SLS 261 PART 3 : 1991

~~Draft~~ Sri Lanka Standard

PLYWOOD FOR GENERAL PURPOSES
(FIRST REVISION)
PART 3 : METHODS OF TESTS

SRI LANKA STANDARDS INSTITUTION

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FOREWORD

This Sri Lanka Standard was authorized for adoption and publication, by the Council of the Sri Lanka Standards Institution on 91/10/29, after the draft, finalized by the Drafting Committee on Plywood for general purposes, had been approved by the Civil Engineering Divisional Committee.

Sri Lanka Standard specification for plywood for general purposes SLS 261 : 1974, provided for three grades of plywood based on the type of adhesive used, three classes of plywood based on species of timber, and six types of plywood depending upon the visual features of the face and back. SLS 261 : 1974 is now revised as Sri Lanka Standard Plywood for General Purposes, in three parts as follows :

Part 1 Terminology;
Part 2 Specification for manufacture; and
Part 3 Methods of tests.

In this revision there are (a) four grades of plywood based on types of adhesive ; (b) ten types of plywood based on appearence of face and back; (c) two classes based on durabilily ; and (d) two categories based on species of timber.

This part of the standard (Part 3) specifies test methods related to plywood. Part 1 of this standard deals with terminology applicable to plywood. Part 2 of this standard deals with requirements for manufacture and specifies grades, types, classes, materials, manufacture, dimensions and tolerances, workmanship and finish, sampling and criteria for conformity, tests, a method of marking and delivery.

For the purpose of deciding whether a particular requirement of this part of the standard is complied with, the final value observed or calculated expressing the result of a test or an observation shall be rounded off in accordance with CS 102. The number of significant figures to be retained in the rounded off value shall be the same as that of the specified value in this standard.

The Sri Lanka Standards Institution gratefully acknowledges the use of relevant publications of the American Society for Testing and Materials, British Standards Institution, Bureau of Indian Standards and the Singapore Institute of Standards and Industrial Research, in the preparation of this standard.

1 SCOPE

This Part of the Standard specifies test methods for the determination of glue shear strength in dry state, resistance to micro-organisms, resistance to water, moisture content, dimensions and durability.

2 REFERENCES

ASTM D 1758	Evaluating wood preservatives by field tests with stakes
BS 4512	Methods of tests for clear plywood
CS 102	Presentation of numerical values
SLS 420	Random sampling methods
SLS 261	Plywood for general purposes, Part 1 - Terminology.
SLS 261	Plywood for general purposes, Part 2 - Specification for manufacture

3 DETERMINATION OF GLUE SHEAR STRENGTH IN DRY STATE

3.1 Object

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

3.2 Preparation of test specimen

3.2.1 At least three test specimens shall be cut from each of the boards selected in the manner specified in 11.3.2 of SLS 261 : Part 2 : 1991. Test specimens shall be three-ply and dimensions shall be as shown in Figure 1. The grain direction of the outer plies shall be parallel to the longer side of the specimen. Saw cuts shall be made perpendicular to the longer side of the specimen, and their layout and dimensions shall be as shown in Figure 1.

3.2.2 In case where thickness of veneer of face or back of a test specimen exceeds 1.5 mm, the form of test specimen shall be as shown in Figure 1 A. In case where it is 1.5 mm or less, the form of test specimen shall be as shown in Figure 1 B. However, it is permitted to test in the form B instead of A when tested veneer was broken perform in the testing of specimen in form A.

3.2.3 Plywood consisting of more than five plies shall be stripped retaining any three layers in the specimens. Number of specimens shall be such that every glue line of the given sample panel is represented. In case where three specimens from each sample are not enough to cover all the glue lines of the sample without omission, test specimens shall be prepared as many as sufficient to test all the glue lines.

3.2.4 Any specimen containing any local defect which affects bonding strength shall not be used.

3.2.5 The two faces of the test specimen shall be each shaped to the same thickness.

3.2.6 In the preparation of specimens, stripping of veneers or reduction of veneer thickness can be carried out by chiselling, planing, sanding or any combination of the above as appropriate.

3.2.7 The moisture content of the test specimen at the time of test, when determined according to the method prescribed in 6, shall be between 10 per cent and 16 per cent. If the moisture content of the specimen is outside the range, the specimen shall be conditioned to a moisture content between 10 per cent and 16 per cent.

3.3 Procedure

3.3.1 Each test specimen shall be gripped at the two ends in the jaws of a suitable testing machine, and shall be pulled apart. The grain of the centre ply shall be perpendicular to the direction of application of load.

3.3.2 During the test, the load shall be applied to the test specimen, as uniformly as possible, and so adjusted as to increase at a rate such that failure takes place in not less than one minute.

3.3.3 The maximum load at the time of complete failure of each specimen shall be recorded. Records shall also be made as to failure whether in wood or glue by visual examination of the area under shear. In case of wood failure the percentage wood failure shall also be recorded. Measurement shall be made of the width of the bonding surface and length of bonding surface under shear. Shear strength shall be calculated by dividing the failure load by the area of the bonding surface between saw cuts of the failed glue line.

3.3.4 In case of persistent wood failure of more than 50 per cent, the test shall be carried out by reducing the length of shear area as shown in Figure 1B.

3.4 Interpretation of the results

3.4.1 Shear strength of the specimens determined in accordance with 3.3 shall be averaged. The average and individual values shall be compared with those given in Table 5 of SLS 261 : Part 2 1990.

In case wood failure in an individual specimen is more than 50 per cent, and the load at which the test specimen fails is less than the average, the values for such specimen shall be discarded for the purpose of averaging the shear strength.

3.4.2 If wood failure should predominate even after the reduction in shear area, the test specimen shall be considered to have passed the test provided the value obtained in each test is greater than 90 per cent of the specified average strength and panel satisfies 10.1.1 of SLS 261 : Part 2 : 1991 in all other respects.

3.4.3 In case of unbalanced construction, resulting even after preparation of test specimens as specified in 3.2.5, a reduction of 15 per cent in average shear and 10 per cent in individual shear strength shall be permissible, provided;

a) No individual value differs from the minimum of individual values by not more than 10 per cent ; and

b) The average wood failure is more than 60 per cent and the minimum wood failure is not less than 30 per cent.

4 DETERMINATION OF RESISTANCE TO MICRO-ORGANISMS (FUNGI)

4.1 Object

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.

4.2 Preparation of test specimen

The number, preparation, dimension and details of the test specimens shall be the same as required in 3.2.

4.3 Procedure

4.3.1 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 saw dust obtained from the sapwood of a perishable timber, like Katuimbul, Malaboda or Iriya in its natural condition. It is essential that the material shall be free from preservatives, insecticides and other added substances that inhibit or retard mould growth. The sawdust shall have previously been moistened with water containing 15 g of sucrose (normally domestic sugar or 30 g of commercial malt extract) to a litre of water so that it is saturated with moisture, 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.

4.3.2 The sawdust shall then be charged with the spores of the commonly occurring fungi for example Lentinus subnudus and loosely compacted. The test specimens shall be pressed down into it so that their upper surfaces are level with the top of the sawdust layer.

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

4.3.4 The dish and the contents shall be maintained at a temperature of 27 ± 2°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 3 for compliance to the requirements laid down in 10.1.2 of SLS 261 : Part 2 : 1991.

4.4 Interpretation of the results

Results shall be interpreted for compliance with 10.1.2 of SLS 261 Part 2 : 1991 as given in 3.4 of this part of the standard.

5 TEST FOR RESISTANCE TO WATER

5.1 Test pieces

Test pieces shall be prepared as described in 3.2.

5.2 Procedure

5.2.1 The test pieces shall be immersed in boiling water at 100°C for 72 hours for BWP grade of plywood and for 8 hours in case of BWR grade of plywood. For WWR grade of plywood the specimen shall be immersed in water at 70 ± 2°C for 3 hours and for CWR grade for 24 hours at 27 ± 2°C. At the conclusion of the specified time, the test pieces shall be quickly transferred from the boiling/hot water and submerged in cold water. Period of /2 hours mentioned for boiling may be a contiuous period or an aggregate of shorter periods of boiling if the test piece is left in cold water between these shorter periods.

5.2.2 The test pieces, while still wet, shall be subjected to shear strength test as described in 3 for compliance to the requirement laid down in 10.1.3 of SLS 261 : Part 2 : 1991.

5.3 Interpretation of the results

Results shall be interpreted for compliance with 10.1.3 of SLS 261 : Part 2 : 1991 as given in 3.4.

6 TEST FOR MOISTURE CONTENT

6.1 Principle

Determination, by weighing, of the loss of mass of a test piece between its state at the time of sampling and its state after drying to constant mass at 103 ± 3°C and calculation of this loss of mass as a percentage of the mass of the test piece after drying.

6.2 Apparatus

6.2.1 Balance, capable of weighing to an accuracy of 0.01 g.

6.2.2 Air convection drying oven, the temperature of which can be maintained at all points at 103 ± 3°C.

6.2.3 Desiccator, containing a desiccant to maintain air as close as possible to the absolutely dry condition, for example, phosphorous pentoxide or anhydrous calcium chloride .

6.3 Sampling and test specimens

6.3.1 Sampling
Sampling of plywood panels shall be carried out in accordance with 11.3.2 of SLS 261 : Part 2 : 1991. At least one test specimen shall be cut from each of the boards selected.

6.3.2 Test specimens
The test specimens may be of any shape and dimensions with a minimum dry mass of 10 g, provided they are representative of the whole cross section of the piece. A 50mm x 50mm test specimen is usually suitable and for multy-ply boards the test specimen may be reduced to 50mm x 25mm. The test specimen shall be free from all loose splinters and sawdust.

NOTE - If smaller test specimens with a dry mass below 10 g have to be chosen, it must be ensured that the accuracy of the balance is high enough to allow readings to an accuracy of at least 0.1 per cent of the mass of the dry test specimen.

6.4 Procedure

6.4.1 Weigh each test specimen in the same state as at the time of sampling (see Note below) to an accuracy of 0.01 g.

NOTE - The first weighing should be carried out immediately after sampling. If this is impossible, all precautions should be taken to avoid variations of moisture content during the time from sampling to weighing.

6.4.2 Dry each test specimen at a temperature of 103 ± 3 °C to constant mass.

NOTES
1. Care shall be taken not to overcrowd the oven, and fresh test specimens shall not be added to the oven if it contains test specimens almost ready for final weighing.

2. Constant mass is considered to be reached when the results of two successive weighing operations carried out at an interval of 6 h do not differ by more than 0.1 per cent of the mass of the test specimen.

6.4.3 After cooling in the desiccator, weigh each test specimen with the same accuracy as before, rapidly enough to avoid an increase of moisture content greater than 0.1 per cent.

6.5 Expression of results

6.5.1 Calculate the moisture content M of each test specimen as a percentage by mass to the nearest 0.1 per cent, in accordance with the following formula :

$$M = \frac{m_H - m_0}{m_0} \times 100$$

where,

m_H is the mass of the test specimen at the time of sampling, in grams;

m_0 is the mass of the test specimen after drying, in grams.

6.5.2 The moisture content of a plywood panel or of a number of plywood panels is equal to the arithmetical mean value of the moisture content of all the relevant test specimens. It shall be stated to the nearest 0.1 per cent for compliance to the requirements laid down in 10.2 of SLS 261 : Part 2 : 1991.

7 TEST FOR DETERMINATION OF PHYSICAL FEATURES

7.1 Sampling

For post-manufacture batch testing, sample panels for the measurement of dimensions and tolerances shall be taken in accordance with 11.3.1 of SLS 261 : Part 2 : 1990.

7.2 Apparatus

7.2.1 For determination of thickness
A suitable measuring instrument, having circular, flat and parallel measuring surfaces of 16 ± 1 mm diameter, the contact area being 200 mm^2 approximately.

The graduation of the instrument shall allow a reading to an accuracy of 0.05 mm.

7.2.2 For determination of edge straightness

7.2.2.1 Suitable measuring instrument (sliding caliper or scale), allowing readings to an accuracy of 0.5mm.

7.2.2.2 Metal straightedge, of suitable length.

7.2.3 For determination of squareness

7.2.3.1 Suitable means
measuring instrument (sliding caliper or scale),
allowing readings to an accuracy of 0.5mm.

7.2.3.2 Try-square or a suitable instrument, 1m X 1m of 90° corner angles with an accuracy of not more than ± 0.2mm/m.

7.2.4 For determination of length and width
A suitable measuring instrument, allowing readings to an accuracy of 1mm.

7.2.5 For determination of flatness

7.2.5.1 Metal straightedge or cord, of suitable length.

7.2.5.2 Suitable rule, allowing readings to an accuracy of 1 mm.

7.3 Moisture content at test

The moisture content of panels on which measurements are made shall be assessed in accordance with 6. If the moisture content is outside the range of 6 per cent to 16 per cent, it shall be brought within this range before further measurements are taken.

7.4 Procedure

7.4.1 Thickness

Measure the thickness of a panel by applying, slowly and at a reasonable pressure, the flat and circular measuring surfaces of the measuring instrument (7.2.1). A pressure of approximately 0.02 MPa is appropriate. The thickness shall be measured in millimetres upto one place of decimal.

Take measurements at the mid point of each of the four sides at not less than 25 mm from the edge of the panel. Determine the mean panel thickness as the arithmetic mean of these values.

7.4.2 Edge straightness

Determine the edge straightness of a panel to the nearest 0.5 mm using the measuring instrument (7.2.2.1). Arrange the metal straightedge (7.2.2.2) to touch the two corners of the panel (see Figure 2).

Note the maximum deviation from a line connecting the corners and expressed to the nearest 1 mm per metre with a designation plus (+) if the edge is convex and designation minus (-) if the edge is concave.

Measure each edge of the panel.

7.4.3 Squareness

7.4.3.1 Measurement of diagonals

Assess the squareness of a panel in the first instance by measuring the length of each diagonal of the panel to the nearest millimetre using the measuring instrument (7.2.3.1) and then express the difference as a percentage of the longer diagonal.

7.4.3.2 Try square method

Although assessing squareness by measuring the diagonals of a panel is convenient, in certain instances it can give misleading information and when a doubt exists or when squareness is a subject of a dispute, then determine the squareness of a panel with the try-square (see 7.2.3.2).

Apply the square to the panel as shown in Figure 3(a). If the edge of the panel being assessed exceeds 1 m, use the try-square in conjunction with two straightedges as shown in figure 3(b). Ensure that the 45° line coincides with the corner being measured (point A) and one arm of the square is coincident with or parallel the longer panel edge as shown in Figure 3(a) or Figure 3 (b).

Determine the maximum deviation between the square and the edge of the panel at point B to the nearest 0.5mm.

Express the result to the nearest 1mm per metre of the shorter dimension of the panel.

If the angle at the corner is less than 90°, give the designation minus (-) and if the angle is greater than 90°, give the designation plus (+).

Repeat the measurement on the diagonally opposite corner.

7.4.4 Length and width
Determine the length and width of a panel to the nearest millimetre at each edge of the panel, parallel to the edge and approximately 25mm from the edge, using the measuring instrument (see 7.2.4).

Record both measurements for length and width to the nearest millimetre and express as an average of the two measurements made in the same grain direction.

7.4.5 Flatness
Hold the panel to be measured upright without restraint, with the shorter dimension vertical, on an essentially horizontal floor.

Place the straightedge vertically, or the thin cord stretched vertically (7.2.5.1), at three positions, i.e. the two ends and the centre of the panel, and record the maximum deviation from the straightedge or cord at each position to the nearest millimetre, using the rule (7.2.5.2).

For measurements relating to the longer dimension, place the straightedge or stretch the thin cord from end to end, again in three positions, i.e. at the two edges and the centre of the panel, and record the maximum deviation at each position as before.

For thin panels, liable to cup under their own weight when held vertically, determine flatness by placing the panel on a horizontal plane surface. Measure the distance of the underside at the edge of the panel from the plane surface when the middle of the panel is held in close contact with the horizontal surface. Take measurements both along and across the panel at three points, i.e. at the two edges and the centre of the panel. Turn the panel so that measurements are made with each surface in turn in contact with the plane surface and record the maximum value.

7.5 Expression of results

All results of measurements and where appropriate their arithmetical mean value shall be recorded.

8 DETERMINATION OF DURABILITY BY FIELD TESTS

8.1 SCOPE

This covers the method for the field testing of preservative treated plywood or untreated plywood for durability.

8.2 Species

Test stakes shall be made from preservative treated plywood or untreated plywood under investigation, while control stakes shall be made from the heartwood of Teak (Tectona grandis).

8.3 Selection of plywood or timber for test or control stakes

The material shall be free from large knots, stain, mould, decay or other defects such as splits and checks that may distort the durability test results.

8.4 Dimensions of stakes

Cross-sectional dimensions of the stakes given in Table 1 were obtained by keeping the ratio of surface area to volume of a stake near $0.37307 mm^{-1}$. The dimensions of test or control stakes shall be selected, depending on the plywood board thickness from Table 1.

TABLE 1 - Dimensions of stakes

Thickness of plywood (mm)	Dimensions of stakes			Surface area to volume ratio (mm^{-1})
	Thickness (mm)	Breadth (mm)	Length (mm)	
3	NOT SUITABLE			
4	NOT SUITABLE			
5	NOT SUITABLE			
6	6	50	150	0.38667
8	8	16	150	0.38833
9	9	13	150	0.38940
12	12	10	150	0.38
15	15	9	150	0.36888
16	16	8	150	0.38833
19	19	8	150	0.36860
22	22	7	150	0.38996
25	25	7	150	0.37905

8.5 Number of stakes

Use not less than 20 untreated control stakes of the same size used for preservative treated or untreated plywood throughout the test area when plot is first established and each time a new series of tests is installed. In the case of preservative treated or untreated plywood use not less than 20 test stakes.

Five stakes in each category (test or control) can be used as extra stakes, or pilot stakes, that may be removed periodically in the early course of a test to determine the presence and progress of fungus or termite attack.

8.6 Test plot

8.6.1 General requirements

A warm humid climate is preferred. Select a natural area of fertile, fallow, level land of uniform soil character that is moist but well drained and large enough to permit expansion of future stake installations. The presence of wood-destroying fungi and active subterranean termites shall be proved by observation or experience and checked by exposure of suitable small specimens of untreated wood. No natural or artifical fertilizer or other chemicals shall be applied to the plot during its use as a test ground. Protection against fire, predators and pilferage shall be provided as far as practicable.

8.6.2 Control of vegetation
As a general rule vegetation shall be controlled manually or by suitable mechanical means only, with minimum soil disturbance. No chemical controls shall be permitted. Weeding and cleaning
the plot shall be uniform over any given test area.

8.6.3 Reuse of ground
Stakes placed in ground that has been used previously for test purposes shall not be set closer than 150 mm to any earlier stake location.

8.7 Installation of stakes

Bury the stakes (test or control) so that half the length of each stake is below the ground while the other half is exposed above the ground. Compact the soil around each stake. Position the stakes on a grid of two perpendicular series of rows spaced at 600 mm apart.

Randomize the test or control stake settings in an appropriate manner within the selected test plot area.

Map the plot and the position of each installed stake to

facilitate inspection and records.

Extra stakes or pilot stakes (see 8.5) can be used where paracticable to determine the identity of the attacking fungus and the depletion or change in character of the preservative tested.

8.8 Inspection of stakes

After installation of stakes in the test plot, carry out regular inspections every month in the first year, after every two months in the second year and half yearly in the third year and subsequent years till the termination of the test (see 8.10).

Remove the stakes from the ground carefully by a straight upward pull, disturbing the soil as little as possible, using any appropriate leverage tool if the stakes are firmly fixed in the earth. Avoid rocking the stakes and enlargement of the stake hole as far as possible. Use a blunt instrument, such as a putty knife or a blunt knife blade, to scrape adhering soil from the wood surface. Avoid unnecessary probing, picking and gouging of the wood. Test the soundness of the stake by use of a blunt instrument. A light tap may be used with caution to test the groundline area for loss of impact strength. Some preservatives do not indicate loss in cross-section area or visible decay, but for all practical purposes preservative failure occurs if the strength of the wood is lost. Take special care in ratings made when the stakes are very wet, because softening due to high moisture content can be mistaken for decay.

After each inspection, replace the stake at its original position in relation to ground surface original depth of exposure and compact the soil against the stake.

Evaluate the decay by visual observation and comparison of results with Table 2.

TABLE 2 - Decay score and state of decay

Percentage depth of attack	Decay score	State of decay
Up to 5	0	Negligible
Over 5 and up to 10	1.5	Slight
Over 10 and up to 25	3.0	Moderate
Over 25 and up to 50	4.5	Bad
Over 50	5.0	Destroyed

NOTES

1. Assess the depth of attack as the depth to which material is missing or the depth to which material has softened.

2. Stakes with delaminated veneers or stakes with substantial drop in strength shall be considered as destroyed with a decay score of 5.0.

8.9 Evaluation of results

At each inspection calculate the index of condition by the formula

$$I = \frac{f \times y}{f}$$

where,
I = average index of condition of test stakes or control stakes;
f = number of test stakes or control stakes in each plywood class (see 6 of SLS 201 Part 2 : 1991) ; and

Y = decay score.

Example

Number of stakes in the group	Decay score	Number of test stakes (Y)	(f)
20		0	0
		1.5	3
		3.0	6
		4.5	8
		5.0	3
$I = \frac{3 \times 1.5 + 6 \times 3.0 + 8 \times 4.5 + 3 \times 5.0}{20} = \frac{73.5}{20} = 3.675$			

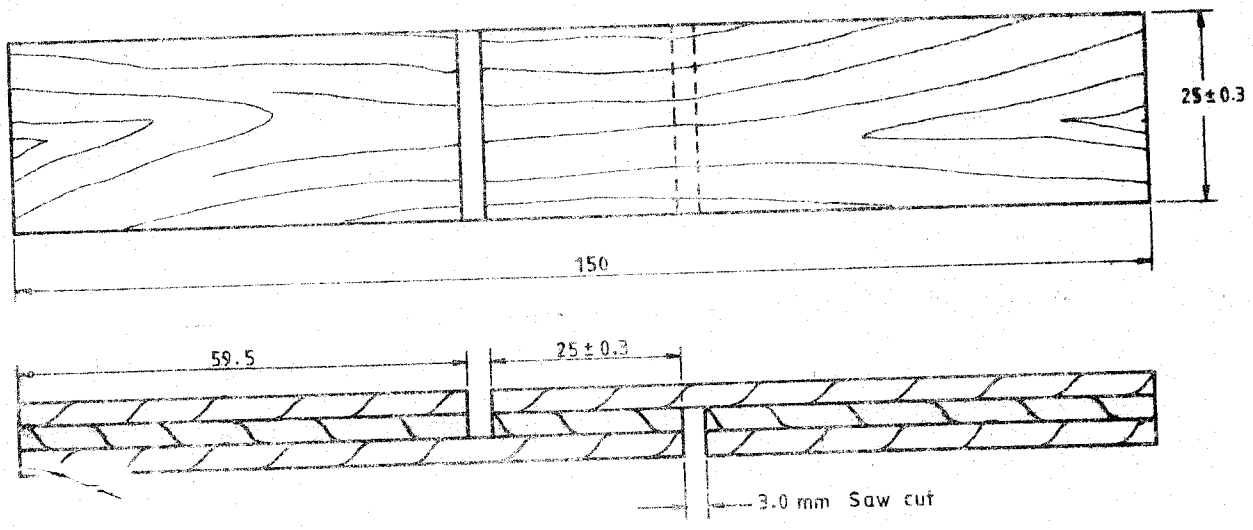
Preservative treated or untreated plywood can be considered durable if the index of condition of the test stakes at the termination of the test is not greater than 2.5.

8.10 Termination of the test

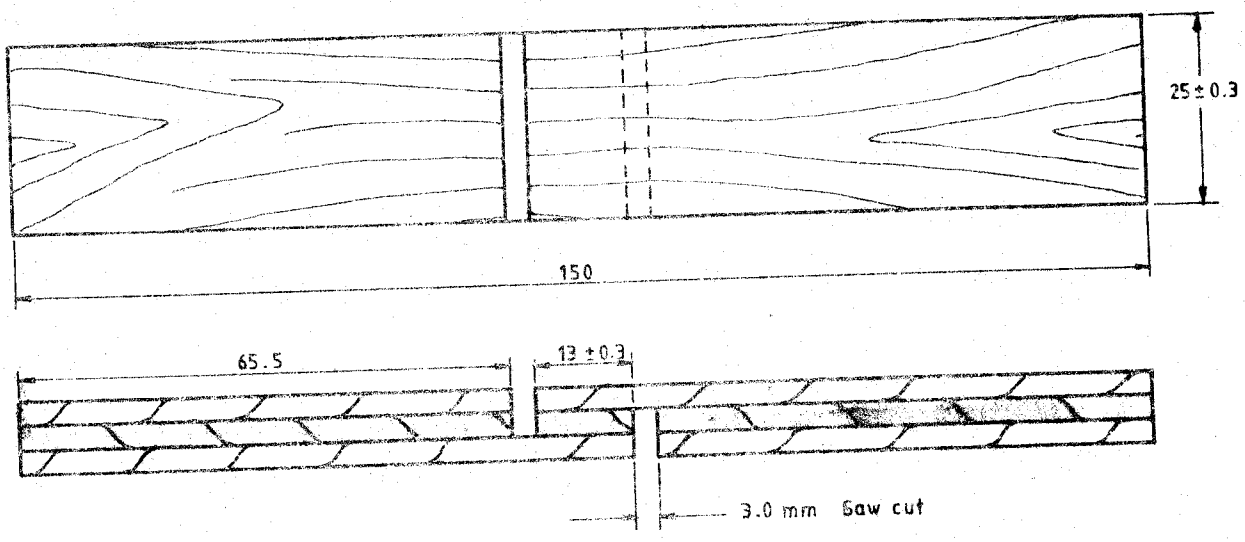
Terminate the test when the index of condition of the test stakes at any inspection is greater than 4.5 or when the index of condition of the control stakes at any inspection is greater than 1.5.

8.11 Expression of results

Index of condition for each group of test stakes or control stakes shall be given at periodic inspections and at the termination of the test.



1A



1B

All dimensions in millimetres

FIGURE 1 – Test specimen for glue shear strength test.

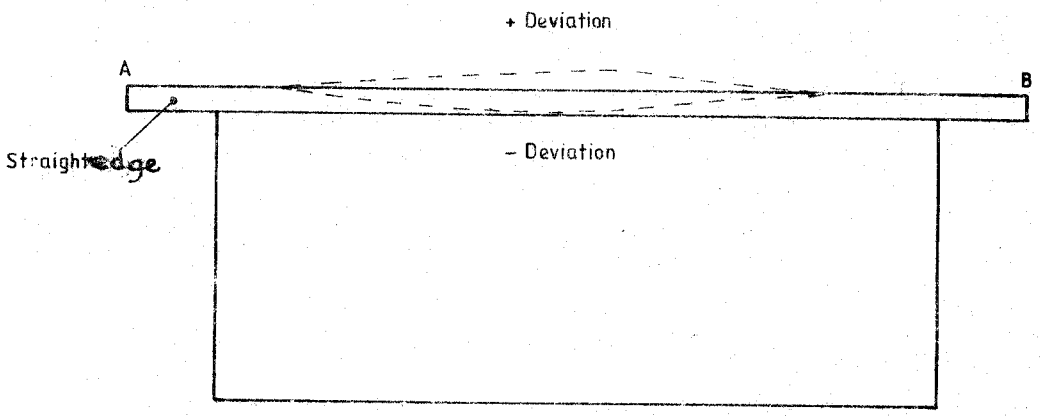
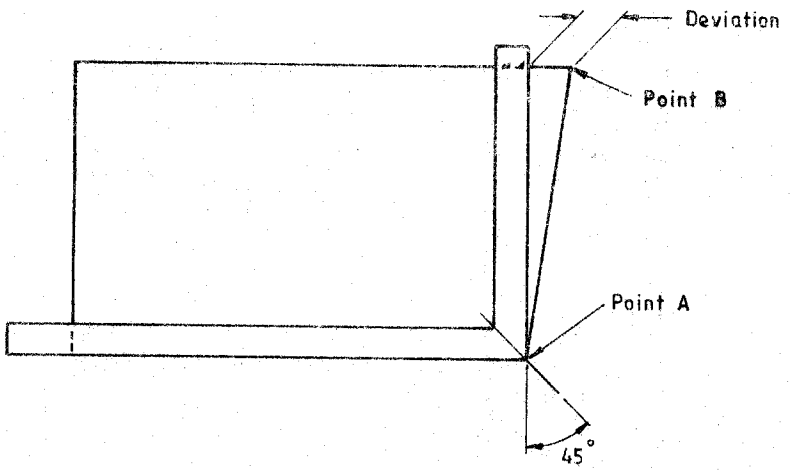
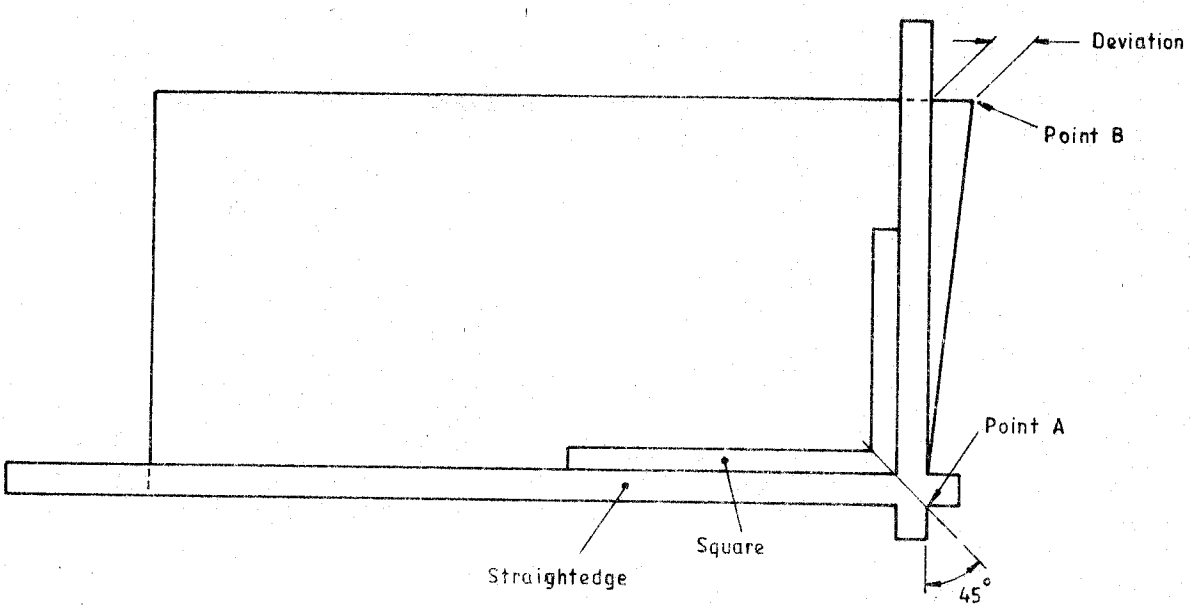


FIGURE 2 Measurement of edge straightness



(a) Measurement when the edge of the panel being assessed does not exceed 1 m



(b) Measurement when the edge of the panel being assessed exceeds 1 m

FIGURE 3 Measurement of squareness