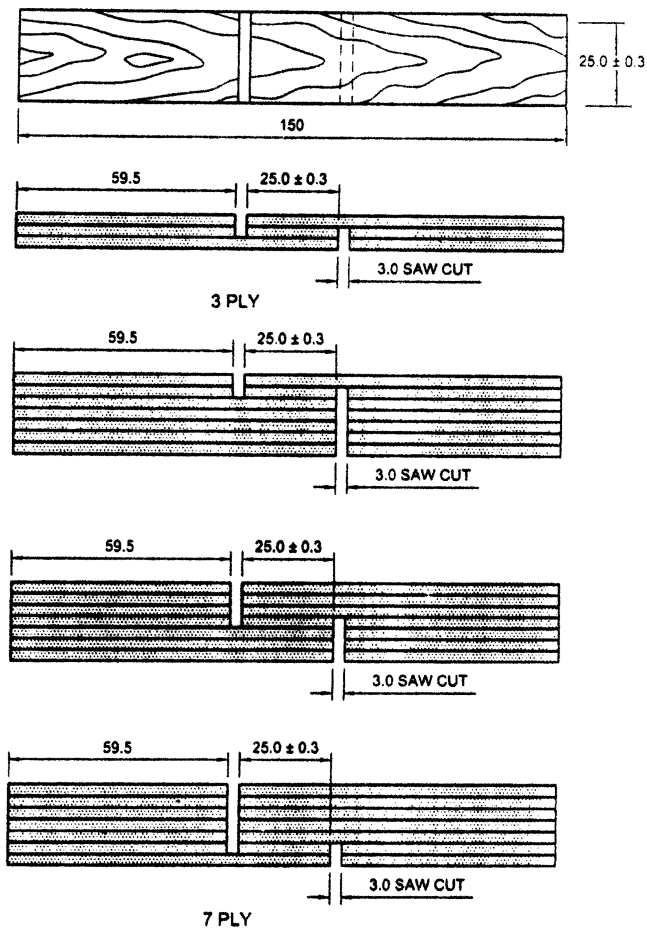
3.2 The test pieces from 3-ply plywood shall be prepared by making saw cuts (*see* Fig. 1). When the number of plies exceeds three, specimens shall be prepared to test all pairs of glue lines. Each test specimen shall be cut so that the grain direction of the ply between the glue lines under test is perpendicular to the length of the test specimen. Method of preparation of specimens for 7-ply plywood is shown in Fig. 1. The test specimens shall be prepared and saw cuts made to allow the examination of each and every pair of glue lines in the panel.

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All dimensions in millimetres.

FIG. 1 TEST SPECIMEN FOR GLUE ADHESION TEST

4. PROCEDURE

4.1 Each test specimen shall be gripped symmetrically at two ends in the jaws of a suitable testing machine, and shall be pulled apart. The distance between the notches on the test specimen and the end of the gripping jaws of the testing machine shall be between 10 mm and 20 mm. The pull should be, as far as possible, in the centre line of the central veneer. The grain of the centre ply shall be perpendicular to the direction of application of load. Measure the width of each specimen and distance between the notches to nearest 0.025 cm to determine the shear area.

4.2 During the test, the load shall be applied to the test specimens as uniformly as possible, and so adjusted as to increase at a rate lying in the range of $1\,300 \pm 500$ N/min.

4.3 The maximum load at the time of complete failure of each specimen shall be recorded. Record shall also be made as to failure whether in wood or in glue by visual examination of the area under shear. In case of wood failure the percentage wood failure shall also be recorded.

NOTE — In case of dispute, measurement of wood failure shall be done with the help of a graphical mesh of area 25×25 mm printed on a transparent material placed on the sheared surface, the wood failure may be objectively and quantitatively estimated.

4.4 *Clause deleted*

5. REPORT

5.1 Failing load and percentage of wood failure of the tested specimens for each pair of glue lines determined in accordance with **4** shall be straight averaged and compare with values given in appropriate Indian Standard specification for plywood.

5.1.1 All the details shall be recorded under the following sub-heads:

- a) Name of the manufacturer/source from whom the plywood is procured,
- b) Type and grade of plywood,
- c) Construction of plywood in terms of the ratio of thickness of individual plies,
- d) Species of individual plies,
- e) Adhesive used,

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- f) End use of plywood,
- g) Specimen No./Reference,
- h) Area of cross section of bonding surface under shear,
- j) Average load for each and every pair of glue lines, and
- k) Average percentage of wood failure for each and every pair of glue lines.

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 5 TEST FOR ADHESION OF PLIES

(Second Revision)

UDC 674-419.32 : 620.179.4

1. SCOPE

1.1 This standard (Part 5) covers test for adhesion of plies.

2. OBJECT

2.1 This test is intended to estimate the tenacity with which the bonding material holds the adjacent plies together.

3. TEST SPECIMEN

3.1 The test specimen shall be of the full thickness of the material and at least 250×250 mm. The specimen shall be preconditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$.

4. APPARATUS

4.1 The type of knife required to be used in the test is given in Fig. 1. It may be made from a file. The cutting edge should be kept chiselsharp.

4.2 The test shall be carried out on a stout table to which is screwed a wooden batten against which the edge of the test piece is placed as indicated in Fig. 2.

5. PROCEDURE

5.1 The knife is inserted with its cutting edge parallel to the grain of the outer veneer and worked into, or if possible, along a glue line and the veneer is prised upward. A hard and dense species of plywood requires considerable force to effect entry and to prise the veneer. In a soft timber, the knife tends to follow an easy course through the wood in this case it is essential that the knife be firmly guided along the glue line.

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5.2 Examples of cases when the bond just passes the requirements are indicated in Fig. 3 and this is judged by the relative amounts of wood fibre left on the core veneer, and the area prised off. The grading is assessed chiefly on the appearance of the break, but it is a concomitant requirement that force shall be needed to effect separation.

5.3 The bond is excellent, when it is difficult to find the glue line and impossible to keep the tool within it for more than 3 to 6 mm without cutting into adjacent wood. On prising upwards, the veneer usually breaks off over a width only slightly greater than that of the tool. Examples of excellent bond are illustrated in Fig. 4.

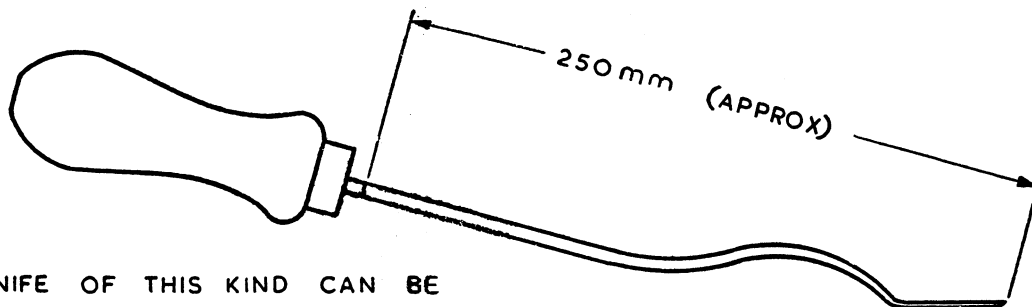
5.4 The bond is poor, when the knife meets little opposition in the glue line and the prise results in the easy removal of almost all the veneers from one side of the test piece. The separated veneers are usually almost free from adherent fibre. Examples of poor bond are illustrated in Fig. 5.

NOTE — Interpretation of knife test results requires experience which can be obtained with practice and a little help.

6. REPORTING OF TEST RESULTS

6.1 The results shall be reported as 'minimum pass', 'excellent', 'poor' (*see* Fig. 3, 4 and 5). All the details shall be recorded under the following sub-heads:

- a) Name of the manufacturer/source from whom the plywood is procured,
- b) Type and grade of plywood,
- c) Construction of plywood in terms of the ratio of thickness of individual plies,
- d) Species of individual plies,
- e) Adhesive used,
- f) End use of plywood,
- g) Specimen No./reference, and
- h) Result — minimum pass/excellent/poor.



A KNIFE OF THIS KIND CAN BE
MADE FROM 250 X 25mm FILE

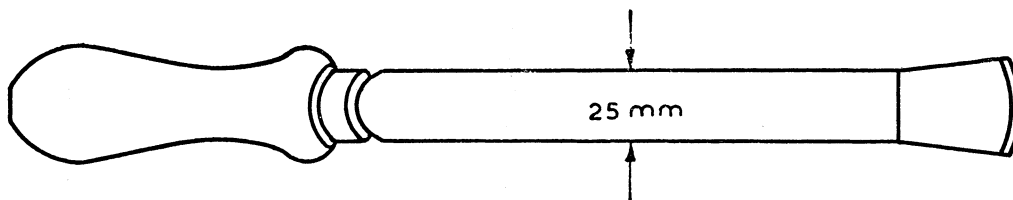


FIG. 1 KNIFE FOR TESTING PLYWOOD FOR ADHESION OF PLIES

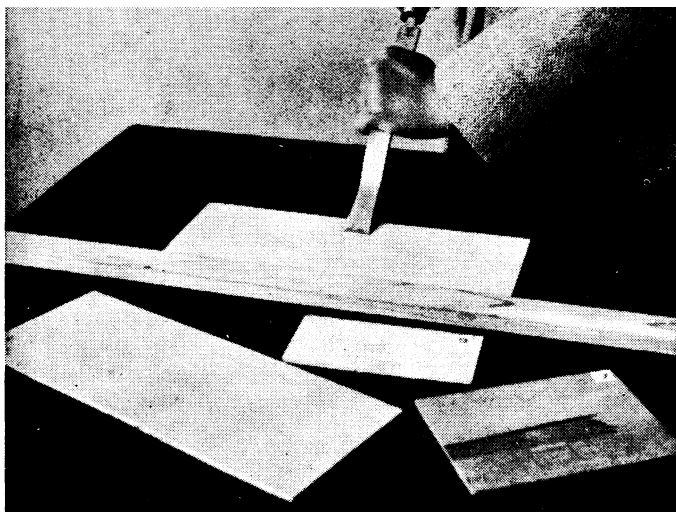


FIG. 2 METHOD OF TESTING FOR ADHESION



FIG. 3 EXAMPLE OF 'MINIMUM PASS' STANDARD

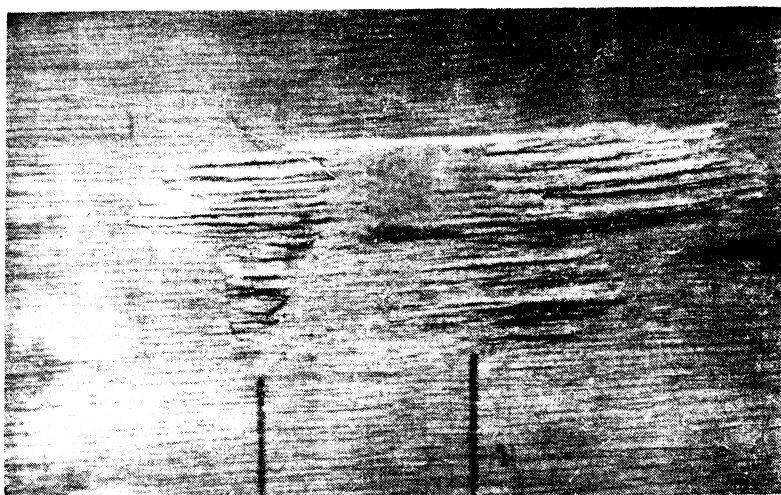


FIG. 4 EXAMPLES OF 'EXCELLENT' ADHESION

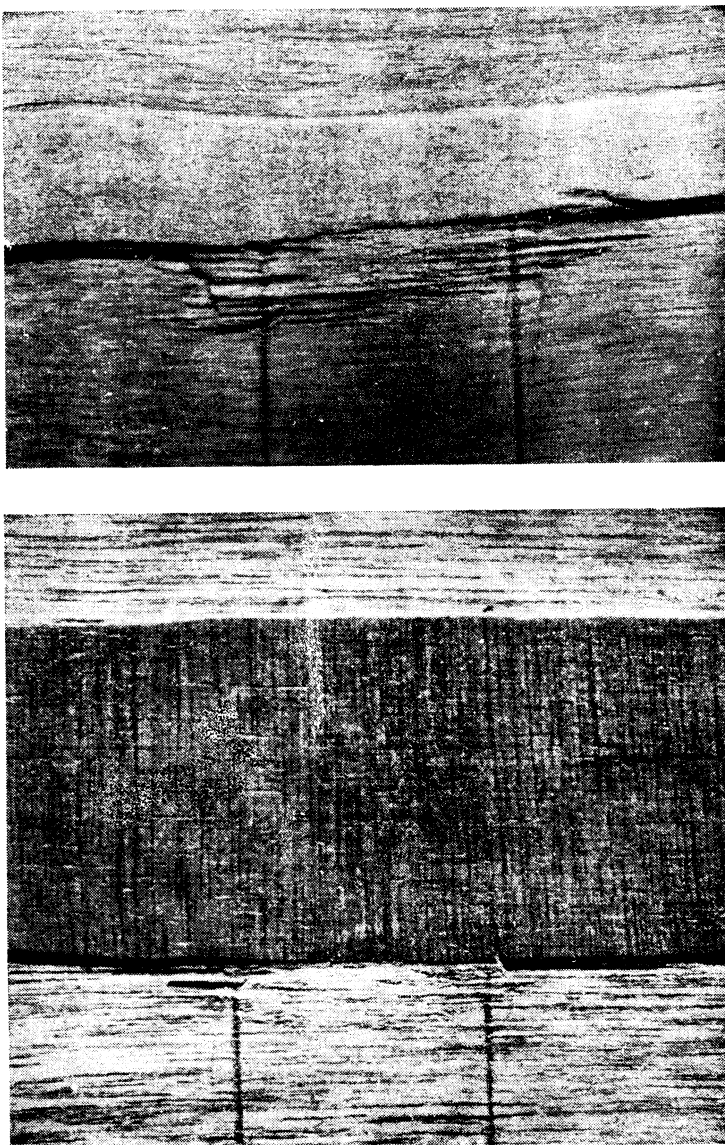


FIG. 5 EXAMPLES OF 'POOR' ADHESION

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 6 DETERMINATION OF WATER RESISTANCE

(Second Revision)

(Incorporating Amendment Nos. 1 & 2)

UDC 674-419.32 : 620.193.19

1. SCOPE

1.1 This standard (Part 6) covers the methods of test for the determination of water resistance of plywood.

2. OBJECT

2.1 This test is primarily intended to determine the acceptability or otherwise of plywood panel where it is subjected to alternate drying and wetting or high humidity.

3. SPECIMEN

3.1 Specimen for Glue Shear Strength

Dimensions and details of the test specimen shall be same as given in 3 of IS : 1734 (Part 4)-1983

3.2 Specimen for Adhesion of Plies

From each board at least 4 test specimens each approximately 250 mm × 250 mm shall be cut from different positions in the board such that the grain of the face veneer is parallel to the length of the piece.

4. PROCEDURE

4.1 *Clause deleted.*

4.2 For the boiling water immersion tests, these specimens shall be kept submerged in a pan of boiling water for a period as specified for the particular grade of the plywood, for example, 72 hours for BWP

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and 8 hours for BWR. However, for moisture resistance test (applicable to MR grade of plywood), the specimen shall be kept immersed in warm water at $60 \pm 2^{\circ}\text{C}$ for a period of 3 hours. These test pieces shall then be removed from the water and cooled down to room temperature by plunging them in cold water. These wet pieces while still in wet condition shall be tested for 'glue shear strength' and/or 'adhesion of plies' according to methods laid down in IS : 1734 (Part 4)-1983* and IS : 1734 (Part 5)-1983† respectively.

5. REPORT

5.1 All the details shall be recorded and reported as required in IS : 1734 (Part 4)-1983* and/or IS : 1734 (Part 5)-1983†.

5.2 Visual examination shall also be made before carrying out 'glue shear strength' and/or 'adhesion of plies' for any delamination, blister formation, etc.

5.3 The plywood when tested as above shall comply with the standard specified for its end use.

*Methods of test for plywood: Part 4 Determination of glue shear strength (*second revision*).

†Methods of test for plywood: Part 5 Test for adhesion of plies (*second revision*).

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 7 MYCOLOGICAL TEST

(Second Revision)

(Incorporating Amendment No. 1)

UDC 674-419.32 : 620.193.81

1. SCOPE

1.1 This standard (Part 7) covers the mycological test for plywood.

2. OBJECT

2.1 This test is intended to evaluate the resistance of glue line (adhesive) to attack by micro-organisms. It is not a test of the durability of the species from which the plywood is manufactured.

3. TEST SPECIMEN

3.1 Dimensions and details of the test specimen shall be the same as required under 3 of IS : 1734 (Part 4)-1983*.

4. PROCEDURE

4.1 A flat rectangular dish of enamelled iron, glass or porcelain (such as a photographic developing dish), of a minimum depth of 50 mm, shall be filled to a depth of about 25 mm with a layer of sawdust obtained from the sapwood of a perishable timber, like semul (*Bombax ceiba*) in its natural condition. The sawdust shall have previously been moistened with water containing 15 g of sucrose (normally sugar may be used; but if unavailable, 30 g of commercial malt extract may be substituted) to a litre of water so that it is saturated with moisture,

*Methods of test for plywood: Part 4 Determination of glue shear strength (*second revision*).

IS : 1734 (Part 7) - 1983

but not so wet that free water is squeezed out of it by hand pressure. To attain this condition with dry sawdust, it is usually necessary to add three times its mass of water.

4.2 The saw dust shall then be charged with the spores of the commonly occurring mould fungi like *Aspergillus niger* (Black mould), *Aspergillus* sp. (Yellow mould), *Pencillium* sp. (Green or blue mould) and loosely compacted. The test specimens shall be pressed down into it so that their upper surfaces are in level with the top of the sawdust layer.

4.3 The dish shall then be covered with a sheet of glass and the edges of the dish sealed against the glass with modelling clay or a similar suitable material so that the atmosphere round the test specimens shall remain saturated with water vapour.

4.4 The dish and the contents shall be maintained at a temperature of $27 \pm 2^{\circ}\text{C}$ for a period of three weeks, after which the test pieces shall be removed, washed in water at room temperature, and whilst still water-soaked, shall be tested at room temperature for glue shear strength as laid down in IS : 1734 (Part 4)-1983* for compliance to the minimum requirement laid down in the relevant Indian Standard specification for plywood.

5. REPORT

5.1 All the details shall be recorded and reported as required in IS : 1734 (Part 4)-1983*.

*Methods of test for plywood: Part 4 Determination of glue shear strength (*second revision*).

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 8 DETERMINATION OF *pH* VALUE

(*Second Revision*)

UDC 674-419.32 : 543-257.1

1. SCOPE

1.1 This standard (Part 8) covers the method of test for the determination of *pH* value.

2. OBJECT

2.1 This test is intended to evaluate the resistance of plywood to deterioration upon normal ageing as the flexural, impact and shear strength values of plywood may be affected by the *pH* value of the glue used in the panels.

3. PREPARATION OF SPECIMEN AND TEST PROCEDURE

3.1 A sufficient portion of the wood adjacent to the glue line of the plywood panel is ground in a mill to pass 425- μ m IS Sieve. One gram of the powder, accurately weighed, shall be placed in a clean vial or a small heat resistant flask and 5 ml of freshly boiled, cooled distilled water shall be added and thoroughly stirred. The glass container shall be kept stoppered throughout the test except when *pH* determinations are being made. The mixture shall be allowed to stand for 72 hours at $27 \pm 2^\circ\text{C}$ after which time the mixture shall be stirred and the *pH* value determined by a suitable *pH* meter. The determination of *pH* value shall be repeated at intervals of 24 hours until difference between the consecutive readings is not more than 0.05 *pH* units; the last reading taken shall be regarded as the equilibrium *pH* value for the specimen.

NOTE — Alternatively *pH* be measured by *MpH* value as wood exerts buffering action. This may be done by adding the wood powder to various solutions containing free hydrogen ions and measuring the *pH*; where there is no *pH* change it is the correct value of the wood. One gram of wood adjacent to the glue line is ground to fine sawdust and suspended in 5 ml of hydrochloric acid of *pH* 4. The same is done to the veneers where the *pH* of the plywood is lower than that of the veneers.

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4 REPORT

4.1 The *pH* value determined shall be reported. All the details shall be recorded under the following sub-heads:

- a) Name of the manufacturer/source from whom the plywood is procured,
- b) Type and grade of plywood,
- c) Construction of plywood in terms of the ratio of thickness of individual plies,
- d) Species of individual plies,
- e) Adhesive used,
- f) End use of plywood,
- g) Specimen No./reference, and
- h) *pH* value.

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 9 DETERMINATION OF TENSILE STRENGTH

(Second Revision)

UDC 674-419.32 : 620.172

1. SCOPE

1.1 This standard (Part 9) covers the method of test for the determination of tensile strength.

2. OBJECT

2.1 This test is intended to evaluate the ultimate tensile strength of plywood.

3. TEST SPECIMEN

3.1 For the tensile strength test, specimens of Types *A*, *B*, *C*, *D* or *E* as illustrated in Fig. 1 are particularly recommended, but specimens of any other types that give equally satisfactory results may be used. The grain direction of the face plies shall be parallel or perpendicular to the length of the test specimen. The specimen shall be preconditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$.

3.2 When the evaluation of elastic properties as well as ultimate tensile strength is required, the size and shape of the test specimen shall be selected from Types *A*, *B* and *C*. The basis for selection shall be the grain angle and the thickness of the material. If the grain of the individual plies makes an angle of other than 0° or 90° , with the length of the specimen, Type *C* shall be used regardless of the thickness of the material. For grain angles individual ply of 0° or 90° , Type *A* shall be used for material over 6 mm in thickness and Type *B* for material 6 mm or less in thickness. The specimen shall have a thickness equal to that of the material and the thickness and the width of each specimen at the critical section shall also be measured to an accuracy of not less than ± 0.3 percent.

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3.3 When the evaluation of the ultimate tensile strength only is required specimens of Types *D* and *E* may be used. Type *D* is designed for specimens greater than 6 mm in thickness, and Type *E* for specimens 6 mm or less in thickness. Measurements of each specimen shall be made to an accuracy of not less than ± 0.3 percent.

3.4 The test specimens shall be properly shaped, using a template in conjunction with a vertical-spindle woodworking shaper or any other method that will give equally satisfactory results.

4. PROCEDURE

4.1 The load shall be applied continuously throughout the test at a rate of traverse of the movable head of 1 mm/min. The specimen shall be held in wedge-type self-tightening and self-aligning grips.

4.2 Data for load-deformation curves may be taken to determine the modulus of elasticity and the tensile stress at proportional limit. Increments of load shall be chosen so that not less than 12 and preferably 15 or more readings of load and deformation are taken to the proportional limit. The deformation measuring apparatus shall be attached at the central portion of the length of the specimen at the central portion of constant cross section. Deformation readings shall be taken to the nearest 0.002 mm.

5. REPORT

5.1 Maximum tensile stress, the modulus of elasticity and the tensile stress at proportional limit, if required, shall be reported. The moisture content of the specimen and its temperature at the time of test shall be recorded.

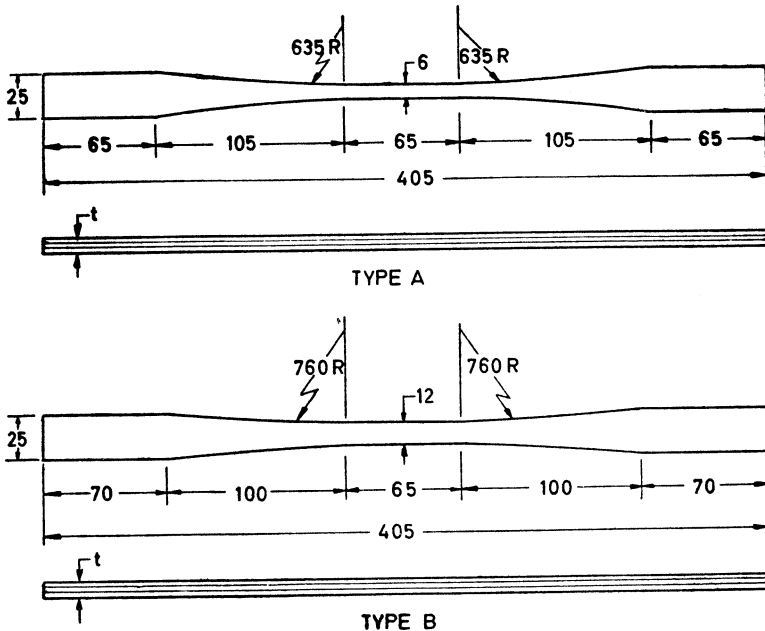
5.1.1 The details shall be recorded under the following sub-heads:

- a) Name of the manufacturer/source from whom the plywood is procured;
- b) Type and grade of plywood;
- c) Construction of plywood in terms of the ratio of thickness of individual plies;
- d) Species of individual plies;
- e) Adhesive used;
- f) End use of plywood;
- g) Specimen No./reference and name of test;
- h) Area of cross section;

- j) Gauge length;
- k) Rate of loading;
- m) Maximum load;
- n) Moisture content, percent; and
- p) Room temperature.

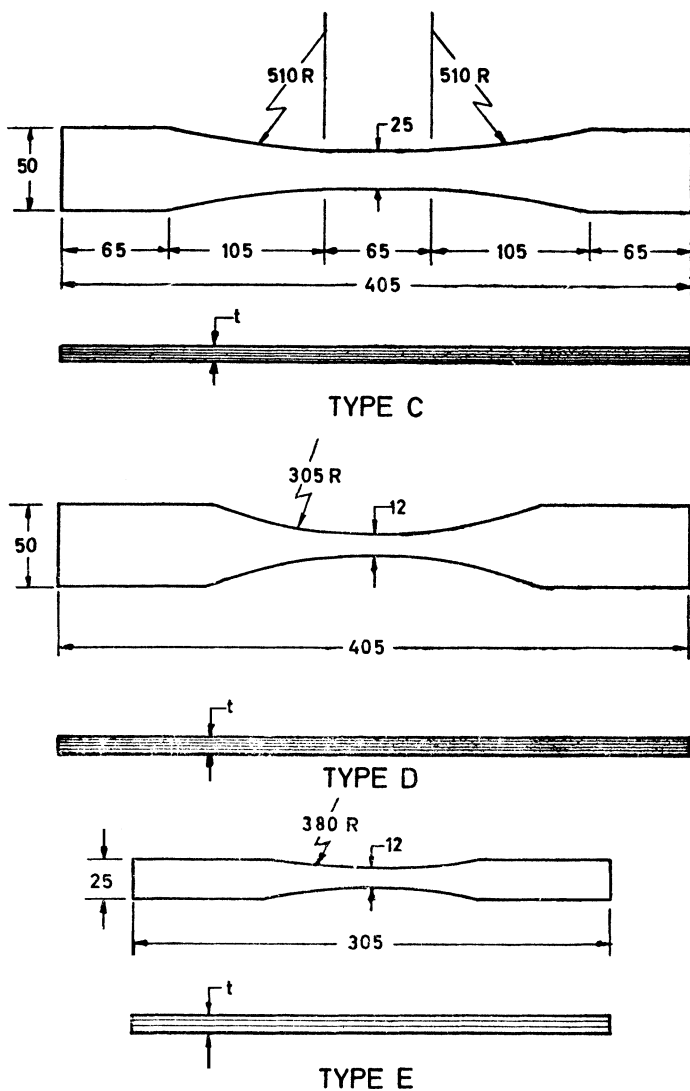
5.1.2 In addition, the following properties may also be recorded:

- a) Load at proportional limit;
- b) Deformation (elongation) at proportional limit;
- c) Maximum tensile stress;
- d) Modulus of elasticity;
- e) Tensile stress at proportional limit; and
- f) Density at the above moisture content (if determined otherwise).



All dimensions in millimetres.

FIG. 1 DETAILS OF PLYWOOD TENSILE TEST SPECIMENS — *Contd*



All dimensions in millimetres.

FIG. 1 DETAILS OF PLYWOOD TENSILE TEST SPECIMENS

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 10 DETERMINATION OF COMPRESSIVE STRENGTH

(Second Revision)

UDC 674-419.32 : 620.173

1. SCOPE

1.1 This standard (Part 10) covers the method of test for the determination of compressive strength.

2. OBJECT

2.1 This test is intended to evaluate the compressive strength at elastic limit as well as maximum compressive strength of plywood.

3. TEST SPECIMEN

3.1 The test specimen shall be rectangular. The thickness, width and length of each specimen shall be measured to an accuracy of not less than ± 0.3 percent. The grain direction of the face plies may be parallel or perpendicular to the length of the test specimen. The specimen shall be conditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$.

3.2 When tests to evaluate both elastic and maximum compressive strength properties are required (see **4.1.1**), the size of the specimen shall be as follows:

- a) For material over 6 mm in thickness, the specimen shall have a thickness equal to the material and the width shall be a minimum of 25 mm but not less than the thickness. The length shall be not greater than seven times the least cross-sectional dimension.
- b) For material 6 mm or less in thickness, the specimen shall have a thickness equal to that of the material and shall be 25 mm wide. The length shall be 10 cm. Such specimen shall be supported laterally throughout the test.

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3.3 When tests to evaluate maximum compressive strength alone are required (see **4.1.2**) plywood specimens of 10 cm length shall be glued together such that the total thickness is equal to the width and lies between 20 mm and 40 mm.

3.4 Care shall be taken in preparing the test specimen to make the end surfaces smooth and parallel to each other and at right angles to the length.

4. TYPES OF TEST

4.1 The two types of compressive strength tests are as follows:

- a) Method A, providing lateral support of the specimen when needed. This shall be used when tests to evaluate both elastic and maximum compressive strength properties are required; and
- b) Method B may be used when tests to evaluate maximum compressive strength only are required.

4.1.1 *Method A — for Evaluation of Both Maximum Compressive Strength and Elastic Properties*

4.1.1.1 Test specimens 6 mm or less in thickness intended for use in obtaining load deformation data shall be supported laterally to prevent buckling during the test, but undue pressure shall not be exerted against the sides of the specimen. This support shall not measurably restrain the normal compressive deformation under load.

4.1.1.2 *Procedure* — The load shall be applied through a spherical bearing block preferably of the suspended, self-aligning type. The load shall be applied with a continuous motion of the movable head to maximum load at a rate of 0.003 cm/cm length of the specimen per minute within a permissible variation of ± 25 percent. Data for load-deformation curves may be taken to determine the modulus of elasticity and the proportional limit. Increments of load shall be chosen so that not less than 12, but preferably 15 or more, readings of load and deformation are taken to the proportional limit. The deformation shall be read to the nearest 0.002 mm. Compressometers shall be attached over the central portion of the length of the specimen and the points of attachment shall be not less than 18 mm from the specimen ends.

4.1.2 *Method B — for Evaluation of Maximum Compressive Strength Only* — Specimens shall be held together by suitable supports, and the load shall be applied through a spherical bearing block of self-aligning type with a continuous rate of cross-head movement of 0.5 mm per minute till a failure is indicated. Maximum crushing stress shall be calculated and reported with reference to the grain of the face veneer.

5. REPORT

5.1 Maximum crushing stress, modulus of elasticity and crushing stress at elastic limit, if required, shall be reported with reference to the grain of the face veneer. Moisture content and temperature at the time of test shall also be reported.

5.1.1 The details shall be recorded under the following sub-heads:

- a) Name of the manufacturer/source from whom the plywood is procured;
- b) Type and grade of plywood;
- c) Construction of plywood in terms of the ratio of thickness of individual plies;
- d) Species of individual plies;
- e) Adhesive used;
- f) End use of plywood;
- g) Specimen No./reference;
- h) Area of cross section;
- j) Gauge length;
- k) Rate of loading;
- m) Maximum load;
- n) Moisture content, percent; and
- p) Room temperature.

5.1.2 In addition, the following properties may also be recorded:

- a) Load at proportional limit;
- b) Deformation (elongation) at proportional limit;
- c) Maximum compressive stress;
- d) Modulus of elasticity;
- e) Compressive stress at proportional limit; and
- f) Density at the above moisture content, if determined otherwise.

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 11 DETERMINATION OF STATIC BENDING
STRENGTH

(Second Revision)

UDC 674-419.32 : 620.174

1. SCOPE

1.1 This standard (Part 11) covers the method of test for the determination of static bending strength of plywood as determined by central loading method and two-point load method.

2. CENTRAL LOADING METHOD

2.1 Object— This test is intended to determine the strength (modulus of rupture), stiffness (modulus of elasticity $\times$ moment of inertia) and other properties related to flexural stress and is applicable to material that is uniform with respect to elastic and strength properties. Total deflection and modulus of elasticity computed from it, include a relatively constant component attributable to shear deformation. It is well suited to investigations of many variables that influence properties uniformly throughout the panel in controlled studies and to test small, defect-free specimens cut from large panels.

2.2 Test Specimen— The test specimen for plywood shall be rectangular. The depth of the specimen shall be equal to the thickness of material and the width shall be 2.5 cm for depths less than 6 mm and 5 cm for greater depths. When the grain direction of the face plies is parallel to the span, the length of the specimen shall be 48 times the depth plus 5 cm; when the grain direction of the face is perpendicular to the span, the length of the specimen shall be 24 times the depth plus 5 cm. The specimen shall be preconditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$. The width and depth of each specimen shall be measured to an accuracy of not less than ± 0.3 percent.

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2.3 Procedure

2.3.1 Span — The span shall be 48 times the nominal depth when the grain direction of the face plies of the test specimen is parallel to the span and 24 times the nominal depth when the grain direction of the face plies is perpendicular to the span.

2.3.2 The load shall be applied through an appropriate loading block for centre loading with a continuous motion of the movable head throughout the test till a failure is indicated. The rate of application of load shall be such that the unit rate of fibre strain is equal to 0.001 5 cm/cm of outer fibre length per minute within a permissible variation of ± 25 percent. The rate of motion of moving head may be calculated as follows:

$$N = \frac{zL^2}{6d}$$

where

N = rate of motion of moving head in cm/min,

z = unit rate of fibre strain in cm/cm of outer fibre length per minute = 0.001 5,

L = span in cm, and

d = depth of beam in cm.

2.4 Report — Data for load deflection curves may be taken to determine the various characteristics using the formulae given below. Deflection readings shall be recorded to the nearest 0.02 mm. Increments of load shall be so chosen that not less than 12 and preferably 15 or more readings of load and deflection are taken to the proportional limit. The moisture content of the specimen and the temperature at the time of test shall be recorded:

- a) Fibre stress at proportional limit, $\text{N/mm}^2 = \frac{3PL}{2bh^2}$
- b) Modulus of rupture, $\text{N/mm}^2 = \frac{3P'L}{2bh^2}$
- c) Modulus of elasticity, $\text{N/mm}^2 = \frac{PL^3}{4bh^3\Delta}$
- d) Work to proportional limit, $\text{N mm/mm}^3 = \frac{CA}{Lbh} = \frac{P\Delta}{2Lbh}$

$$\begin{aligned}
 \text{e) Work to maximum load, N mm/mm}^3 &= \frac{CA'}{L bh} \\
 \text{f) Total work, N mm/mm}^3 &= \frac{CA''}{L bh} \\
 \text{g) Stiffness (EI) N mm}^2 &= \frac{L^3 P}{48 \Delta}
 \end{aligned}$$

where

P = load in N at proportional limit;

L = span in mm;

b = width of the specimen in mm;

h = thickness of the specimen in mm;

P' = maximum load in N;

Δ = deflection at proportional limit in mm;

C = area constant, that is, the energy represented by one square mm which is equal to load in N represented by one mm ordinate multiplied by deflection in mm represented by one mm abscissa;

A = area in mm^2 of load deflection curve to proportional limit;

A' = area in mm^2 up to maximum load; and

A'' = area in mm^2 up to final reading.

2.4.1 All the details shall be recorded under the sub-heads indicated below:

- a) Name of the manufacturer/source from whom the plywood is procured;
- b) Type and Grade of plywood;
- c) Construction of plywood in terms of the ratio of thickness of individual plies;
- d) Species of individual plies;
- e) Adhesive used;
- f) End use of plywood;
- g) Specimen No./reference and name of test;
- h) Length, width, thickness and mass;
- j) Span;
- k) Rate of loading;
- m) Load at proportional limit;
- n) Maximum load;

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- p) Deformation at proportional limit;
- q) Flexural stress at proportional limit;
- r) Modulus of rupture;
- s) Modulus of elasticity;
- t) Work to proportional limit;
- u) Work to maximum load;
- v) Total work;
- w) Moisture content, percent; and
- y) Density at the moisture content given in (w), if determined otherwise.

3. TWO-POINT LOADING

3.1 Object — This method, like method described in 2, is suited to the investigations of factors that influence strength and elastic properties uniformly throughout the panel in controlled studies and testing small clear and defect-free control specimens cut from large panels. This may be used to determine the effects of finger joints, veneer joints and gaps and other features which can be placed entirely between the load points and whose effects can be projected readily to full panel width. Deflection and modulus of elasticity obtained from this method are related to flexural stress only and do not contain a shear component. Significant errors in modulus of rupture can occur where nominal moment is used.

3.2 Test Specimen — The test specimen shall be rectangular in cross-section. The length shall exceed by 5 cm the span (see 3.2.2) on which it is to be tested. The depth of the specimen shall be equal to the thickness of the plywood, and the width shall be 25 mm for thickness less than 6 mm and 50 mm for thickness 6 mm and above. The specimen shall be conditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$. This specimen thickness shall be measured at mid-span at two points near each edge and the average recorded. Measurement shall be taken to the nearest 0.02 mm or 0.3 percent. Width shall be measured at mid-span to the nearest 0.3 percent.

3.2.1 When needed for interpretation of test results thickness of each ply shall be measured nearest to 0.02 mm at mid-span at each edge and the average shall be recorded.

3.2.2 Span — Span-depth ratio has relatively little influence on the results of tests using two-point loading and the method measuring deformation described for it in this standard. However, it is important that the distance between load point and adjacent support be sufficient to prevent rolling shear failures.

3.2.2.1 Specimen tested for stiffness only shall have a span at least 48 times the nominal thickness if face grain is parallel to span and 24 times the nominal thickness if face grain is perpendicular to span.

3.2.2.2 It is recommended that two-point loading tests to failure be made on a span at least equal to the spacing between load points plus 48 times the specimen thickness or 24 times the specimen thickness for face grain parallel or perpendicular respectively. Material having high rolling shear strength or having all its grain parallel to span may use closer spacing between loads and supports.

3.3 Procedure — The ends of a small flexure specimen shall be supported on special reaction bearings which, in turn, rest on the table of a conventional testing machine. Two equal loads shall be applied to the specimen equidistant from the supports by cylindrical surfaces having a radius of curvature of at least one-and-a-half times the specimen thickness wherever it may contact the specimen. The axes of these surfaces shall remain parallel and at least one of them shall be free to turn about its axis or be loaded through rollers to prevent the application of friction forces to the surfaces of the specimen. Construction of a satisfactory loading head is shown in Fig. 1. The pivot point which equalizes the two loads shall be located near the original neutral axis of the specimen, thus subjecting the middle half of the specimen to conditions of nearly pure movement.

Load point shall be spaced sufficiently to provide a deflection which can be adequately measured. A spacing of at least 24 and 12 times specimen thickness is recommended for specimen with face grain parallel and perpendicular to span respectively. The sum of two loads shall be measured to an accuracy of at least 1 percent of indicated value or 0.4 percent of full scale whichever is larger.

3.4 Speed of Test — Load shall be applied at a continuous rate of motion of the load points with respect to the supports within a permissible range of 25 percent of the rate determined by the following formula:

$$N = \frac{Za}{3d} (3L - 4a)$$

where

N = rate of motion in cm/min,

Z = unit rate of fibre strain in (cm/cm)/min,

a = distance from support to adjacent load in cm,

d = depth of beam in cm, and

L = span in cm.

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3.5 Measurement and Deflection — Deflection on mid-span with respect to a line between two points equidistant from mid-span and just inside the two loading points shall be measured to an accuracy of at least 1.5 percent of total deflection, if tested for stiffness only, or 1.5 percent of deflection at approximate proportional limit. All the three points shall lie on the longitudinal axis of the specimen. Deflection shall be measured with a dial gauge or transducer. A typical equipment of the transducer type is illustrated in Fig. 1.

A dial gauge could replace the transducer for manual reading. If individual gauge readings are taken, at least 12 and preferably 15 or more load and deflection readings shall be taken below approximate proportional limit or for determining specimen stiffness.

3.6 Report and Calculation — Modulus of rupture and stiffness shall be calculated by the following formula:

Notations other than those given below shall have the same meaning as given in 2.4.

$$\begin{aligned}\text{Modulus of rupture (M of R)} &= \frac{3P (L - L_1)}{2bh^2}, \text{ or} \\ &= \frac{P (L - L_1) c}{4I}\end{aligned}$$

where

L_1 = span between load points in mm,

c = distance from neutral axis to extreme fibre in mm,

I = moment of inertia in mm⁴, and

P = maximum load in N.

$$\text{Modulus of elasticity, N/mm}^2 = \frac{3P (L - L_1) L_2^2}{8bh^3 \Delta}$$

$$\text{Stiffness (EI)} = \frac{(L - L_1) L_2^2}{32} \times \frac{P}{S}$$

where

L_2 = span between deflection measurement points in mm, and

S = deflection of mid-span relative to ends of span L_2 in mm.

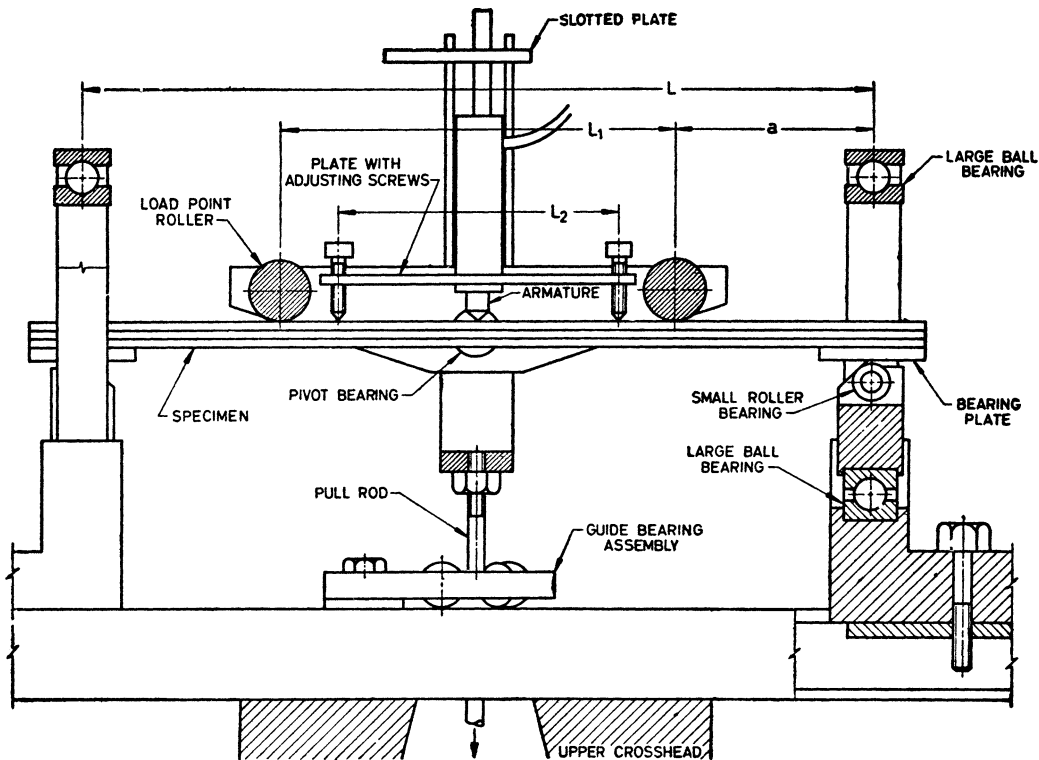


FIG. 1 TWO-POINT LOAD TEST FOR SMALL PLYWOOD FLEXURE SPECIMENS

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 12 DETERMINATION OF SCARF JOINT STRENGTH

(Second Revision)

UDC 674-419.32 : 674.028.11 : 620.17

1. SCOPE

1.1 This standard (Part 12) covers the method of test for the determination of scarf joint strength of plywood.

2. OBJECT

2.1 The two tests, namely, mandrel test and tensile strength test, are prescribed to evaluate the strength of a scarf joint.

3. MANDREL TEST (BENDING TEST FOR SCARF JOINT FOR PLYWOOD UP TO 3 mm IN THICKNESS)

3.1 Test Specimen — Each test specimen shall be approximately 38×2.5 cm and shall be cut in a direction at right angles to the line of the scarf with the scarf approximately in the centre of the specimen. The test specimen shall be preconditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$.

3.2 Procedure — Test specimens are bent round a mandrel of a diameter 200 times the thickness of plywood, in such a way that the scarf is within the fully bent position and then examined for signs of delamination or damage at the scarf joint.

Test specimens are then broken on a mandrel of smaller diameter and distribution of adherent fibres examined and expressed as a percentage of the whole area. The test shall be repeated with a specimen of the same dimension but without the scarf joint.

NOTE 1 — A number of mandrels of progressively smaller diameters are to be tried till the specimen breaks.

NOTE 2 — For aircraft plywood the mandrel test is employed as a quality control test. In this case the diameter of the mandrel is only 100 times that of the thickness of

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plywood and the test is employed up to 5 mm thickness. Breakages or fractures of more than 20 percent of all the specimens tested shall be considered as the cause for the rejection of the whole lot.

3.3 Report — The percentage of wood failure for each test specimen shall be reported.

3.3.1 The ratio of percentages of wood failure in the case of two types of test specimens, namely, one with scarf joint and the other without scarf joint shall also be reported.

4. TENSILE STRENGTH TEST OF THE SCARF JOINT (ALSO KNOWN AS LONGITUDINAL TEST) (FOR PLYWOOD ABOVE 3 mm IN THICKNESS)

4.1 Test Specimen — Dimensions and details of the test specimens shall be the same as for mandrel test (see **3.1**) except that the scarf joint is exactly centrally disposed in a direction at right angles to the length of the test specimen.

4.2 Procedure — The test specimens shall be tested in the same manner as for the determination of tensile strength of plywood [see IS : 1734 (Part 9)-1983*]. The test shall be repeated with a specimen of the same dimensions but without the scarf joint.

4.3 Report — The load taken by both the test specimens shall be reported separately together with the ratio of the loads of the piece with the scarf joint to that without the scarf joint. The location of the failure and the percentage of wood failure on the joints shall also be reported. All the details shall be recorded under the following sub-heads:

- a) Name of the manufacturer/source from whom the plywood is procured;
- b) Type and grade of plywood;
- c) Construction of plywood in terms of the ratio of thickness of individual plies;
- d) Species of individual plies;
- e) Adhesive used;
- f) End use of plywood;
- g) Specimen No./reference;
- h) Thickness of specimen;

*Methods of test for plywood : Part 9 Determination of tensile strength (*second revision*).

- j) Diameter of standard mandrel;
- k) Visual examination of the specimen when bent round the standard mandrel;
- m) Diameter of the mandrel on which the specimen breaks;
- n) Percentage of wood failure:
 - 1) with scarf joint,
 - 2) without scarf joint, and
 - 3) ratio of above; and
- p) Load taken by the specimen:
 - 1) with scarf joint,
 - 2) without scarf joint, and
 - 3) ratio of above; and
- q) Location of failure.

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 13 DETERMINATION OF PANEL SHEAR STRENGTH

(Second Revision)

UDC 674-419.32 : 620.176.2

1. SCOPE

1.1 This standard (Part 13) covers the method of test for the determination of panel shear strength.

2. OBJECT

2.1 This test is intended to evaluate the panel shear strength of the plywood.

3. METHOD A

3.1 Test Specimen — The grain direction of the individual plies shall be at an angle of 0° or 90° with the edges of the panel. The dimensions of the test specimen (*see* Fig. 1) shall conform to the sizes prescribed in Table 1 for the respective thickness of plywood used. The size and thickness of reinforcing wooden blocks shall also conform to the values prescribed in Table 1. The thickness, width and length of each specimen shall be measured to an accuracy of not less than ± 0.3 percent. The specimen shall be preconditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$.

3.2 Procedure

3.2.1 Size and Location of Pins — The sizes and location of the pins used to load the panel shall be as prescribed in Table 1. Care shall be taken in drilling the holes to make the surfaces smooth and the axes perpendicular to the plane of the plywood.

3.2.2 Pins and Rollers — The pins shall be of a quality equal to that of steel having a yield point of approximately 686 N/mm^2 and an ultimate tensile strength of approximately 862 N/mm^2 . The rollers shall be the ball or roller bearing type of standard bearing sizes with an inside diameter approximately 0.025 mm larger than the pin

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diameter. Where necessary, a sleeve bushing shall be pressed, into the bearing to achieve this tolerance. For pin diameters in excess of 8-mm double-row ball bearings or roller bearings of equivalent strength shall be used. The outside bearing diameter shall be equal to that prescribed in Table 1.

3.2.3 Loading Procedure — The load shall be applied by special steel loading blocks which articulate with the rollers and pins attached to the test specimen. The angle between faces of the loading block shall be 90° and between each face and the base shall be 45°. A spherical bearing block, preferably of the suspended self-aligning type, shall be employed in the loading system. The load shall be applied continuously throughout the test with a uniform motion of the movable head of the testing machine equal to 0.005 cm/cm length of diagonal per minute within a permissible variation of ± 25 percent until the maximum load is reached.

3.2.4 Moisture and Density — After the test, a section shall be cut out of the panel and used to determine the moisture content and density of the specimen.

3 3 Calculation — The panel shear stress on the plywood panel shall be calculated as follows:

$$\text{Panel shear stress in N/mm}^2 = \frac{0.707 P}{L t}$$

where

P = total applied load in N,

L = side of square panel specimen in mm (see Fig. 1), and

t = thickness of specimen in mm (see Fig 1).

4. METHOD B

4.1 Test Specimen — The dimensions of the test specimen shall be as shown in Fig. 2. The size and thickness of the reinforcing blocks shall be as indicated. A jig for accurate location of the pads shall be used. Material up to 1.25 cm in thickness requiring a total load of less than 44 kN may be tested by this method. The thickness of the specimen shall be measured to an accuracy of not less than ± 0.3 percent. The material shall be conditioned prior to gluing on the pads and then conditioned again before testing. In general, the tests shall be made with the face grain of the material parallel or perpendicular to the sides of the loading rig. Tests may also be made with the grain inclined to the sides.

4.2 Procedure — The load shall be applied by compression across a diagonal. The movement of the cross-head of the testing machine shall be continuous at the rate of 2.0 mm/min $\pm$ 25 percent. A suitable test apparatus is shown in Fig. 1. Shear stress calculations, moisture content and density determinations shall be made as described in Method A (3).

4.3 Report — The panel shear stress, the moisture content and density of each specimen shall be reported. All the details shall be recorded under the following sub-heads:

- a) Name of the manufacturer/source from whom the plywood is procured;
- b) Type and grade of plywood;
- c) Construction of plywood in terms of the ratio of the thickness of individual plies;
- d) Species of individual plies;
- e) Adhesive used;
- f) End use of plywood;
- g) Specimen No./reference;
- h) Size of the specimen:
 - 1) Thickness, and
 - 2) Average side of the square panel;
- j) Rate of loading;
- k) Maximum load;
- m) Panel shear stress;
- n) Moisture content, percent; and
- p) Density.

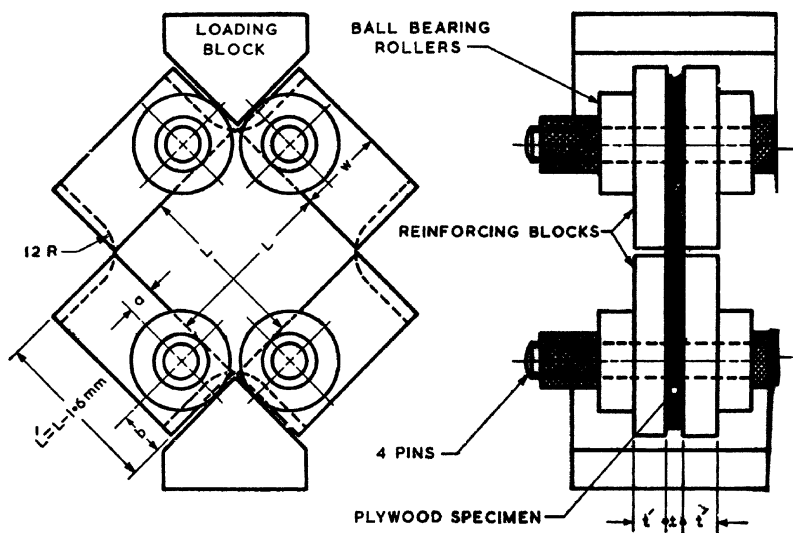
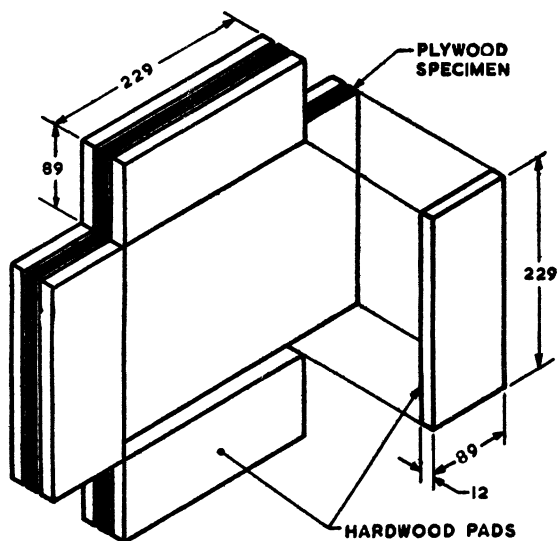


FIG. 1 TEST SPECIMEN AND APPARATUS FOR PANEL SHEAR TEST



All dimensions in millimetres.

FIG. 2 ALTERNATE TEST SPECIMEN AND ARRANGEMENT FOR PANEL SHEAR TEST

TABLE 1 DIMENSIONS OF PLYWOOD PANEL SHEAR SPECIMENS(*Clauses 3.1, 3.2.1, and 3.2.2, and Fig. 1*)

All dimensions in millimetres.

	PLYWOOD THICKNESS	MAXIMUM ALLOWABLE PANEL SIZE (BETWEEN BLOCKS)	MINIMUM BLOCK WIDTH <i>W</i>	MINIMUM BLOCK THICKNESS <i>t</i>	DIAMETER OF PINS <i>d</i>	DIAMETER OF PIN HOLE	DIAMETER OF ROLLERS <i>D</i>	INNER EDGE OF BLOCK TO CENTRE LINE OF PIN HOLE <i>a</i>	END OF BLOCK TO CENTRE LINE OF PIN HOLE <i>b</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5	<i>Group I Woods (High Density Species)</i>								
	1.27 to 2.54	25.40	25.40	6.35	6.35	6.35	32	6.35	9.52
	2.54 to 5.08	50.80	25.40	9.52	9.94	9.92	30	7.94	13.50
	5.08 to 7.62	76.20	38.10	14.29	14.90	15.08	35	11.91	13.50
	7.62 to 10.16	101.60	50.80	19.05	19.90	20.24	47	15.87	17.46
	10.16 to 12.70	127.00	63.50	23.81	24.90	25.00	62	19.84	23.81
	12.70 to 15.24	152.40	76.20	28.57	30.00	30.16	72	23.81	27.00
	<i>Group II Woods (Medium Density Species)</i>								
	1.27 to 2.54	25.40	25.40	4.76	6.35	6.35	22	6.35	9.52
	2.54 to 5.08	25.40	25.40	7.94	9.94	9.92	30	7.94	13.50
	5.08 to 7.62	76.20	31.75	14.29	13.20	13.49	35	11.91	3.50
	7.62 to 10.16	101.60	44.45	17.46	19.90	20.24	47	15.87	17.46
	10.16 to 12.70	127.00	57.15	22.22	22.22	22.62	62	19.84	23.81
	12.70 to 15.24	152.40	63.50	25.40	30.00	30.16	72	23.81	27.00
	<i>Group III Woods (Low Density Species)</i>								
	1.27 to 2.54	25.40	19.05	4.76	6.35	6.35	22	6.35	9.52
	2.54 to 5.08	50.80	25.40	7.94	7.94	7.92	26	7.94	10.32
	5.08 to 7.62	76.20	31.75	11.11	11.11	11.11	32	11.91	11.91
	7.62 to 10.16	101.60	38.10	14.29	14.29	15.08	35	15.87	12.70
	10.16 to 12.70	127.00	50.80	17.46	17.46	20.24	47	19.84	13.50
	12.70 to 15.24	152.40	63.50	22.22	22.22	22.62	62	23.81	19.84

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 14 DETERMINATION OF PLATE SHEAR STRENGTH

(Second Revision)

UDC 674-419.32 : 620.176.2

1. SCOPE

1.1 This standard (Part 14) covers the methods of tests for the determination of plate shear strength.

2. OBJECT

2.1 This test is intended to evaluate the shearing modulus of elasticity of plywood.

3. TEST SPECIMEN

3.1 The grain direction of the individual plies shall be parallel or perpendicular to the edges of the test specimen (*see* Note). The test specimen shall be square with the thickness equal to the thickness of the material and the length and width not less than 25 nor more than 40 times the thickness. The specimen shall be preconditioned to a constant mass at relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^{\circ}\text{C}$. The thickness, length and width of each specimen shall be measured to an accuracy of not less than ± 0.3 percent. Care shall be taken to avoid obtaining test specimens with initial curvature.

NOTE — This method of test is primarily designed for material in which the grain of the individual plies or laminations is parallel or perpendicular to the edge of the specimen. It may be used, however, for specimens in which the grain is at 45° to the specimen edges if a four-ply panel with the plies of the same thickness is used. The controlling condition is that the value of EI (modulus of elasticity $\times$ moment of inertia) along both diagonals shall be equal.

4. PROCEDURE

4.1 Loading — The test specimen shall be supported on rounded supports having a radius of curvature not greater than 6 mm on the opposite ends of a plate diagonal, and loaded in a similar manner on the opposite ends of the other diagonal. In order that the loads may be

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applied at the corners, metal plates shall first be attached as shown in Fig. 1. The loading and supporting frame shall be rigid. The load shall be applied with a continuous and uniform motion of the movable head at a rate of 0.003 times the length of the plate in cm expressed in cm/min within a permissible variation of ± 25 percent.

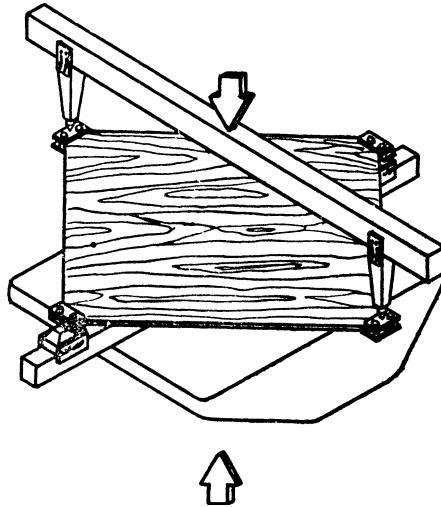


FIG. 1 METHOD OF MAKING PLATE SHEAR STRENGTH TEST

4.2 Deformation Measurements — The deformation shall be measured to the nearest 0.02 mm at two points on each diagonal equidistant from the centre of the plate. These measurements shall preferably be made at the quarter points of the diagonals, and if points other than these are chosen, care shall be taken to avoid locations near the plate corners to avoid the load and reaction effects. The plate shall not be stressed beyond its elastic range, and increments of load shall be chosen so that not less than 12 and preferably 15 load deformation readings are taken. To eliminate the effects of slight initial curvature two sets of data shall be obtained, the second set with the panel rotated 90° about an axis through the centre of the plate and perpendicular to the plane of the plies. The two results shall be averaged to obtain the shear modulus for the plate.

4.3 After the test, a section shall be cut out of the plate and used to determine the moisture content and density of the specimen.

5. CALCULATIONS

5.1 The shearing modulus of elasticity shall be calculated as follows:

$$\text{Shearing modulus, } G, \text{ N/mm}^2 = \frac{3 u^2 P}{2 h^3 w}$$

where

u = distance from the centre of the plate to the point where the deflection is measured in mm,

P = load applied to each corner in N,

h = thickness of the plate in mm, and

w = deflection relative to the centre in mm.

NOTE — The average value of P and w are generally taken from the slope of a plotted load-deflection curve.

6. REPORT

6.1 The shearing modulus of elasticity, the moisture content and density of each specimen shall be reported. All the details shall be recorded under the following sub-heads:

- a) Name of the manufacturer/source from whom the plywood is procured;
- b) Type and grade of plywood;
- c) Construction of plywood in terms of the ratio of thickness of individual plies;
- d) Species of individual plies;
- e) Adhesive used;
- f) End use of plywood;
- g) Specimen No./reference;
- h) Size of the specimen;
- j) Rate of loading;
- k) Average distance from the centre to the point where the deflection is taken (u);
- m) Average value of load/deflection (P/w) taken from the slope of the load-deflection curve;
- n) Shear modulus of elasticity;
- p) Moisture content, percent; and
- q) Density, if calculated otherwise.

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 15 CENTRAL LOADING OF PLATE TEST

(Second Revision)

UDC 674-419.32 : 620.178.3

1. SCOPE

1.1 This standard (Part 15) covers central loading of plate test for plywood.

2. OBJECT

2.1 This test is intended to make a comparative estimate of flexural rigidity (stiffness) of a plywood plate.

3. TEST SPECIMEN

3.1 The test specimen shall be of a square shape with side not less than 25 times, and not more than 40 times the thickness. The grain direction of face ply shall be parallel to the edge. The thickness (h) and the sides (a) shall be measured to an accuracy up to 0.1 mm. The test specimen shall be conditioned to a constant mass in a humidity chamber maintained at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$. The mass may be determined to an accuracy of 0.01 g.

4. PROCEDURE

4.1 Loading — The specimen shall be held in a frame shown in Fig. 1A and 1B. This frame shall then be supported horizontally on 4 pillars at its corners. The load shall be applied vertically at the centre on the top of plywood plate by means of a hemispherical steel ball of diameter 10 times the thickness of plywood. Load shall be applied continuously and uniformly at a rate of 0.003 times the length of the plate expressed in cm/min.

4.2 Deflection Measurement — The deflection at the centre of the plate shall be taken to the nearest 0.02 mm at equal increments of load by means of a dial gauge or scale fixed at the moving head of the machine. The test shall be carried until maximum load is reached and failure is indicated. The deflection shall be plotted against load, and

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maximum load P ; load P and deflection d at elastic limit shall be recorded.

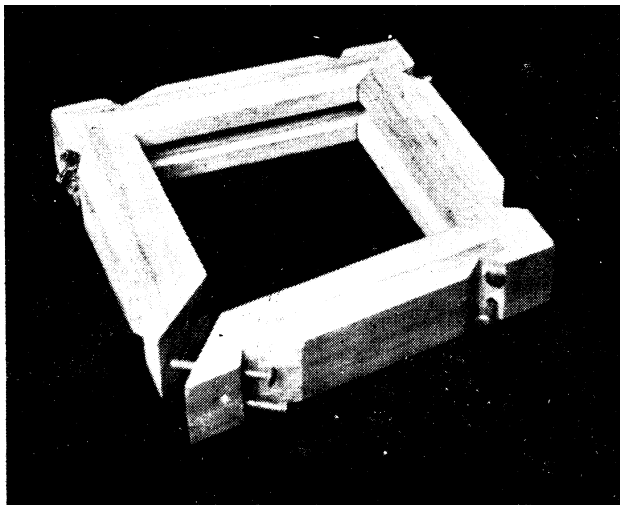
4.3 Clamped Edges Test — If the plywood plate is required to be tested under central loading with clamped edges (all the four sides clamped) the specimen as described above shall be clamped firmly in a frame shown in Fig. 1C and tested as mentioned in 4.1 and 4.2. In this case a is the internal distance from edge to edge.

5. REPORT

5.1 The estimate of stiffness shall be calculated from the formula $\frac{Pa^2}{dh^3}$ and reported for a particular type of the plywood.

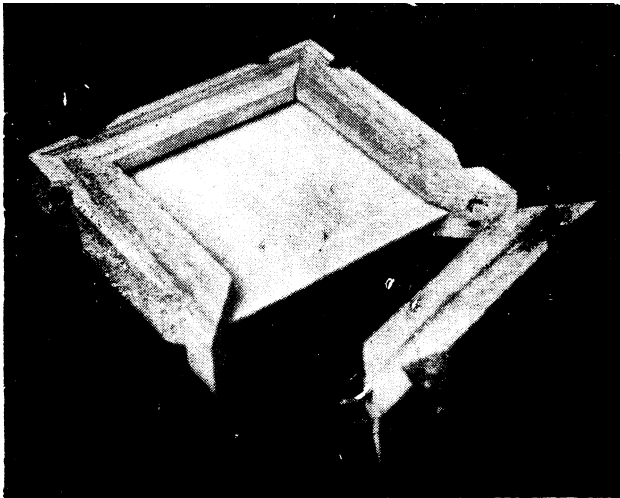
5.2 All the details shall be recorded under the sub-heads indicated below:

- a) Name of the manufacturer/source from whom the plywood is procured;
- b) Type and grade of plywood;
- c) Construction of plywood in terms of the ratio of thickness of individual plies;

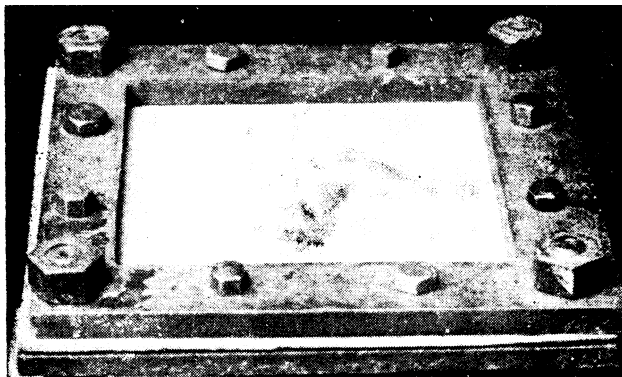


1A Frame for Holding Plywood Plate with 'Simply Supported Edges'

FIG. 1 CENTRAL LOADING OF PLATE TEST — *Contd*



1B Plywood Plate in the Frame for 'Simply Supported Edges'



1C Plywood Plate in Frame Under 'Clamped Edges'

FIG. 1 CENTRAL LOADING OF PLATE TEST

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- d) Species of individual plies;
- e) Adhesive used;
- f) End use of plywood;
- g) Specimen No./reference;
- h) Size of specimen;
 - 1) Side,
 - 2) Thickness;
- j) Mass of specimen at 65 ± 5 percent relative humidity and at a temperature of $27 \pm 2^\circ\text{C}$;
- k) Rate of loading;
- m) Load at elastic limit $\overline{P}$;
- n) Deflection at elastic limit d ;
- p) Maximum load P ; and
- q) Stiffness factor $\frac{Pa^2}{dh^3}$ simply supported/clamped edges.

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 16 VIBRATION OF PLYWOOD PLATE TEST

(Second Revision)

UDC 674-419.32 : 620.178.53

1. SCOPE

1.1 This standard (Part 16) covers vibration of plywood plate test.

2. OBJECT

2.1 This test provides a non-destructive method of estimating the resonant characteristics of the material and the stiffness of a plywood plate under dynamic conditions.

3. METHOD A

3.1 Test Specimen — The test specimen shall be of a square shape with side not less than 25 times, and not more than 40 times the thickness. The grain direction of face ply shall be parallel to the edge. The thickness (h) and the sides (a) shall be measured to an accuracy up to 0.1 mm. The test specimen shall be conditioned to a constant mass in a humidity chamber maintained at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$. The mass may be determined to an accuracy of 0.01 g.

3.2 Procedure — A small thin soft iron piece shall be attached firmly at the centre of the specimen plate by means of ordinary glue or lac. The specimen shall then be held in the frame which will be held rigidly in any rig. An electromagnetic driver shall be placed just below the centre of the sample under the soft iron piece fixed to the sample. The distance between soft iron piece and the electromagnet shall be suitably adjusted to get free vibrations. The electromagnet shall be energized by a calibrated oscillator and the sample shall be made to vibrate. The vibrations shall be picked up by means of an electromagnetic or piezoelectric pick-up and fed to a cathode ray oscillograph or ac millivoltmeter. By varying the frequency of the

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oscillator, the specimen plate shall be made to vibrate to resonance as may be indicated either in the input or in the output circuits. A schematic diagram showing the arrangement for carrying out the vibration of plywood test is shown in Fig. 1.

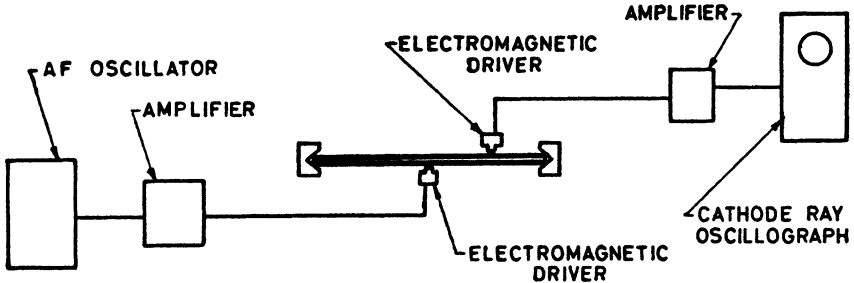


FIG.1 SCHEMATIC DIAGRAM FOR VIBRATION OF PLYWOOD PLATE TEST

3.3 Report — The resonant frequency N shall be reported along with the other details of plywood under the sub-heads indicated below:

- a) Name of the manufacturer/source from whom the plywood is procured;
- b) Type and grade of plywood;
- c) Construction of plywood in terms of the ratio of thickness of individual plies;
- d) Species of individual plies;
- e) Adhesive used;
- f) End use of plywood;
- g) Specimen No. reference;
- h) Size of specimen;
 - 1) Side a , and
 - 2) Thickness h ;
- j) Mass of specimen at 65 ± 5 percent relative humidity and at a temperature of $27 \pm 2^\circ\text{C}$;
- k) Resonant frequency N ; and

m) Stiffness of plywood plate $S = \frac{Na^2}{h}$.

4. METHOD B

4.1 Procedure — Rectangular test specimen of size 70×30 cm shall be supported at two points located at a distance from each end equal to 0.224 times its length with suitable end fixtures to simulate zero displacement conditions and these shall be excited to a known frequency through a variable frequency oscillator and a loudspeaker, placed below the specimen at the middle or at one end. A suitable pick-up shall be used above the surface or at the other end. The resonant frequency shall be obtained using an oscilloscope, care shall be taken to see that only the fundamental and not the higher harmonies are recorded.

4.2 Calculation — The Young's modulus of the specimen (in the grain direction) shall be determined from the observed values of the fundamental frequency by the following formula:

$$E = \frac{f_f^2 l^3 m g}{1\ 036\ b d^3}$$

where

E = dynamic modulus of elasticity in bending in N/mm^2 ;

f_f = fundamental resonant frequency in cycles per second (Hz);

m = specimen mass in kg;

l, b, d = length, width and the thickness of the specimen in mm;
and

g = acceleration due to gravity.

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 17 LONG TIME LOADING TEST OF PLYWOOD STRIPS

(Second Revision)

UDC 674-419.32 : 620.178.3

1. SCOPE

1.1 This standard (Part 17) covers long time loading test of plywood strips to determine the creep behaviour of plywood and coefficient of sustained loading. By using standard specimen construction and constant loading this method may also be used to evaluate creep behaviour of adhesives for use in plywood.

2. LONG TIME LOADING TEST OF PLYWOOD STRIPS

2.1 Object — The object of this test is to study the creep behaviour of plywood as well as adhesives used in plywood.

2.2 Test Specimen — The specimen shall be rectangular and its thickness shall be the thickness of the plywood. The width shall be 2.5 cm for thickness less than 6 mm and 5 cm for thickness 6 mm or more. The length shall be 48 times the thickness plus 5 cm, and the grain direction of the face plies shall be parallel to the length. The specimen shall be conditioned to a constant mass at 65 ± 5 percent relative humidity and at a temperature of $27 \pm 2^\circ\text{C}$. The dimensions shall be measured to an accuracy of 0.1 mm and mass shall be taken to an accuracy of 0.01 g.

2.3 Procedure

2.3.1 The test specimen shall be simply supported on horizontal parallel iron rollers having a radius of about 5 mm placed at a distance centre-to-centre of 48 times the nominal thickness of the specimen. Loading shall be done at the centre of the span and along a line parallel to the end either by means of suitable lever arrangement (see Fig. 1) or simply by means of an iron roller of about 5 mm diameter and carrying a stirrup (see Fig. 2). The total mass of the

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roller and stirrup shall not be more than 250 g. The position assumed under this initial load after a period of 30 seconds shall be treated as the zero condition.

2.3.2 When the test is to be conducted at an elevated temperature the apparatus including specimen (preferably wrapped in polyethylene sheet) shall be kept in the conditioning chamber maintained at the desired temperature and humidity.

2.3.3 Additional weights such that the total load is equal to 30 percent of maximum load, calculated according to IS : 1734 (Part 11)-1983* on a similar type of specimen shall then be suspended from the stirrup directly or by means of lever arrangements and instantaneous deflection at the mid-point of the span (preferably at the neutral axis) shall be noted by means of a cathetometer or dial gauge placed suitably at the mid-point of the span. If the lever system shown in Fig. 1 is used, the estimation of load is done as below:

$$P = \frac{WM + wB}{A} + p$$

where

P = load applied to specimen;

W = load, including mass of tray, applied at a distance M from the pivot point;

w = mass of lever arm;

p = mass of loading plate and rod;

B = distance from pivot point to centre of gravity of the loading arm; and

A = distance between pivot point and load point.

Deflection shall be measured correct to 0.01 mm. If the creep behaviour is required to be studied at different loads, these shall be expressed as percentage of maximum load calculated according to IS : 1734 (Part 11)-1983*.

2.3.4 Deflection shall then be noted every 10 minutes for about 2 hours, then every half an hour for another 3 hours, then hourly for another 5 hours and then twice daily for about a week or till failure has occurred. A curve between deflection and time t shall be plotted. Creep rate in millimetres per hour or millimetre per day shall be calculated for any portion of the curve (beyond initial deflection).

*Methods of test for plywood : Part 11 Determination of static bending strength (second revision).

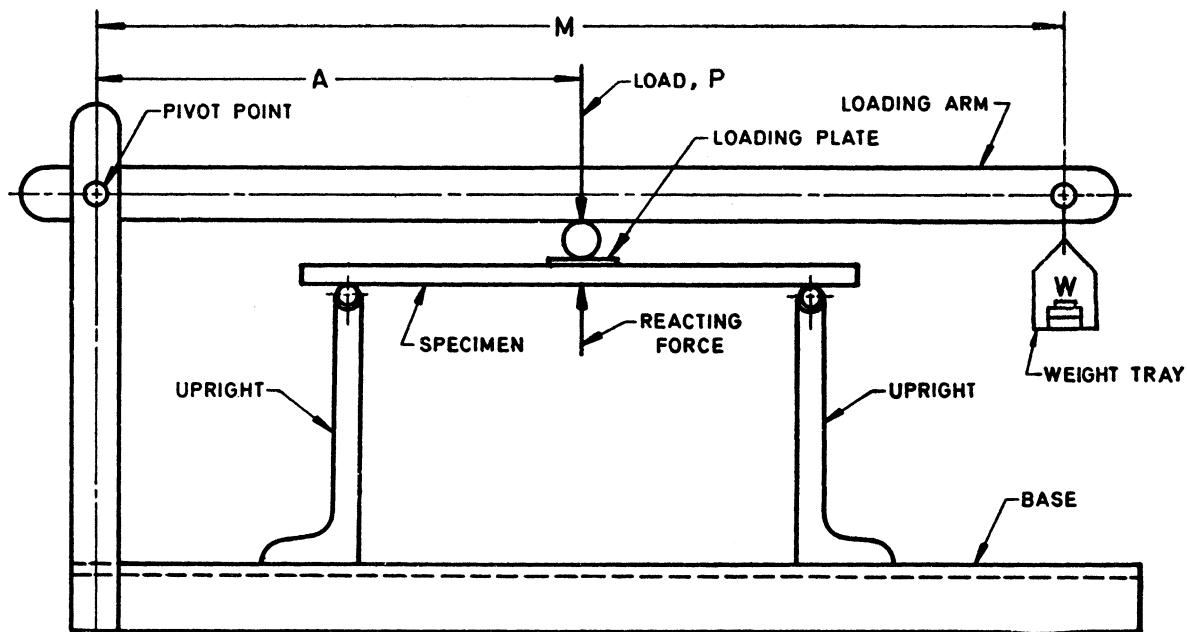


FIG. 1 DIAGRAM SHOWING ARRANGEMENT FOR LONG TIME LOADING TEST OF PLYWOOD STRIP
(LEVER ARRANGEMENT)

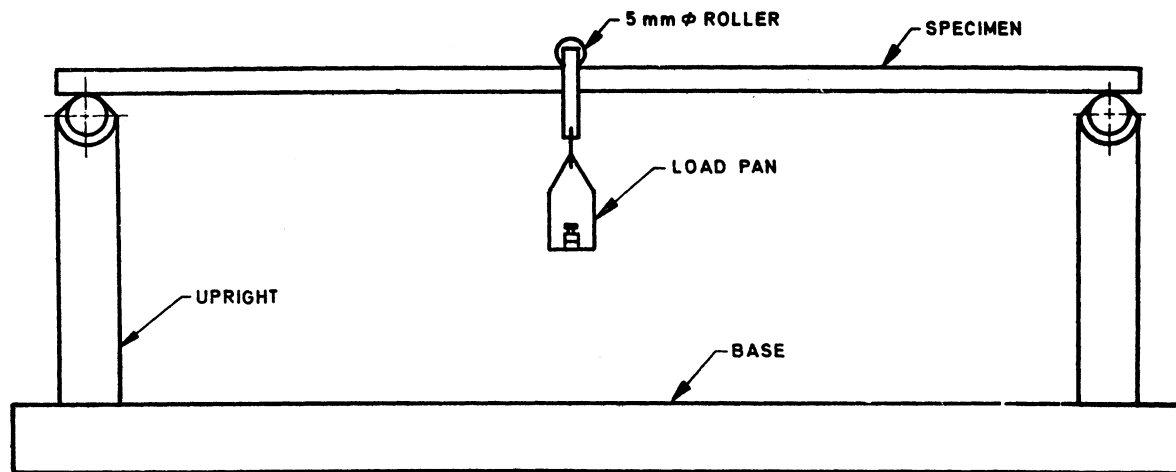


FIG. 2 DIAGRAM SHOWING ARRANGEMENT FOR LONG TIME LOADING TEST OF PLYWOOD STRIP
(IRON ROLLER AND STIRRUP ARRANGEMENT)

For comparison, creep may be expressed as percentage of initial deflection.

$$\text{Creep percentage of instantaneous deflection} = \frac{d_t - d_0}{d_0} \times 100$$

where

d_t = total deflection under constant load at time t , and

d_0 = initial static deflection under the same load and the same temperature.

A plot of $\frac{d_t - d_0}{d_0}$ against time t also provides useful data.

2.3.5 If the creep data for longer periods is not required then the load shall be removed after 24 hours and after the lapse of a further period of 24 hours the residual deflection shall be noted.

2.4 Report — Creep rate or creep expressed as percentage of instantaneous deflection or curve between $\frac{d_t - d_0}{d_0}$ and t or deflection after 24 hours under load and residual deflection 24 hours after removal of load shall be reported with other details as below:

- a) Name of the manufacturer/source from whom the plywood is procured;
- b) Type and grade of plywood;
- c) Construction of plywood in terms of the ratio of thickness of individual plies;
- d) Species of individual plies;
- e) Adhesive used;
- f) End use of plywood;
- g) Specimen No./reference;
- h) Size of specimen;
 - 1) Length,
 - 2) Width, and
 - 3) Thickness;
- j) Mass of specimen at 65 ± 5 percent relative humidity and at a temperature of $27 \pm 2^\circ\text{C}$;
- k) Span;
- m) Temperature at which the test is done;
- n) Mass of stirrup with roller (if loaded by dead loads);

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- p) Description of arrangement of lever (if loaded by means of lever);
- q) Load added [expressed in percent of maximum load evaluated according to IS : 1734 (Part 11)-1983*];
- r) Deflection readings:
 - 1) Immediately after placing the load,
 - 2) 24 hours after placing the load,
 - 3) Immediately after removal of load, and
 - 4) 24 hours after removal of load;
- s) Creep (percent of instantaneous deflection) at time; and
- t) Observations on the curve between $\frac{d_t - d_0}{d_0}$ and t .

3. DETERMINATION OF COEFFICIENT OF SUSTAINED LOADING

3.1 Loading — Several percentages of the ultimate breaking load, called here as instantaneous breaking load, determined according to IS : 1734 (Part 10)-1983† shall be used as constant load values for creep tests on a multiple testing fixture with several units as shown in Fig. 1. At least 10 specimens shall be loaded in this fixture simultaneously. This fixture shall be kept in a room where the temperature and relative humidity do not fluctuate considerably over the entire duration of the test for example, a basement room. Time shall be measured from the instant of loading and the times taken for the specimens to fail in creep under the action of the different constant loads shall be noted. These times to failure shall be plotted against the respective constant load values expressed as percentage of the instantaneous breaking load. A curve which is known as the sustained load shall be drawn through the points as shown in Fig. 3. An asymptote to the sustained load curve intersects the load axis at a value known as the limit of sustained loading.

The coefficient of sustained loading K_s is defined as the ratio of the limit of sustained loading of plywood (σ_{sust}) to its instantaneous breaking load (σ_{br})

$$K_s = \frac{\sigma_{\text{sust}}}{\sigma_{\text{br}}}$$

The value of K_s shall be reported to the nearest second decimal place.

*Methods of test for plywood : Part 11 Determination of static bending strength (second revision).

†Methods of test for plywood : Part 10 Determination of compressive strength (second revision).

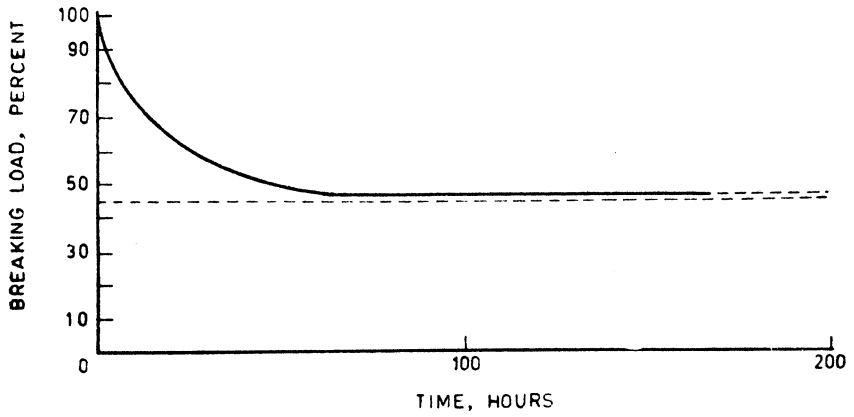


FIG. 3 SUSTAINED LOAD CURVE FOR PLYWOOD

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 18 IMPACT RESISTANCE TEST

(Second Revision)

UDC 674-419.32 : 620.178.7

1. SCOPE

1.1 This standard (Part 18) covers impact resistance test on the surface of plywood, and panel impact resistance.

2. OBJECT

2.1 This test affords a good means of quality assessment of resistance of the surface of plywood to impact and total panel to breakages by sudden blows.

3. IMPACT RESISTANCE ON SURFACE OF PLYWOOD

3.1 Equipment

3.1.1 Steel Ball — The ball required for dropping on the surface of plywood shall be of 5 cm diameter and weighing 450 ± 25 g.

3.1.2 Dial Gauge — The dial gauge shall have least count of 0.01 mm and shall be suitably fixed on a plane surface so as to measure maximum indentation, that is, depression perpendicular to the plane of the surface.

3.2 Test Specimen — The specimen of plywood shall be 20×20 cm in size and shall be preconditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$.

3.3 Procedure — The specimen shall be placed horizontally on a plane smooth platform. The steelball shall be allowed to fall freely from a height of 100 cm at any 5 different points on the surface of plywood. If any indentation is noticed that shall be measured by the dial gauge.

3.4 Report — Maximum indentation shall be reported and any cracking, tearing, etc, shall also be noted.

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4. PANEL IMPACT RESISTANCE TEST

4.1 Test Specimen — The specimen of plywood shall be 30×30 cm with the face grain parallel and perpendicular to the sides. The specimen shall be preconditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ\text{C}$.

4.2 Apparatus — The test apparatus shall be as shown in Fig. 1. The combined mass of the rod, cone and hemisphere shall be 5 kg. The diameter of hemisphere shall be 5 cm.

4.3 Procedure — The panel shall be freely supported along all four edges and the hemisphere shall be made to strike the centre of the panel. The rod shall be dropped through heights increasing in increments of 10 mm until fracture of the panel occurs. Fracture is indicated when the hemispherical end has penetrated the panel and is arrested by the flange of the cone.

4.4 The height of drop required to produce fracture shall be taken as the panel impact strength.

4.5 In case, the specimen does not fail with 5 kg mass from height up to 1 000 mm, the mass shall be increased to 10 kg and the test be repeated from the height of 500 mm.

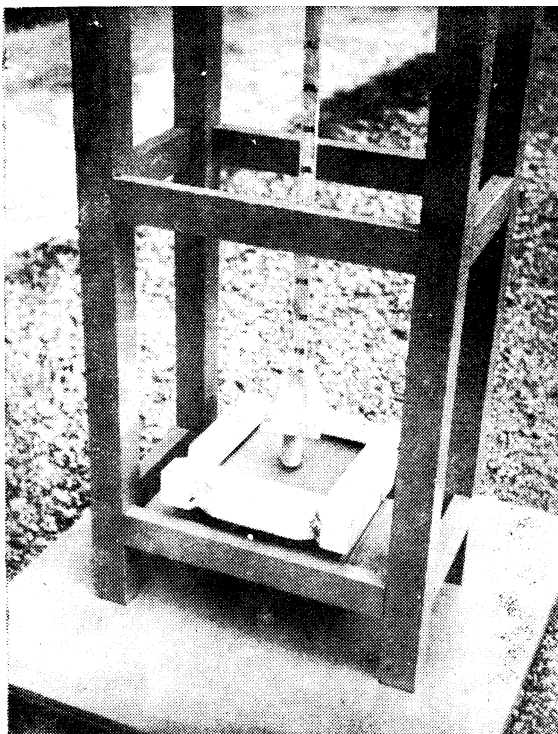


FIG. 1 IMPACT TEST APPARATUS

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 19 DETERMINATION OF NAILS AND SCREW HOLDING POWER

(Second Revision)

UDC 674-419.32 : 620.17 : 621.886.2 : 621.882.2

1. SCOPE

1.1 This standard (Part 19) covers the method of test for the determination of nails and screw holding power of plywood.

2. OBJECT

2.1 This test is intended to assess the nail and screw holding capacity of the plywood.

3. EQUIPMENT

3.1 The test shall be conducted on a suitable testing machine with an arrangement to pull the screw and nails so as to measure the maximum load required for complete withdrawal.

3.2 Nails shall be 50 mm long and 2.5 mm shank and shall be bright, galvanized, diamond pointed and shall have plain heads. These shall conform to IS : 723-1972*.

3.3 Screws shall be of 4 mm size and 5 cm in length and shall be galvanized gimlet pointed conforming to IS : 6761-1972†.

3.4 Each nail and screw shall be used only once.

4. TEST SPECIMEN

4.1 Plywood strips of 5 × 25 cm shall be glued one over the other as to give total thickness of more than 5 cm. Grain direction of the face ply shall be parallel to length. After conditioning the specimen to constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^{\circ}\text{C}$, two nails and two screws mentioned in **3.2** and **3.3** shall be

*Specification for steel countersunk head wire nails (*second revision*).

†Specification for countersunk head screws with hexagon socket.

IS : 1734 (Part 19) - 1983

driven to a total penetrative of 25 mm exactly at right angle to the surface of the plywood specimen at a regular distance of 5 cm on the middle line of the surface. In the case of screw a prebore of 2.5 mm diameter shall be made.

5. PROCEDURE

5.1 The specimen shall be placed on the testing machine and the nail or screw shall be withdrawn one at a time at a uniform rate of 2 mm/min until the nail or screw is pulled out completely. Maximum load for complete withdrawal of nail or screw shall be recorded.

6. REPORT

6.1 The average maximum load for withdrawal of nail or screw shall be reported for the particular type and grade of the plywood.

Indian Standard

METHODS OF TEST FOR PLYWOOD

PART 20 ACIDITY AND ALKALINITY RESISTANCE TEST

(Second Revision)

UDC 674-419.32 : 620.193.25/26

1. SCOPE

1.1 This standard (Part 20) covers acidity and alkalinity resistance test.

2. OBJECT

2.1 The object of this test is to assess the resistance of plywood surface against mild acidic or alkaline reaction of the material packed in plywood containers.

NOTE — For testing plywood for use in containers to hold acids or alkalis, strength tests are necessary. While wood is fairly resistant to acid having pH more than or equal to 2, it is not so resistant to alkalis above pH of 11. So, if the containers are made of the material for storing such chemicals then an appropriate protective treatment shall be given.

3. PREPARATION OF SOLUTIONS FOR TEST

3.1 Dissolve 5 g of chemically pure glacial acetic acid in 100 g distilled water in a clean beaker stirring by a glass rod. This solution shall be termed as 5 percent acid solution.

3.2 Dissolve 1 g of pure sodium carbonate (anhydrous) in 100 g distilled water in a clean beaker stirring by a glass rod. This solution shall be termed as 1 percent alkaline solution.

4. TEST SPECIMEN

4.1 Four specimens of 7.5 cm square size shall be prepared from each type of the plywood sheet. These shall be preconditioned to a constant mass at a relative humidity of 65 ± 5 percent and at a temperature of $27 \pm 2^\circ C$.

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5. PROCEDURE

5.1 All the 4 specimens shall be placed horizontally on separate tables. On the surface of two specimens about 2 ml of acid solution and on the surface of other two specimens about 2 ml of alkaline solution mentioned in **3** shall be dropped. The wet part of the specimens shall be covered by a watch-glass for 6 hours. After the lapse of 6 hours the specimen shall be washed with water and dried at a room temperature for 24 hours. Care shall be taken that the specimens are properly marked for acidic and alkaline test. The affected surface shall be examined under oblique light for any blister, delamination, crack, softening and for any remarkable change in colour or lustre.

6. REPORT

6.1 Any visible damage, that is, blister, delamination, crack, softening or any remarkable change in colour or lustre shall be reported separately for acidic and alkaline tests.

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Amendments Issued Since Publication

Parts No.	Amend No.	Date of Issue
Part 3	Amd. No. 1	October 1987
Part 3	Amd. No. 2	January 1999
Part 4	Amd. No. 1	December 1998
Part 4	Amd. No. 2	November 2002
Part 4	Amd. No. 3	August 2005
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Part 6	Amd. No. 2	January 2005
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