BRITISH STANDARD

BS 5669-1: 1989

Incorporating Amendment Nos 1, 2, 3 and 4

Particleboard —

Part 1: Methods of sampling, conditioning and test

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Timber Standards Policy Committee (TIB/-) to Technical Committee TIB/14, upon which the following bodies were represented:

British Cement Association
British Plastics Federation
British Woodworking Federation
Department of the Environment (Building Research Establishment)
Department of the Environment (Property Services Agency)
European Structural Panel Association
Flat Roofing Contractors Advisory Board
Furniture Industry Research Association
International Cement Bonded Particleboard Federation
National Federation of Roofing Contractors
National House-building Council
Timber Research and Development Association
Timber Trade Federation
United Kingdom and Ireland Particleboard Association
Zurich Municipal Building Guarantee

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Contents

Foreword

BS 5669 has been prepared under the direction of the Timber Standards Policy Committee. This revision supersedes BS 5669:1979, which is withdrawn.

Since BS 5669:1979 was published, the range of particleboards available has continued to grow. The format of the 1979 edition, which covered only four board types, did not permit the expansion necessary to include additional types of particleboard and this revision therefore comprises a series of Parts of BS 5669 as follows.

— *Part 1: Method of sampling, conditioning and test;*

— *Part 2: Specification for wood chipboard;*

— *Part 3: Specification for oriented strand board (OSB);*

— *Part 4: Specification for cement bonded particleboard;*

— *Part 5: Code of practice for the selection and application of particleboards for specific purposes.*

The methods of sampling, conditioning and test given in this Part of BS 5669 are derived from the now withdrawn BS 1811 and BS 2604, and from Appendix A and Appendix B of BS 5669:1979.

Many of the test methods from Appendix A of BS 5669:1979 have been retained, but the inclusion of a new structural grade of wood chipboard (C5) in BS 5669-2 and the additional type of material specified in BS 5669-4 has required the development of further methods given in this Part of BS 5669. The deletion of types C3 and C4 wood chipboard from BS 5669-2 and their replacement by types C3(M) and C4(M) has also required the addition of a further test method, clause **27**, *Determination of moisture resistance under cyclic exposure,* to this Part. Determination of some board properties, e.g. fire properties, is made using methods already given in other British Standards, and in such cases cross-references are given in the appropriate clauses of BS 5669-2 and BS 5669-4.

Not all the methods of test given in this Part of BS 5669 are called up in BS 5669-2 and BS 5669-4. They are given, however, because they have been found useful for purposes of development and research and, in some cases, for comparison of particleboards with other wood-based panel products. To enable the user to distinguish between the tests in BS 5669-2 and BS 5669-4, they are listed in Appendix A, which also indicates tests introduced for the first time in this Part of BS 5669.

The test methods for assessing particleboards given in this Part of BS 5669 can be applied to all the board types specified in BS 5669-2 and BS 5669-4, thus permitting direct comparison of property levels among all particleboards. Grade stresses and moduli derived from the specification for type C5 boards in BS 5669-2 are included in BS 5268-2.

In this revision attention has been paid to comparability and equivalence of test methods with ISO[1)]and European (CEN[2)]) standards, and also the recommendations of Technical Committee TIB/26 for uniformity of methods of test for plywood, fibre building boards and particleboards.

The question of providing precision data for the methods of test has been considered by the Technical Committee responsible for this standard, but it is deemed that such data are not applicable to nonhomogeneous materials.

[1)] ISO = International Organization for Standardization.

[2)] CEN = European Committee for Standardization.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 42, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This Part of BS 5669 describes methods for the selection of boards and the sampling and conditioning of such boards and of test pieces, methods for the preparation of test specimens from such test pieces and methods of test for determining specific board properties.

Appendix A gives cross-references for the test methods and the requirements specified in BS 5669-2, BS 5669-3 and BS 5669-4.

Appendix B gives guidance on the use of quality control charts and methods of sampling.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 5669 the definitions given in BS 6100-4.3 apply together with the following.

2.1
lot

quantity of boards manufactured or produced under conditions that are presumed uniform

2.2
test board

board required for testing or to provide test specimens

NOTE Test boards may be of any size of whole boards available, or may consist of 600 mm widths cut from boards at right angles to the direction of production.

2.3
test piece

piece cut from a test board

2.4
test specimen

piece cut from a test piece to comply with the dimensions required for any of the appropriate tests

Section 2. Methods of sampling, conditioning and preparation of test specimens and determination of dimensions and mass of test specimens

3 Sampling

3.1 Methods of sampling (excluding for determination of extractable formaldehyde)

NOTE Guidance on the use of quality control charts for random sampling during manufacture is given in Appendix B.

When a consignment (lot) is to be tested (for example for compliance of one or more properties with the mean quality levels for a particular board type) the sample shall consist of six boards taken at random from the lot. Six test pieces shall be selected at random from each board.

3.2 Method of sampling for determination of extractable formaldehyde

3.2.1 *For quality control.* At appropriate intervals, three test pieces selected by random sampling (see **B.2**) shall be cut from a single board. Each test piece shall be conditioned in accordance with clause **4** and further subdivided to provide a mass of test specimens as required by clause **22**. The three groups of test specimens shall be placed in a container and mixed thoroughly. A quantity of test specimens having a mass of 160 g to 170 g shall be taken from the mixed sample for each test.

3.2.2 *For consignment (lot) testing.* The procedure described in **3.2.1** shall be followed except that the sample shall consist of three boards taken at random. Three test pieces selected in accordance with **3.1** shall be taken from each board and conditioned in accordance with clause **4**. The appropriate quantity of test specimens shall then be cut and mixed in accordance with **3.2.1**. A sample of 160 g to 170 g of test specimens shall be taken from the mixed samples for the determination of extractable formaldehyde.

4 Conditioning of whole boards, test pieces and test specimens

Whole boards, test pieces and test specimens selected in accordance with clause **3** shall be conditioned to constant mass in an atmosphere of 20 ± 2 °C and 65 ± 5 % r.h. (or 45 ± 5 % r.h. in the case of the formaldehyde test described in clause **22**).

NOTE Constant mass is considered to be attained when two successive weighings carried out at an interval of 24 h do not differ by more than 0.1 % of the mass of the board, test piece or test specimen.

5 Preparation of test specimens

Test specimens shall be cut from test pieces that have been conditioned to constant mass in accordance with clause **4**. The dimensions and/or mass shall be as required for the appropriate test method. All edges shall be at right angles to the board surface.

6 Determination of dimensions and mass of test specimens

6.1 Apparatus

6.1.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

6.1.2 *Micrometer,* having flat and parallel measuring surfaces 16 ± 1 mm diameter and means, such as a weight, spring or slipping clutch, to apply a pressure of approximately 0.02 N/mm^2 to the measuring surfaces. It shall be graduated to allow readings to an accuracy of 0.01 mm.

6.1.3 *Sliding caliper,* with jaws not less than 3.5 mm thick and graduated to allow readings to an accuracy of 0.1 mm.

6.1.4 *Steel rule,* graduated in divisions of 1.0 mm.

6.1.5 *Balance,* capable of determining mass to the nearest 0.01 g.

6.2 Procedure

6.2.1 *Length and width.* Measure the width and length of the test specimen to the nearest 0.1 mm or 1.0 mm, as appropriate to the test method, using either the sliding caliper (**6.1.3**) or the steel rule (**6.1.4**). When using the sliding caliper, apply the jaws slowly to the edge of the test specimen at an angle of approximately 45°, as shown in Figure 1, and record the result.

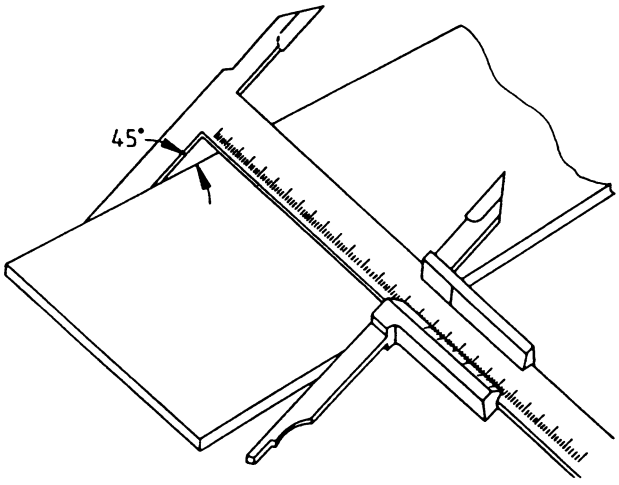


Figure 1 — Measurement of length and width using a sliding caliper

6.2.2 *Thickness.* Apply the micrometer (**6.1.2**) to the test specimen at the point(s) indicated in the appropriate test method. The thickness at each point shall be expressed to the nearest 0.01 mm, or the mean thickness shall be calculated and recorded from two or more measurements as required by the test method.

6.2.3 *Mass.* Weigh the test specimen to the nearest 0.1 g, using the balance (**6.1.5**) and record the result.

Section 3. Methods of test for specific properties

7 Determination of dimensions of boards

7.1 Determination of length and width

7.1.1 *Principle.* Whole boards are measured with a metal tape or rule.

7.1.2 *Test specimens.* Test specimens shall be whole boards of any size as supplied by the manufacturer and conditioned in accordance with clause **4**.

7.1.3 ***Apparatus***

7.1.3.1 *General.* The apparatus shall be periodically calibrated.

7.1.3.2 *Steel tape or rule,* of sufficient length to measure the greatest dimension of the test specimen, graduated to allow a reading to an accuracy of 1.0 mm.

7.1.4 *Procedure.* Apply the steel tape or rule (**7.1.3.2**) to each edge of the board in turn on a line approximately 25 mm from, and parallel to, the edge. Measure each edge to the nearest 1 mm and record the results.

7.1.5 *Calculation and expression of results.* The mean of the two pairs of length and width measurements shall be calculated and expressed to the nearest 1.0 mm as the length and width of the board.

7.2 Determination of thickness

7.2.1 *Principle.* Whole boards are measured using a micrometer.

7.2.2 *Test specimens.* Test specimens shall be in accordance with **7.1.2**.

7.2.3 ***Apparatus***

7.2.3.1 *General.* The apparatus shall be periodically calibrated.

7.2.3.2 *Micrometer* as described in **6.1.2**.

7.2.4 *Procedure.* Apply the micrometer (**7.2.3.2**) to three points, selected at random, along the long edges of the board and approximately 25 mm from the edge. Measure the thickness to the nearest 0.05 mm and record the results.

7.2.5 *Calculation and expression of results.* The mean of the six measurements shall be calculated and the board thickness shall be expressed to the nearest 0.05 mm.

7.3 Determination of edge straightness

7.3.1 *Principle.* A metal straight edge is applied to the edge of the board and the deviation of the board edge from the straight edge is measured using a steel rule (see Figure 2).

7.3.2 *Test specimens.* Test specimens shall be in accordance with **7.1.2**.

7.3.3 ***Apparatus***

7.3.3.1 *Steel rule* graduated in 0.5 mm divisions.

7.3.3.2 *Metal straight edge.*

7.3.4 *Procedure.* Apply the metal straight edge (**7.3.3.2**) to each edge of the board in turn, as shown in Figure 2. Measure the maximum gap(s) between the straight edge and the board, using the steel rule (**7.3.3.1**), and record the result to the nearest 0.5 mm.

7.3.5 *Expression of results.* The maximum deviation from a straight line connecting the corners of the board shall be expressed in millimetres per metre, to the nearest 1 mm. The result shall be designated (+) if the edge is convex or (–) if the edge is concave.

7.4 Determination of squareness

7.4.1 *Principle.* Deviations from the inner edges of a try square are measured (see Figure 3).

7.4.2 *Test specimens.* Test specimens shall be in accordance with **7.1.2**.

7.4.3 ***Apparatus***

7.4.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

7.4.3.2 *Steel rule* as described in **7.3.3.1**.

7.4.3.3 *Try square* with arms not less than 1.0 m in length and an accuracy of ± 0.2 mm/m.

7.4.3.4 *Metal straight edges.*

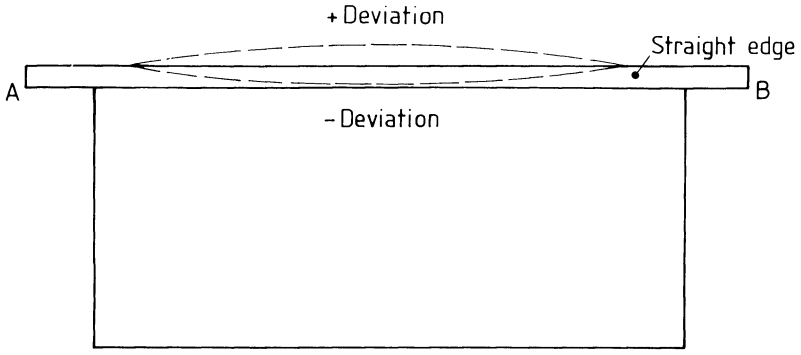


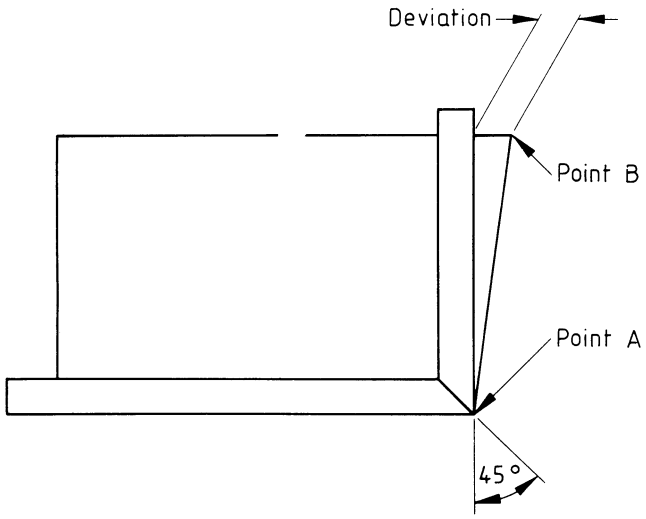
Figure 2 — Measurement of edge straightness

7.4.4 *Procedure.* Apply the try square (**7.4.3.3**) to each corner of the board in turn, as shown in Figure 3(a).

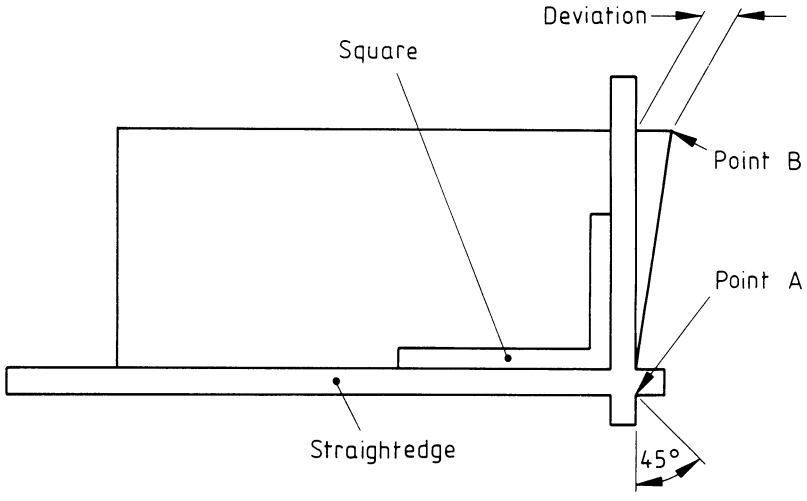
The 45° line shall coincide with the corner being measured (point A) and one arm of the try square shall be coincident with the longer edge of the board.

Measure the maximum deviation between the try square and the edge of the board at point B to the nearest 0.5 mm using the steel rule (**7.4.3.2**). If the side lengths of the board exceed 1 m, use the try square in conjunction with two straight edges as shown in Figure 3(b). Make measurements as previously described in this paragraph.

7.4.5 *Expression of results.* The maximum deviation between the try square and the edge of the board at any one corner shall be expressed to the nearest 0.5 mm per metre length as the squareness of the board. The designations (+) shall be given if the angle is greater than 90° and (–) if the angle is less than 90°.



(a) Where side lengths do not exceed 1 m



(b) Where side lengths exceed 1 m

Figure 3 — Measurement of squareness of boards

7.5 Determination of flatness (only applicable to boards greater than 10 mm in thickness)

7.5.1 *Principle.* The deviation of the board surface from a cord or metal straight edge in contact with both arrises and parallel to either the long edge or short edge is measured. Twist is determined similarly, but along the diagonals of the board.

7.5.2 *Test specimens.* Test specimens shall be in accordance with **7.1.2**.

7.5.3 ***Apparatus***

7.5.3.1 *Steel rule* as described in **7.3.3.1**.

7.5.3.2 *Metal straight edge or thin cord.*

7.5.4 *Procedure.* Stand the test specimen upright on a horizontal floor, so that it is unrestrained, with the shorter edges vertical. Place the straight edge (**7.5.3.2**) (or stretch the thin cord) vertically across the test specimen so that it touches both arrises at points approximately 25 mm from one end.

Measure the maximum distance between the straight edge or cord and the board surface to the nearest 1 mm, using the steel rule (**7.5.3.1**). Repeat this procedure at the centre of the test specimen and at the opposite end. Record the maximum deviation found at any point to the nearest 1 mm.

NOTE This method measures curvature across the board width. Curvature in the length of the board may be similarly measured by placing the straight edge or cord parallel to the longer dimension. Twist can be measured as deviation from a line connecting the diagonally opposite corners of the test specimen.

7.5.5 *Expression of results.* The maximum curvature in width and length or twist shall be expressed to the nearest 1 mm.

8 Determination of density

8.1 Principle

Density is determined from the calculated volume of the test specimen and its mass.

8.2 Test specimens

Test specimens shall be 100 mm square × board thickness and shall be conditioned and prepared in accordance with clauses **4** and **5**.

8.3 Apparatus

8.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

8.3.2 *Micrometer* as described in **6.1.2**.

8.3.3 *Sliding caliper* as described in **6.1.3**.

8.3.4 *Balance* as described in **6.1.5**.

8.4 Procedure

Measure the thickness of the test specimen in accordance with **6.2.2** at the four points shown in Figure 4 using the micrometer (**8.3.2**). Record the mean of the four values as the thickness of the test specimen.

Measure the length and width of the test specimen in accordance with **6.2.1** using the sliding caliper (**8.3.3**).

Calculate the volume of the test specimen.

Weigh the test specimen to the nearest 0.1 g.

8.5 Calculation and expression of results

The density of the test specimen ρ (in kg/m^3) shall be calculated from the equation

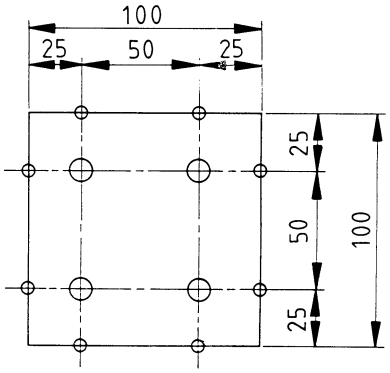
$$\rho = \frac{M}{V}\ 10^6$$

where

M is the mass of the test specimen (in g);

V is the volume of the test specimen (in mm^3).

NOTE The density of the board may be calculated from the mean of the densities of all the test specimens taken from that board and expressed to the nearest 10 kg/m^3.



All dimensions are in millimetres.

Figure 4 — Measuring points on the test specimen for determination of density

9 Determination of moisture content

9.1 Principle

The loss in mass of a test specimen dried to constant mass at 103 ± 2 °C is determined.

9.2 Test specimens

Test specimens shall be 100 mm square × board thickness.

9.3 Apparatus

9.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

9.3.2 *Balance,* as described in **6.1.5**.

9.3.3 *Air circulating oven,* capable of maintaining an internal temperature of 103 ± 2 °C.

9.3.4 *Desiccator,* containing anhydrous calcium chloride or silica gel.

9.4 Procedure

Weigh each test specimen and record the mass to the nearest 0.1 g in accordance with **6.2.3**.

NOTE 1 Test specimens should be cut and weighed as quickly as possible after sampling.

Place the test specimens in the air circulating oven (**9.3.3**) at 103 ± 2 °C, ensuring that they are separated by at least 25 mm on all sides. Dry the test specimens to constant mass, cool in the desiccator (**9.3.4**), reweigh and record the mass to the nearest 0.1 g.

NOTE 2 Constant mass is considered to be attained when two successive weighings carried out at an interval of not less than 6 h do not differ by more than 0.1 % of the mass.

NOTE 3 Test specimens should be cooled to approximately room temperature in the desiccator before weighing.

9.5 Calculation and expression of results

The moisture content of the test specimen ω, expressed as a percentage by mass, shall be calculated from the equation

$$\omega = \frac{(M_h - M_o)}{M_o} 100$$

where

M_h is the mass of the test specimen before drying (in g);

M_o is the mass of the test specimen after drying to constant mass (in g).

The result shall be expressed to the nearest 0.1 %.

10 Determination of bending strength by applying a load perpendicular to the plane of the board (flatwise bending: modulus of rupture)

NOTE Certain particleboards have different property levels along the length of the original board and across its width. Where it is required to test the properties of such boards, two sets of test specimens should be prepared. One set should have its major axis parallel to the maximum strength dimension and the other should have its major axis at right angles to that dimension.

10.1 Principle

A load is applied at the centre of a test specimen resting on two supports. The load is increased until fracture occurs.

10.2 Test specimens

Test specimens shall be conditioned and prepared in accordance with clauses **4** and **5**. They shall be 100 mm wide, with a length of 25 T + 25 mm to the nearest 25 mm, where T is the nominal thickness of the board (in millimetres), but shall not exceed a length of 1 025 mm.

10.3 Apparatus

10.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

10.3.2 *Micrometer,* as described in **6.1.2**.

10.3.3 *Sliding caliper,* as described in **6.1.3**.

10.3.4 *Testing machine,* fitted with adjustable supports as shown in Figure 5, capable of applying sufficient load to cause the test specimen to fail. The machine shall comply with the requirements for repeatability and accuracy specified for grade 1.0 in BS 1610-1.

10.4 Procedure

10.4.1 Mark the midpoints of each long edge and measure the width of the test specimen between these points in accordance with **6.2.1**. Record the width to the nearest 1.0 mm.

Measure the thickness of the test specimen at the mid-length, about 20 mm from each edge, in accordance with **6.2.2** and record the mean of the two values as the thickness of the test specimen to the nearest 0.1 mm.

10.4.2 Support the test specimen on parallel cylindrical metal rollers at a distance apart of 25 T to the nearest 25 mm, where T is the nominal thickness of the board (in millimetres), and not exceeding a length of 1 000 mm, and apply the load via a similar bar positioned at centre span, as shown in Figure 5(a). The metal rollers shall be free to rotate on ball, or other, bearings. Set the cross head speed to approximately 5 mm/min and continue loading until the maximum applied load is attained. Record the maximum applied load (in newtons) to the nearest 5 N or 1 %, whichever is the greater.

10.5 Calculation and expression of results

The bending strength P (in N/mm^2) shall be calculated from the equation

$$P = \frac{3WY}{2BT^2}$$

where

W is the maximum applied load for the test specimen (in N);

Y is the span between the centres of supports (in mm);

B is the width of the test specimen (in mm);

T is the mean thickness of the test specimen (in mm).

NOTE Where the supply of material is limited, bending strength may be determined on the test specimens used to determine modulus of elasticity. Furthermore, 100 mm lengths cut from the failed bending strength specimens, remote from the point of failure, may be used for the determination of density and/or moisture content.

The result shall be expressed to the nearest 1 N/mm^2.

11 Determination of modulus of elasticity

NOTE Certain particleboards have different property levels along the length of the original board and across its width. Where it is required to test the properties of such boards, two sets of test specimens should be prepared. One set should have its major axis parallel to the maximum strength dimension and the other should have its major axis at right angles to that dimension.

11.1 Determination of modulus of elasticity perpendicular to the plane of the board in bending

11.1.1 *Principle.* A load is applied at the centre of a test specimen resting on two supports and the deflection of the test specimen for a given load is measured.

11.1.2 *Test specimens.* Test specimens shall be in accordance with **10.2**.

11.1.3 ***Apparatus***

11.1.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

11.1.3.2 *Micrometer* as described in **6.1.2**.

11.1.3.3 *Sliding caliper* as described in **6.1.3**.

11.1.3.4 *Testing machine* as described in **10.3.4**.

11.1.3.5 *Dial micrometer or displacement transducer,* capable of measuring to 0.01 mm.

11.1.4 *Procedure.*Determine the width and thickness of the test specimen in accordance with **10.4.1**.

Support the test specimen in accordance with **10.4.2** and as shown in Figure 5. Set the cross head speed of the testing machine (**11.1.3.4**) at approximately 5 mm/min and apply an increasing load to the test specimen. Measure the vertical deflection S as shown in Figure 5(b) at midspan relative to the two positions of support. Increase the load up to one-third of the anticipated failing load of the test specimen.

When using machines that automatically plot load-deflection, the deflection recorded shall be that of the test specimen and shall not include indentation or movement within the loading head, linkages and test specimen support.

Construct a load-deflection curve for the data obtained, as shown in Figure 6.

11.1.5 *Calculation and expression of results.* The modulus of elasticity perpendicular to the plane of the board in bending E_m (in N/mm^2) shall be calculated from the equation

$$E_m = \frac{Y^3 \Delta W}{4BT^3 \Delta S}$$

where

Y is the span between the centres of supports (in mm);

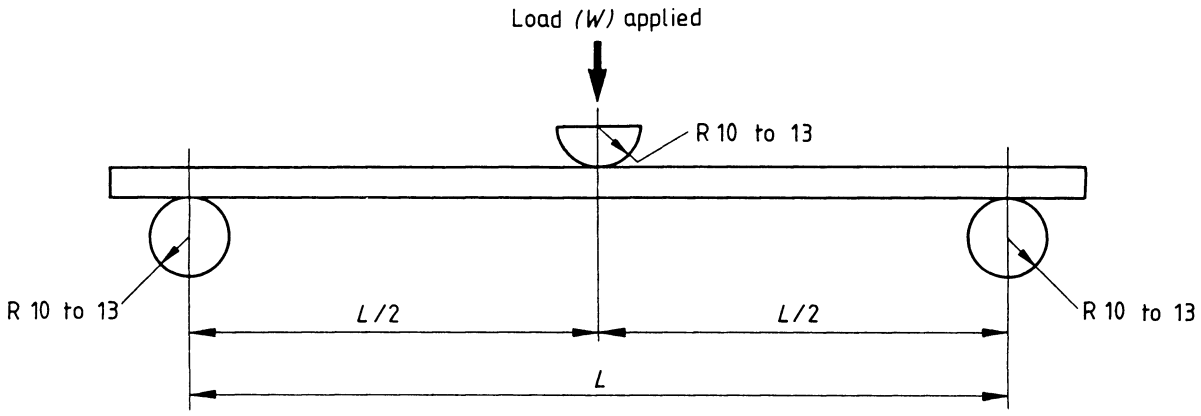
ΔW is the increment in load on the straight line portion of the load deflection curve (in N) (see Figure 6);

B is the width of the test specimen (in mm);

T is the mean thickness of the test specimen (in mm);

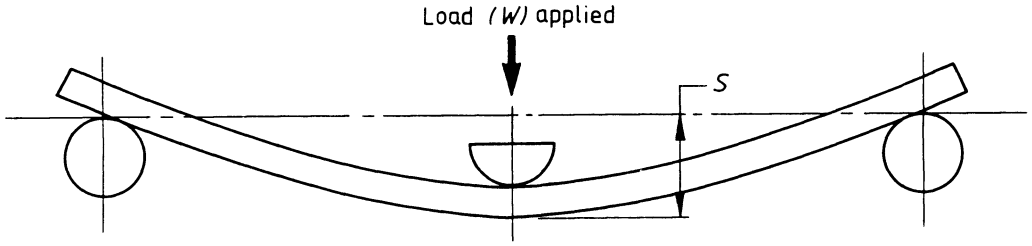
ΔS the increment in deflection corresponding to ΔW increment in load (in mm).

The result shall be expressed to the nearest 10 N/mm^2.



All dimensions are in millimetres.

(a) Test specimen under load for determination of bending strength.



(b) Test specimen under load showing position of maximum deflection ***S*** for determination of modulus of elasticity

Figure 5 — Method of supporting test specimens under load

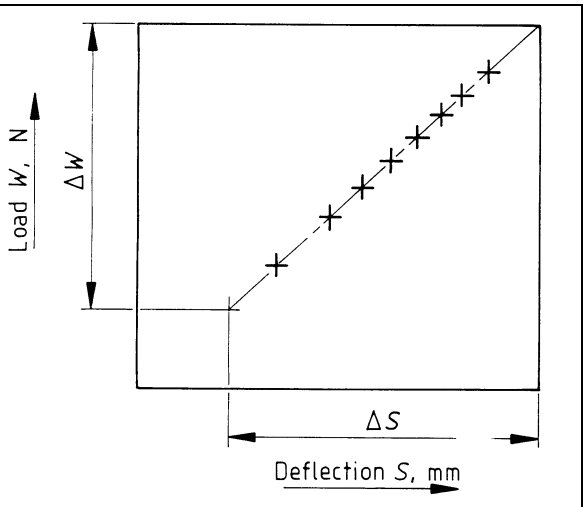


Figure 6 — Load-deflection curve for modulus of elasticity

11.2 Determination of modulus of elasticity parallel to the plane of the board in tension

11.2.1 *Principle.* A tensile load is applied to a test specimen and the extension of the test specimen for a given load is measured.

11.2.2 *Test specimens.* Test specimens shall be the full thickness of the board, of the form shown in Figure 7(a), conditioned and prepared in accordance with clauses **4** and **5**.

NOTE Test specimens may be shaped using a template in conjunction with a vertical spindle moulder.

11.2.3 ***Apparatus***

11.2.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

11.2.3.2 *Sliding caliper* as described in **6.1.3**.

11.2.3.3 *Testing machine* as described in **10.3.4**, fitted with wedge-grips to hold the test specimen. The grips shall be attached to the test machine cross heads with universal joints, to ensure alignment of the load with the axis of the test specimen.

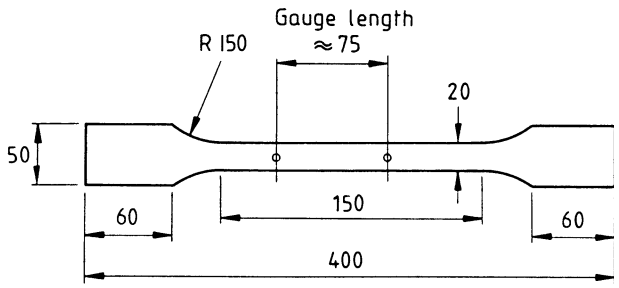
NOTE As an alternative to wedge-grips, the test specimen may be attached to the universal joints via 10 mm diameter metal pins, inserted through holes drilled in the ends of the test specimens as shown in Figure 7(b).

11.2.3.4 *Displacement transducers* having a resolution of 0.001 mm.

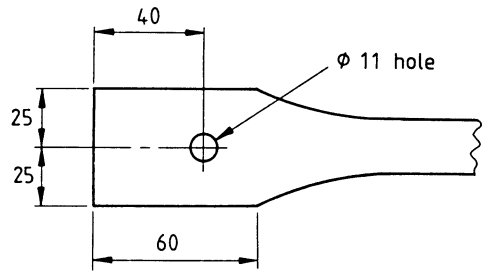
11.2.4 *Procedure.* Measure the width and thickness of the test specimen, at the midpoint of the reduced cross section, to the nearest 0.1 mm, using the sliding caliper (**11.2.3.2**). Calculate the cross-sectional area to the nearest 1 mm^2.

Place the test specimen in the testing machine (**11.2.3.3**), using either wedge-grips or metal pins, as described in **11.2.3.3**. Adjust the cross head speed of the testing machine to approximately 1.0 mm/min.

Measure the elongation of the test specimen on opposite faces within the 75 mm gauge length (see Figure 7(a). The displacement signal should be fed to a suitable load-deflection recorder so that a load-deflection curve can be produced. The method of connection should ensure that the deflection is derived from the mean of the two signals.



(a) Form of test specimen



(b) Location of holes for mounting test specimens using metal pins

All dimensions are in millimetres.

Figure 7 — Test specimen for determination of modulus of elasticity in tension

11.2.5 *Calculation and expression of results.* The modulus of elasticity in tension E_t (in N/mm^2) shall be calculated from the equation

$$E_t = \frac{\Delta W}{\Delta L_g} \frac{L_g}{A}$$

where

L_g is the gauge length of the test specimen (in mm);

A is the cross-sectional area of the test specimen (in mm^2);

ΔW is the increment in load on the straight line portion of the load-extension curve (in N);

ΔL_g is the increment of extension of the gauge length (L_g) corresponding to ΔW (in mm).

The result shall be expressed to the nearest 10 N/mm^2.

11.3 Determination of modulus of elasticity parallel to the plane of the board in compression

11.3.1 *Principle.* An increasing compressive load is applied to a test specimen and the compression of the test specimen as the load increases is measured.

11.3.2 *Test specimens.* Test specimens shall be cuboid, of width and thickness T and length $4T$, where T is the nominal thickness of the board, and shall be conditioned and prepared in accordance with clauses **4** and **5**.

11.3.3 ***Apparatus***

11.3.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

11.3.3.2 *Sliding caliper* as described in **6.1.3**.

11.3.3.3 *Testing machine,* as described in **10.3.4**, fitted with flat, parallel loading surfaces with diameter or side length of at least 75 mm.

11.3.3.4 *Displacement transducers* having a resolution of 0.001 mm.

11.3.4 *Procedure.* Measure the width and thickness of the test specimen to the nearest 0.1 mm using the sliding caliper (**11.3.3.2**). Calculate the cross-sectional area to the nearest 1.0 mm^2.

Place the test specimen between the loading surfaces of the testing machine (**11.3.3.3**), with its length vertical. Adjust the cross head speed of the testing machine to approximately 1.0 mm/min.

Attach the transducers to the midpoint of a central gauge length of 2.8 T (where T is the thickness of the board in millimetres). Apply an increasing compressive load to the test specimen and measure the cross head displacement, using the transducers (**11.3.3.4**), up to one-third of the anticipated failing load of the test specimen.

Plot a load-compression curve as described in **11.2.4**.

11.3.5 *Calculation and expression of results.* The modulus of elasticity in compression E_c (in N/mm^2) shall be calculated from the equation

$$E_c = \frac{\Delta W L_g}{\Delta L_g A}$$

where

L_g is the gauge length calculated as 2.8 × test specimen thickness (T) (in mm);

A is the cross-sectional area (in mm^2);

ΔW is the increment in load on the straight line portion of the load-compression curve (in N);

ΔL_g is the reduction of the gauge length corresponding to ΔW increase in load (in mm).

The result shall be expressed to the nearest 10 N/mm^2.

12 Determination of tensile strength

12.1 Determination of tensile strength parallel to the plane of the board

NOTE Certain particleboards have different property levels along the length of the original board and across its width. Where it is required to test the properties of such boards, two sets of test specimens should be prepared. One set should have its major axis parallel to the maximum strength dimension and the other should have its major axis at right angles to the dimension.

12.1.1 *Principle.* A tensile load is applied to the test specimen and the load is increased until failure occurs.

12.1.2 *Test specimens.* Test specimens shall be of the form shown in Figure 7(a), in accordance with **11.2.2**, and shall be conditioned and prepared in accordance with clauses **4** and **5**.

12.1.3 *Apparatus.* This shall be as described in **11.2.3**. Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

12.1.4 *Procedure.* Determine the width and thickness of the test specimen at the midpoint of the reduced cross section using the sliding caliper. Calculate the cross-sectional area to the nearest 1.0 mm^2.

Place the test specimen in the testing machine, using either wedge-grips or metal pins, as described in **11.2.3.3**.

Adjust the cross head speed of the testing machine to approximately 1 mm/min. Apply a continuously increasing load until the maximum applied load is attained. Record the maximum applied load of the test specimen to the nearest 10 N but ignore the results of test specimens that fail outside the parallel throat section [see Figure 7(a)].

12.1.5 *Calculation and expression of results.* The tensile strength of the test specimen parallel to the plane of the board J_1 (in N/mm^2) shall be calculated from the equation

$$J_1 = \frac{W}{A}$$

where

W is the maximum applied load for the test specimen (in N);

A is the cross-sectional area of the test specimen (in mm^2).

The result shall be expressed to the nearest 0.1 N/mm^2.

12.2 Determination of tensile strength perpendicular to the plane of the board (internal bond strength or transverse tensile strength)

12.2.1 *Principle.* A load is applied to the board via blocks bonded to the surfaces and the load is increased until the maximum applied load is attained.

12.2.2 *Test specimens.* Test specimens shall be 50 ± 1.0 mm × 50 ± 1.0 mm × board thickness and conditioned and prepared in accordance with clauses **4** and **5**. Before testing, suitable plywood and/or hardwood blocks also conditioned and prepared in accordance with clauses **4** and **5**, or metal blocks, shall be bonded to the surface of the test specimen.

NOTE 1 Suitable types of block are shown in Figure 8(a).
NOTE 2 The adhesive should form a strong enough bond to transmit the full load to the test specimen. Polyvinyl acetate (PVAC) or urea formaldehyde adhesives have been found suitable for plywood and hardwood, and hot melt or epoxy adhesives have been found suitable for metal blocks.

12.2.3 ***Apparatus***

12.2.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

12.2.3.2 *Sliding caliper* as described in **6.1.3**.

12.2.3.3 *Testing machine* as described in **10.3.4**, fitted with suitable self-aligning linkage.

NOTE A suitable linkage is shown in Figure 8(b). Other designs are also suitable, provided a universal joint is incorporated to ensure alignment.

12.2.4 *Procedure.* Bond the blocks to the test specimens. Ensure the blocks do not move while the adhesive is setting. Leave until the adhesive is fully set.

Measure the length and width of the test specimens to the nearest 0.1 mm using the sliding caliper (**12.2.3.2**). Calculate the area of the test specimen in square millimetres to the nearest 1.0 mm^2.

Place the assembled test specimens in the testing machine, using either wedge-grips or metal pins, as described in **11.2.3.3**.

Set the cross head speed of the testing machine to approximately 1 mm/min and continue loading until the maximum applied load is attained. Record the maximum applied load to within 1.0 %. Discard results for test specimens that have failed by detachment of a block.

12.2.5 *Calculation and expression of results.* The tensile strength of the test specimen perpendicular to the plane of the board J_r (in N/mm^2) shall be calculated from the equation

$$J_r = \frac{W}{A}$$

where

W is the maximum applied load for the test specimen (in N);

A is the area of the test specimen (in mm^2).

The result shall be expressed to the nearest 0.01 N/mm^2.

13 Determination of panel shear strength and panel shear modulus

NOTE Certain particleboards have different property levels along the length of the original board and across its width. Where it is required to test the properties of such boards, two sets of test specimens should be prepared. One set should have its major axis parallel to the maximum strength dimension and the other should have its major axis at right angles to that dimension.

13.1 Panel shear strength

13.1.1 *Principle.* An increasing load is applied to one of the diagonals of a rectangular test specimen until the maximum applied load is attained. Strength is calculated from the cross-sectional area of the test specimen and the failing load.

13.1.2 *Test specimens*

13.1.2.1 *Boards of thickness up to and including* 25 mm

NOTE See Figure 9.

Test specimens shall be of the form and dimensions shown in Figure 9(a). The reinforcing pads of plywood (or hard-wood with a density greater than 600 kg/m^3) shall be attached with a suitable adhesive and located as shown in Figure 10. Component parts shall be conditioned and prepared, before gluing, in accordance with clauses **4** and **5**, as shall the completed assembly.

13.1.2.2 *Boards of thickness over* 25 mm

NOTE See Figure 11.

Test specimens shall be of the form and dimensions shown in Figure 11(a). The rails shall have minimum dimensions of 35 mm × 115 mm × approximately 700 mm long and shall be glued to both sides of the test piece along both long edges using an appropriate adhesive.

The rails shall be of hardwood with a density greater than 600 kg/m^3 and all rails and test pieces shall be conditioned to the appropriate moisture content in accordance with clause **4** prior to gluing. Completed test specimens shall be similarly conditioned.

13.1.3 *Apparatus*

13.1.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

13.1.3.2 *Micrometer* as described in **6.1.2**.

13.1.3.3 *Testing machine* as described in **10.3.4**.

13.1.3.4 *Load application frames,* as follows.

a) *Boards of thickness up to and including* 25 mm. As shown in Figure 9(a).

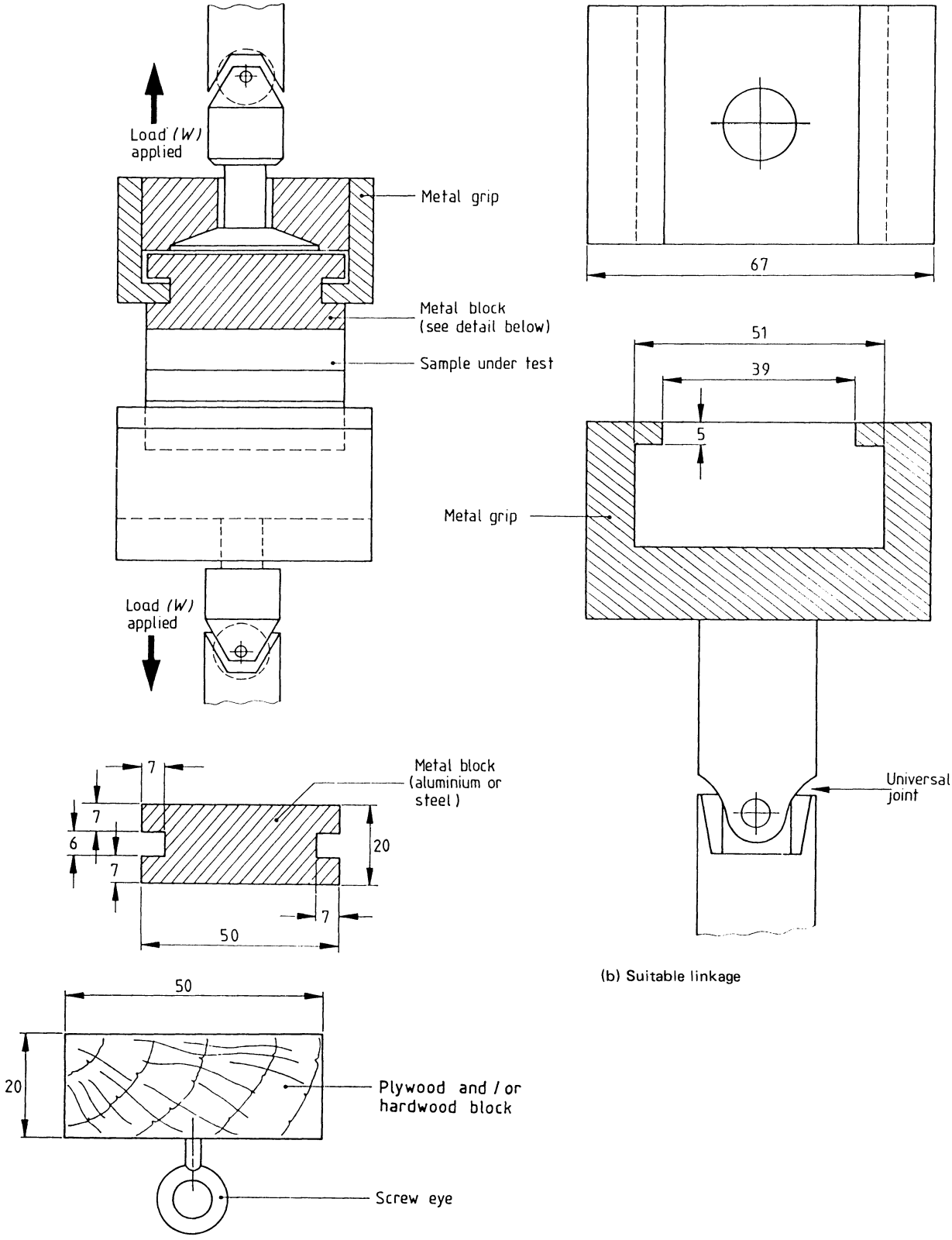
b) *Boards of thickness over* 25 mm. For the two-rail shear test piece, as shown in Figure 11(b).

NOTE The forces applied by the testing machine divide into two components, namely the compressive forces applied to the ends of the rails and the lateral forces which are transmitted to the sides of the rails by means of wooden spacing blocks.

13.1.4 *Procedure*

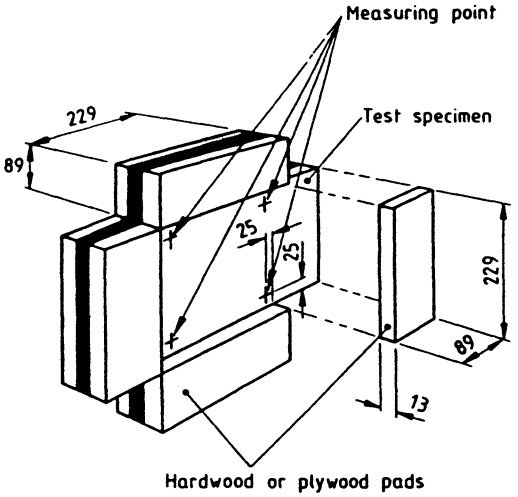
13.1.4.1 *Boards of thickness up to and including* 25 mm. Measure the thickness of the test specimen at the four points shown in Figure 9(a) to the nearest 0.01 mm. Record the mean of the four measurements to the nearest 0.1 mm as the test specimen thickness.

Bolt the test specimen into the clamping frame [**13.1.3.4** a)]. Mount the test specimen in its frame into the testing machine (**13.1.3.3**). Set the cross head speed of the testing machine to approximately 2 mm/min. Apply an increasing compressive load to the assembled test specimen until the maximum applied load is attained, and record the maximum applied load.

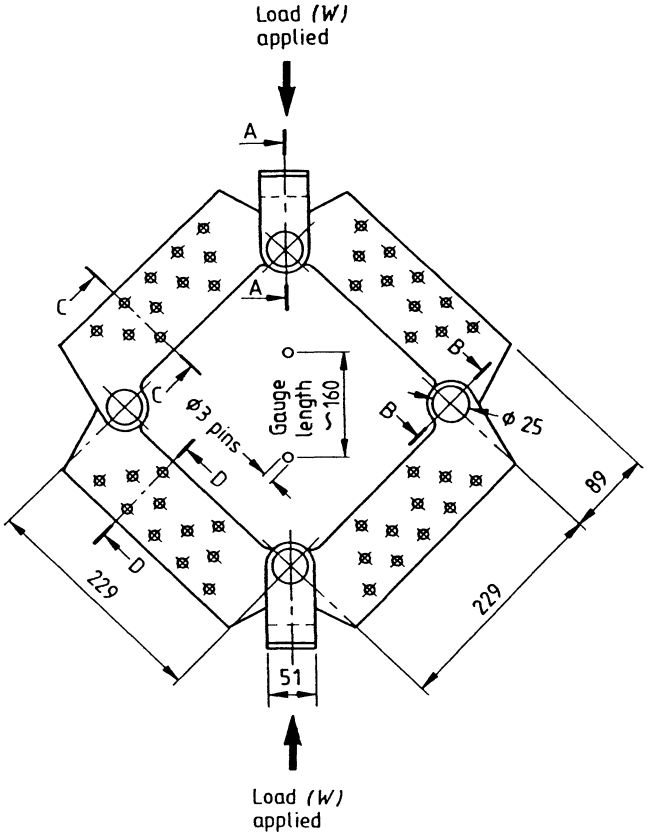


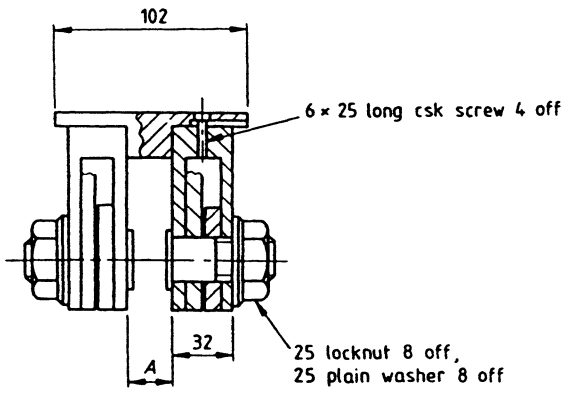
All dimensions are in millimetres.

Figure 8 — Apparatus for determination of tensile strength perpendicular to the plane of the board

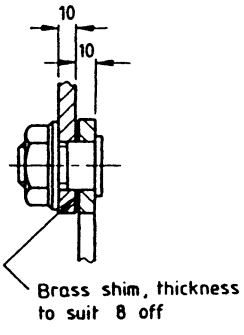


(a) Location of reinforcing pads
All dimensions are in millimetres.

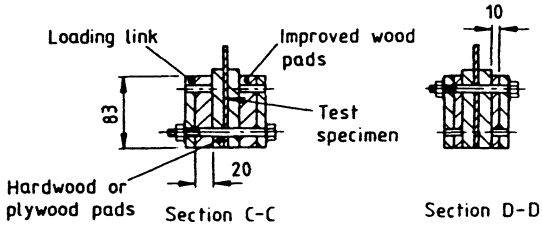




Section A-A



Section B-B



Section C-C

Section D-D

(b) Arrangement of test specimen showing dimensions and location of holes for transducer attachments and details of linkage design

Figure 9 — Test specimen and apparatus for determination of panel shear properties for boards of thickness up to and including 25 mm

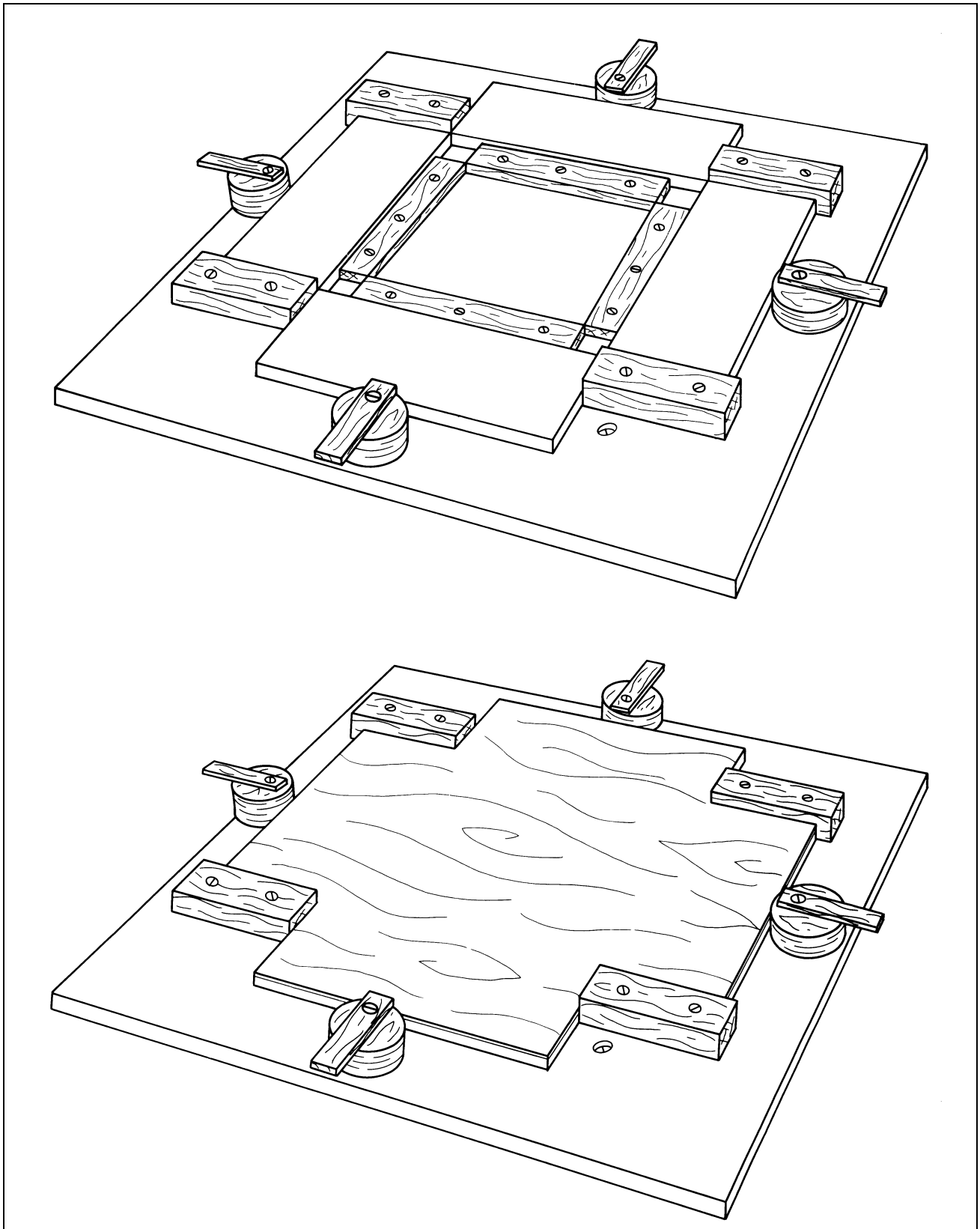
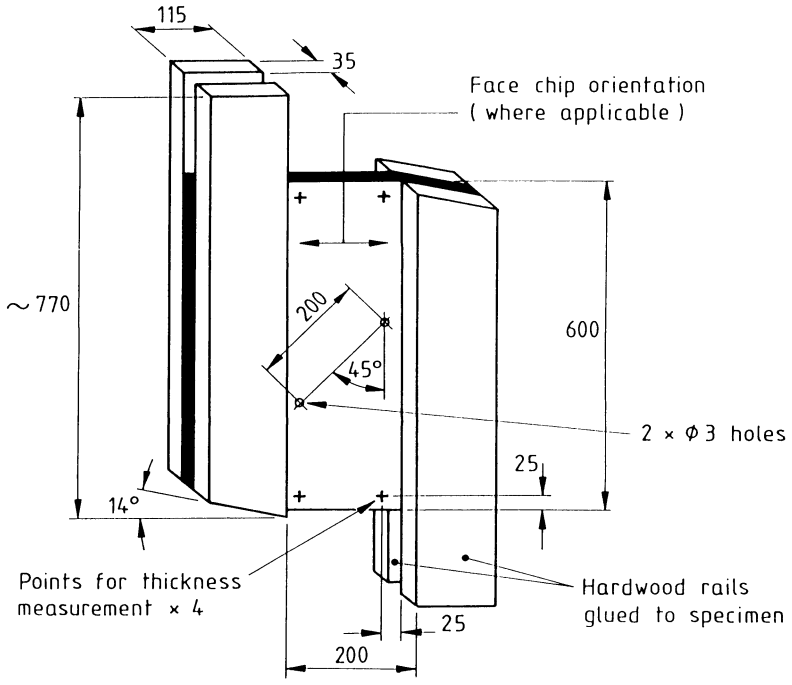
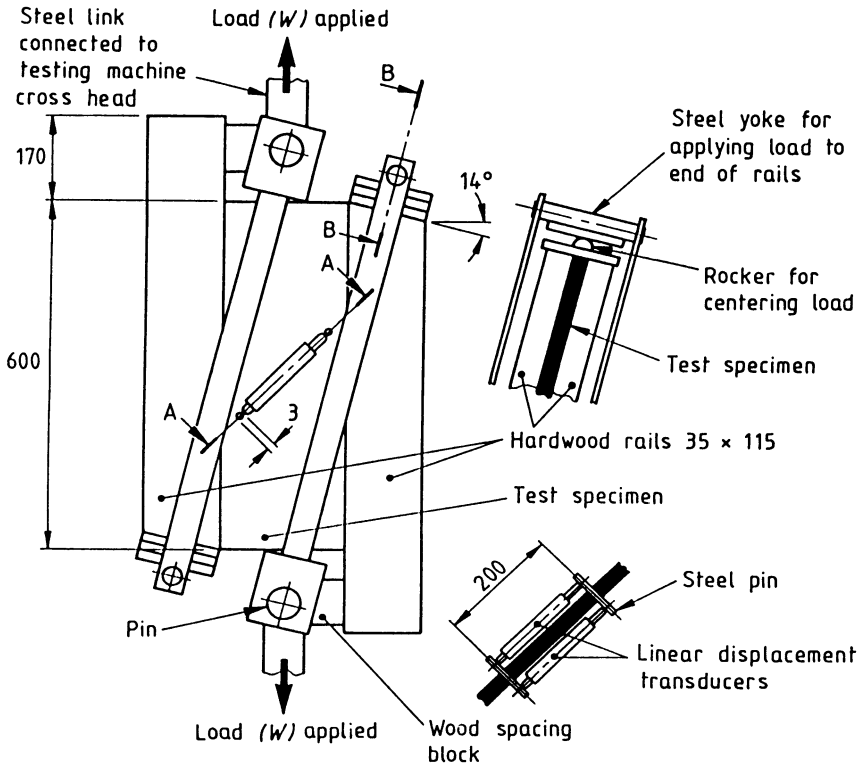


Figure 10 — Jig for location of reinforcing pads



(a) Details



(b) Loading and strain measuring apparatus for test specimen for panel shear test

All dimensions are in millimetres.

Figure 11 — Test specimen and apparatus for determination of panel shear properties for boards of thickness over 25 mm

13.1.4.2 *Boards of thickness over 25 mm.* Measure the thickness of the test specimen at the four points shown in Figure 11(a) to the nearest 0.01 mm. Record the mean of the four measurements to the nearest 0.1 mm as the test specimen thickness.

Mount the test specimen in the loading apparatus [**13.1.3.4** b)] as shown in Figure 11(b). Set the cross head movement of the testing machine (**13.1.3.3**) to approximately 2 mm/min. Apply an increasing tensile load to the assembled apparatus until the maximum applied load is attained and record the maximum applied load.

13.1.5 ***Calculation and expression of results***

13.1.5.1 *Boards of all thicknesses up to and including* 25 mm. The panel shear strength Q (in N/mm^2) shall be calculated from the equation

$$Q = \frac{0.707\,W}{LT}$$

where

W is the maximum applied load for the test specimen (in N);

L is the side length of the test specimen (in mm);

T is the thickness of the test specimen (in mm).

The result shall be expressed to the nearest 0.1 N/mm^2.

13.1.5.2 *Boards of thickness over* 25 mm. The panel shear strength Q (in N/mm^2) shall be calculated from the equation

$$Q = \frac{W}{LT}$$

where W, L and T are as defined in **13.1.5.1**.

The result shall be expressed to the nearest 0.1 N/mm^2.

13.2 Panel shear modulus

13.2.1 *Principle.* An increasing load is applied to one of the diagonals of a rectangular test specimen until the maximum applied load is attained. The compression of the test specimen between two points along a diagonal axis is measured. The shear modulus is calculated from the relationship of load and compression.

13.2.2 *Test specimens.* Test specimens shall be of the appropriate form depending on the thickness of the board (see **13.1.2**) and conditioned and prepared in accordance with clauses **4** and **5**. In addition two 3 mm diameter holes shall be drilled along one diagonal as shown in Figure 9(a) or Figure 11(a) as appropriate.

13.2.3 ***Apparatus***

13.2.3.1 *General.* Use the equipment described in **13.1.3.2** to **13.1.3.4** and that described in **13.2.3.2**. Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

13.2.3.2 *Displacement transducers* with a resolution of 0.001 mm.

13.2.4 *Procedure.* Measure and record the test specimen thickness and attach the test specimen to the appropriate load application frame (**13.1.3.4**).

Insert 3 mm diameter metal pins into the holes described in **13.2.2** and attach the displacement transducers (**13.2.3.2**) to the pins via a linkage. Insert the whole assembly into the test rigs as shown in Figure 9(b) or Figure 11(b) as appropriate.

Set the cross head speed of the testing machine to approximately 2 mm/min.

Apply an increasing load to the assembled test specimen and record the reducing distance between the steel pins (gauge points) using the transducer signal.

Construct a load-compression curve, using the mean of the two transducer readings expressed to the nearest 0.002 mm. Use at least 12 and preferably 15 data points, or employ continuous plotting using a suitable recorder.

13.2.5 ***Calculation and expression of results***

13.2.5.1 *Boards of thickness up to and including* 25 mm. The panel shear modulus G (in N/mm^2) shall be calculated from the equation

$$G = 0.3536\,\frac{\Delta W L_g}{\Delta L_g L T}$$

where

L_g is the gauge length of the test specimen (in mm);

L is the side length of the test specimen (in mm);

T is the thickness of the test specimen (in mm);

ΔW is the increment on linear portion of the load-deformation curve (in N);

ΔL_g is the reduction of the gauge length corresponding to ΔW (in mm).

The result shall be expressed to the nearest 25 N/mm^2.

13.2.5.2 *Boards of thickness over* 25 mm. The panel shear modulus G (in N/mm^2) shall be calculated from the equation

$$G = 0.5 \frac{\Delta W L_g}{\Delta L_g L T}$$

where L_g, L, T, ΔW and ΔL_g are as defined in **13.2.5.1**.

The results shall be expressed to the nearest 50 N/mm^2.

14 Determination of transverse shear strength

NOTE 1 Certain particleboards have different property levels along the length of the original board and across its width. Where it is required to test the properties of such boards, two sets of test specimens should be prepared. One set should have its major axis parallel to the maximum strength dimension and the other should have its major axis at right angles to that dimension.
NOTE 2 This test method is applicable only to boards that are 18 mm to 50 mm in thickness.

14.1 Principle

A test specimen of regular cuboid form is placed in a shearing tool that can apply a compressive force parallel to both the centreline of the test specimen and the original board faces. The force is increased until the maximum applied load is attained. The shear strength is calculated from the maximum applied force and the cross-sectional area of the test specimen.

14.2 Test specimens

Test specimens shall be cubes 50 mm × 50 mm × 50 mm with a tolerance of – 2 mm on each dimension. Where the board thickness is less than 50 mm, the nominal thickness shall be increased to 50^{+0}_{-2} mm by bonding packing pieces of equal thickness to the original board faces.

14.3 Apparatus

14.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

14.3.2 *Sliding caliper,* as described in **6.1.3**.

14.3.3 *Testing machine,* as described in **10.3.4**, but fitted with parallel loading surfaces.

14.3.4 *Shearing tool,* as shown in Figure 12.

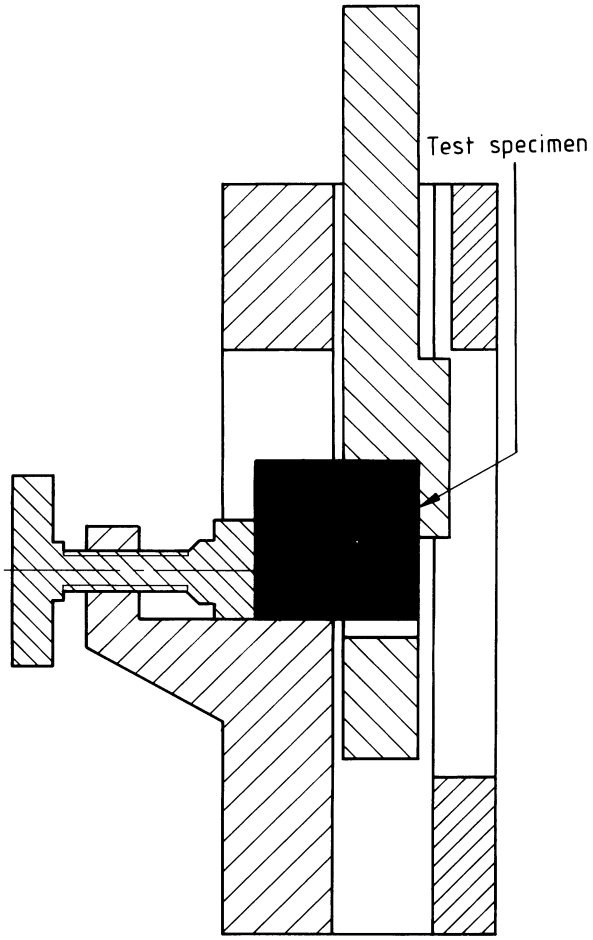


Figure 12 — Shearing tool for determination of transverse shear strength

14.4 Procedure

Mark the centreline of the test specimen, parallel to the original board faces, and measure the thickness in both the vertical and horizontal planes to the nearest 0.1 mm. Calculate the cross-sectional area of the test specimen to the nearest 1.0 mm^2.

Place the test specimen in the shearing tool (**14.3.4**) and stand the shearing tool between the loading faces of the testing machine (**14.3.3**). Set the cross head speed of the testing machine to approximately 0.5 mm/min and apply an increasing loading until the maximum applied load is attained. Record the maximum applied load to the nearest 10 N.

14.5 Calculation and expression of results

The transverse shear strength of the test specimen Z (in N/mm^2) shall be calculated from the equation

$$Z = \frac{W}{A}$$

where

W is the maximum applied load for the test specimen (in N);

A is the cross-sectional area of the test specimen (in mm^2).

The result shall be expressed to the nearest 0.1 N/mm^2.

15 Determination of concentrated load strength

15.1 Principle

A load is applied to the surface of a rigidly supported test specimen, via a punch (loading head) of specified area, until the maximum applied load is attained.

15.2 Test specimen

Test specimens shall be square with a minimum side length of $6T + 125$ mm and of full board thickness, where T is the board thickness in millimetres.

15.3 Apparatus

15.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

15.3.2 *Micrometer* as described in **6.1.2**.

15.3.3 *Testing machine* as described in **10.3.4**, fitted with a suitable circular punch of 25 mm diameter.

NOTE Although a 25 mm punch is required for testing for compliance with BS 5669-2, the test procedure can also be carried out with a 50 mm punch.

15.3.4 *Steel support plate and clamping device* as shown in Figure 13. The steel support plate shall have a circular aperture at its centre with a diameter of $6T + 50$ mm, where T is the board thickness in millimetres, rounded to the nearest 10 mm. The supporting frame shall be rigid.

15.4 Procedure

Mark the diagonals on one face of the test specimen. Measure the thickness at a point on each diagonal 25 mm from each corner, using the micrometer (**15.3.2**). Calculate the test specimen thickness to the nearest 0.1 mm from the mean of the four values.

Place the test specimen in the support fixture as shown in Figure 13. Rigidly clamp the test specimen so that no uplift occurs at the board edges when loaded.

Position the complete assembly in the testing machine (**15.3.3**) so that the centre of the punch is directly over the intersection of the diagonal marks.

Apply a continuously increasing load to the test specimen until the maximum applied load is attained, and record the maximum applied load. The movement of the punching head shall be controlled by a constant rate of loading such that the maximum applied load is obtained after 90 ± 45 s.

15.5 Calculation and expression of results

The concentrated load strength C_L (in N/mm thickness) shall be calculated from the equation

$$C_L = \frac{W}{T}$$

where

W is the maximum applied load for the test specimen (in N);

T is the thickness of the test specimen (in mm).

The result shall be expressed to the nearest 0.1 N/mm.

16 Bond durability tests

16.1 Determination of tensile strength perpendicular to the plane of the board after cyclic treatment

16.1.1 *Principle.* The tensile strength perpendicular to the board plane is measured after subjecting the test specimen to cyclic exposure to water, freezing and dry heat.

16.1.2 *Test specimens.* Test specimens shall be in accordance with **12.2.2**, but the loading blocks shall not be applied until after completion of the cyclic test treatment.

16.1.3 ***Apparatus***

16.1.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

16.1.3.2 *Sliding caliper* as described in **6.1.3**.

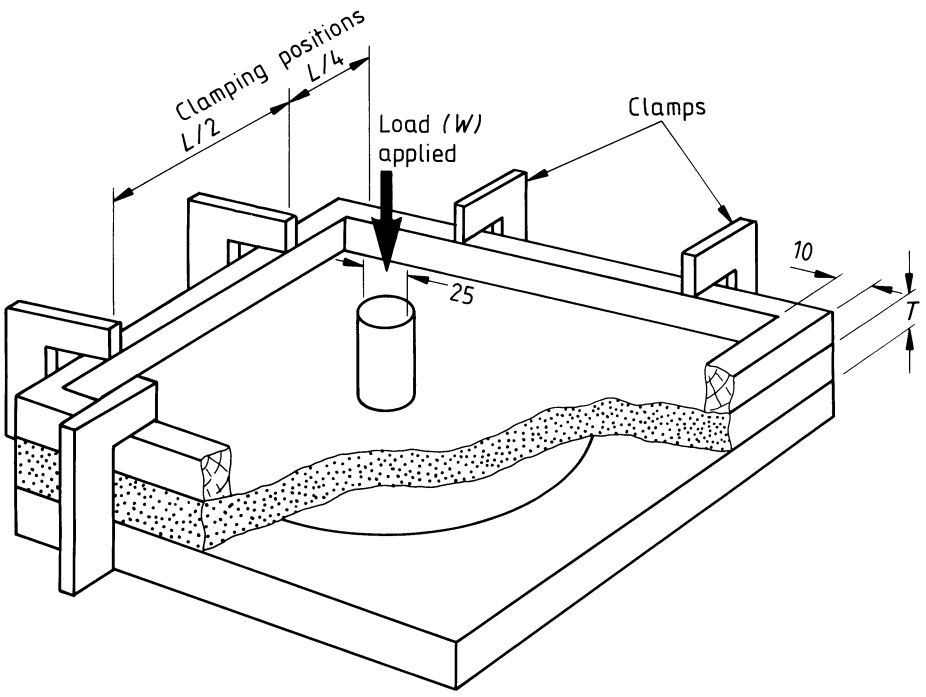
16.1.3.3 *Testing machine* as described in **12.2.3.3**.

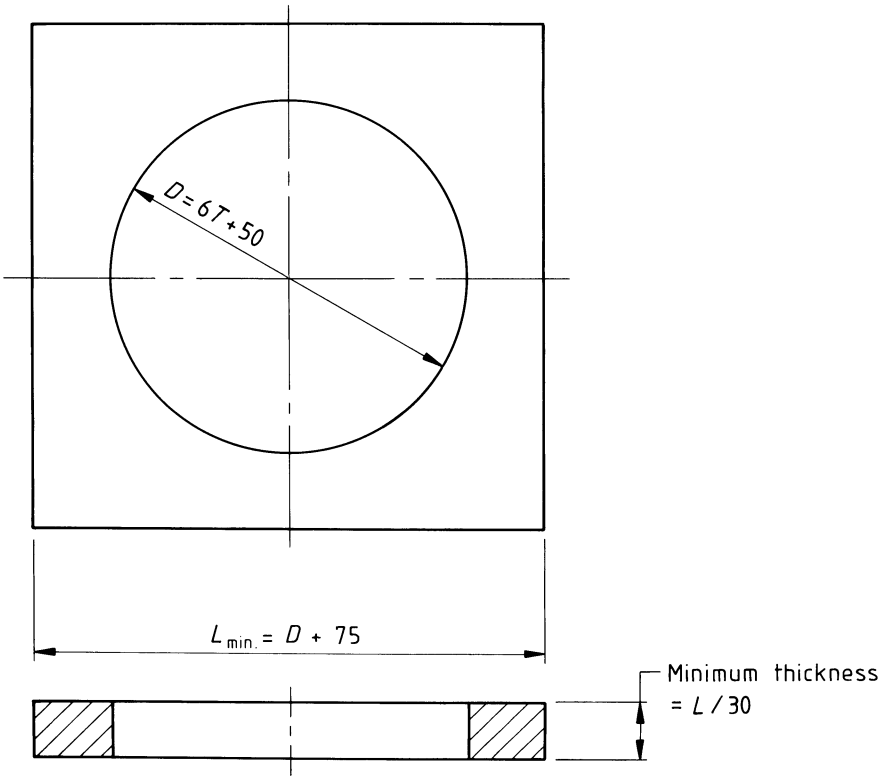
16.1.3.4 *Air circulating oven* capable of maintaining a temperature of 70 ± 2 °C. Air velocity inside the oven shall be approximately 1.5 m/s.

16.1.3.5 *Refrigerator or cold room,* capable of maintaining a temperature of – 12 °C or lower.

16.1.3.6 *Flat bottomed container,* at least 145 mm deep and 130 mm wide.

16.1.3.7 *Thermometers.*





All dimensions are in millimetres.

Figure 13 — Support arrangement for concentrated load test

16.1.4 *Procedure.* Immerse the test specimens in water at 20 ± 2 °C in the flat bottomed container for 72 h with the original board faces vertical. They shall be separated by at least 15 mm from each other, and supported by a wire mesh or narrow bars at least 15 mm from the base of the container. The depth of water above the test specimens shall be between 25 mm and 50 mm.

Remove the test specimens from the water and remove excess surface water with a cloth.

Place the test specimens, standing vertically and separated from one another, in the refrigerator or cold room (**16.1.3.5**) at – 12 °C or less and leave them for 24 h.

Remove the frozen test specimens and place them immediately in the oven (**16.1.3.4**) at 70 ± 2 °C. They shall be placed flat and separated from one another. Leave them for 72 h.

Repeat the above cyclic treatment twice more, making three cycles in all. To prevent the test specimens from tapering, they shall be subjected to the cyclic treatment in a symmetrical manner by rotating them through 180° at the end of each cycle. That is to say, the original bottom edge of the test specimen in cycle one becomes the top edge in cycle two and the bottom edge again in cycle three.

NOTE 1 The three cycles thus take 21 days to complete.

Recondition the test specimens to constant mass in accordance with clause **4**. Bond suitable blocks to the test specimens as described in **12.2.2** and test in accordance with **12.2.4**.

NOTE 2 If the surfaces of the test specimens are rough or uneven as a result of the cyclic treatment, they may be smoothed by rubbing the test specimen on a piece of abrasive paper, held on a flat surface, before bonding on the loading blocks.

16.1.5 *Calculation and expression of results.* The tensile strength perpendicular to the plane of the board J_r (in N/mm^2) shall be calculated and expressed in accordance with **12.2.5**.

16.2 Determination of increase in thickness (residual swelling) after cyclic treatment

16.2.1 *Principle.* The difference in the thickness of the test specimen before and after cyclic treatment is determined.

16.2.2 *Test specimen.* Test specimens shall be 100 mm × 100 mm × board thickness and conditioned and prepared in accordance with clauses **4** and **5**.

16.2.3 ***Apparatus***

16.2.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

16.2.3.2 *Micrometer* as described in **6.1.2**.

16.2.3.3 *Air circulating oven* as described in **16.1.3.4**.

16.2.3.4 *Refrigerator or cold room,* as described in **16.1.3.5**.

16.2.3.5 *Flat bottomed container,* as described in **16.1.3.6**.

16.2.3.6 *Thermometers.*

16.2.4 *Procedure.* Mark the four measuring points on the specimen as shown in Figure 4, using a waterproof marking pen.

NOTE For simplicity, a square template 100 mm × 100 mm, with 18 mm diameter holes located at the four points indicated in Figure 4, may be used to mark the measuring points on the test specimen.

Calculate the mean thickness of the test specimens in accordance with **8.4**.

Expose the test specimens to three cycles of the treatment in accordance with **16.1.4**. Recondition the test specimens to constant mass in accordance with clause **4** and remeasure the mean thickness, using exactly the same points as before.

16.2.5 *Calculation and expression of results.* The residual swelling of the test specimen R_s, expressed as a percentage, shall be calculated from the equation

$$R_s = \frac{(T_2 - T_1)}{T_1}\ 100$$

where

T_1 is the original mean thickness of the test specimen (in mm);

T_2 is the mean thickness of the test specimen after cyclic treatment and reconditioning (in mm).

The result shall be expressed to the nearest 0.5 %.

16.3 Determination of tensile strength perpendicular to the plane of the board after 2 h immersion in boiling water and redrying at 70 °C

16.3.1 *Principle.* A load is applied to a test specimen, which has been immersed in boiling water and redried at 70 °C, via blocks bonded to the surfaces. The load is increased until fracture of the test specimen occurs.

16.3.2 *Test specimen.* Test specimens shall be 50 ± 0.1 mm × 50 ± 0.1 mm × board thickness and conditioned and prepared in accordance with clauses **4** and **5**.

16.3.3 ***Apparatus***

16.3.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

16.3.3.2 *Sliding caliper* as described in **6.1.3**.

16.3.3.3 *Testing machine* as described in **10.3.4**, fitted with suitable grips.

16.3.3.4 *Water bath* capable of maintaining a temperature of 100 °C.

16.3.3.5 *Flat bottomed watertight tray* not less than 100 mm deep.

16.3.3.6 *Blocks,* of wood or metal, as shown in Figure 8.

16.3.3.7 *Screw eyes* approximately 50 mm long × screw gauge 14 (required for wood blocks only).

16.3.3.8 *Oven* as described in **9.3.3**, but capable of maintaining a temperature of 70 ± 2 °C.

16.3.4 *Procedure.* Measure the side lengths of the test specimen to the nearest 0.1 mm, calculate the area and record the result to the nearest 1.0 mm^2.

Immerse the test specimens in boiling water (**16.3.3.4**) for 2 h with their 50 mm faces vertical. They shall be separated by at least 15 mm from each other and supported by a wire mesh screen or narrow bars at least 15 mm from the base of the container. The depth of water above the test specimens shall be between 25 mm and 50 mm.

After 2 h ± 5 min, remove the test specimens and immerse them in water at 20 ± 5 °C for 60 ± 5 min. The test specimens shall have their faces vertical and shall be separated from each other and from the bottom of the container by not less than 15 mm.

Remove the test specimens from the water, dry them with a cloth or paper towel and place them, with their faces horizontal, in the oven (**16.3.3.8**) at 70 ± 2 °C for 16 h.

Remove the test specimens from the oven, allow them to cool to approximately room temperature and bond loading blocks to the surfaces as described in **12.2.2**. Discard any test specimens that show delamination or nonuniform thickness swelling.

NOTE If, as a result of boiling and drying, the surfaces of the test specimen are rough or uneven, they may be smoothed before bonding on the blocks by rubbing on a piece of abrasive paper, which is held on a flat surface.

Place the assembled test specimens in the machine grips and determine the maximum applied load in accordance with **12.2**. Discard results from test specimens that have failed by detachment of a block. Record the maximum applied load to within 1.0 %.

16.3.5 *Calculation and expression of results.* The tensile strength perpendicular to the plane of the board after boiling and redrying J_b (in N/mm^2) shall be calculated from

$$J_b = \frac{W}{A}$$

where

W is the maximum applied load for the test specimen (in N);

A is the surface area of the test specimen (in mm^2) to the nearest mm^2.

The result shall be expressed to the nearest 0.01 N/mm^2.

16.4 Determination of flatwise bending strength after boiling for 2 h

NOTE Certain particleboards have different property levels along the length of the original board and across its width. Where it is required to test the properties of such boards, two sets of test specimens should be prepared. One set should have its major axis parallel to the maximum strength dimension and the other should have its major axis at right angles to that dimension.

16.4.1 *Principle.* The flatwise bending strength is determined in accordance with clause **10** after the test specimen has been immersed in boiling water.

16.4.2 *Test specimens.* Test specimens shall be in accordance with **10.2**.

16.4.3 ***Apparatus***

16.4.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

16.4.3.2 *Micrometer* as described in **6.1.2**.

16.4.3.3 *Sliding caliper* as described in **6.1.3**.

16.4.3.4 *Testing machine* as described in **10.3.4**.

16.4.3.5 *Water bath,* capable of maintaining a temperature of 100 °C and ensuring adequate circulation of the water.

16.4.3.6 *Flat bottomed container* at least 140 mm deep.

16.4.4 *Procedure.* Immerse the test specimens in boiling water (**16.4.3.5**) for 2 h with their 100 mm faces vertical. They shall be separated by at least 15 mm from each other and supported by a wire mesh screen or narrow bars at least 15 mm from the base of the container. The depth of water above the test specimens shall be between 25 mm and 50 mm.

After 2 h ± 5 min, remove the test specimens and immerse them in water at 20 ± 5 °C in the flat bottomed container for 60 ± 5 min. The test specimens shall have their 100 mm faces vertical and shall be separated from each other and from the base of the container by not less than 15 mm.

Remove the test specimens, dry them with a cloth or paper towel and immediately determine the width, thickness and maximum applied load in accordance with **10.4** and record the results.

16.4.5 *Calculation and expression of results.* The bending strength after immersion in boiling water P_b (in N/mm^2) shall be calculated from the equation

$$P_b = \frac{3WY}{2BT^2}$$

where

W is the maximum applied load for the test specimen (in N);

Y is the span between the supports (in mm);

B is the width of the test specimen (in mm);

T is the mean thickness of the test specimen (in mm).

The result shall be expressed to the nearest 0.1 N/mm^2.

17 Determination of surface soundness

17.1 Principle

The force required to pull off a block bonded to the face of the test specimen is measured.

17.2 Test specimens

Test specimens shall be approximately 75 mm × 75 mm × board thickness and conditioned in accordance with clause **4**. Wooden blocks shall be bonded to the faces.

17.3 Apparatus

17.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

17.3.2 *Testing machine,* as described in **10.3.4** and fitted with suitable grips.

17.3.3 *Wooden blocks,* 40 mm × 40 mm ± 0.25 mm × approximately 20 mm thick.

17.4 Procedure

Mark the diagonals on each face of the test specimen. Bond one wooden block (**17.3.3**) to each face of the test specimen, using the diagonal marks to position it at the centre.

NOTE 1 The adhesive should form a strong enough bond to transmit the full load to the test specimen. PVAC or urea formaldehyde adhesives have been found suitable.

Place the assembled test specimen in the testing machine (**17.3.2**) and apply a tensile load until failure occurs by the separation of a block. Set the cross head speed to approximately 1 mm/min and continue loading until the maximum applied load is attained.

NOTE 2 Where failure occurs other than in the surface the result should be discarded.

17.5 Expression of results

The surface soundness τ (in newtons) shall be the maximum load applied to the test specimen and shall be recorded to the nearest 10 N.

18 Determination of resistance to axial withdrawal of wood screws inserted in the face or edge of the board (face and edge screw holding)

18.1 Principle

The force required to withdraw a wood screw from the test specimen is measured.

18.2 Test specimens

Test specimens shall be not less than 75 mm × 75 mm × board thickness and conditioned in accordance with clause **4**.

18.3 Apparatus

18.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

18.3.2 *Testing machine* as described in **10.3.4**, equipped with suitable devices for holding the test specimen and gripping the screw head as shown in Figure 14.

18.3.3 *Steel countersunk wood screws* with a length of 38 ± 2 mm, a shank diameter of 3.25 ± 0.30 mm and a pitch of 1.45 ± 0.25 mm.

18.3.4 *Twist drill,* 1.5 mm.

18.4 Procedure

Drill a 1.5 mm diameter hole to a depth of 6 mm in the centre of one face and two adjacent edges of the test specimen. Insert a screw into each of the holes to a depth of 13 mm, ensuring that it is upright.

NOTE 1 With boards less than 13 mm thick, the screw placed in the face shall be inserted to the full thickness of the board.
NOTE 2 It is usually impracticable to determine edge screw holding with boards less than 6 mm thick.

Place the test specimen in a stirrup which ensures that the face or edge containing the screw will be at 90° to the direction of the applied load. The test specimen shall not be supported at any point nearer than 13 mm to the axis of the screw as shown in Figure 14. Place the head of the screw in the slotted stirrup. The slots shall be parallel and an easy fit for the shank of the screw.

Set the testing machine (**18.3.2**) to a cross head speed of approximately 1 mm/min and apply an increasing force to each screw in turn. Note the maximum load required to withdraw the screw.

18.5 Expression of results

The face screw holding value α (in newtons) is the maximum load required to withdraw the screw from the test specimen, expressed to the nearest 10 N.

The edge screw holding value β (in newtons) is the mean of the two determinations on each test specimen, expressed to the nearest 10 N.

19 Determination of increase in mass (water absorption) and thickness (swelling) due to general absorption of water

19.1 Determination of increase in mass (water absorption)

19.1.1 *Principle.* The difference in mass of the test specimen before and after immersion in water for a period of either 1 h or 24 h is determined.

NOTE The same test specimens may be used for determination of both water absorption and swelling.

19.1.2 *Test specimens.* Test specimens shall be 100 mm × 100 mm × board thickness and conditioned and prepared in accordance with clauses **4** and **5**.

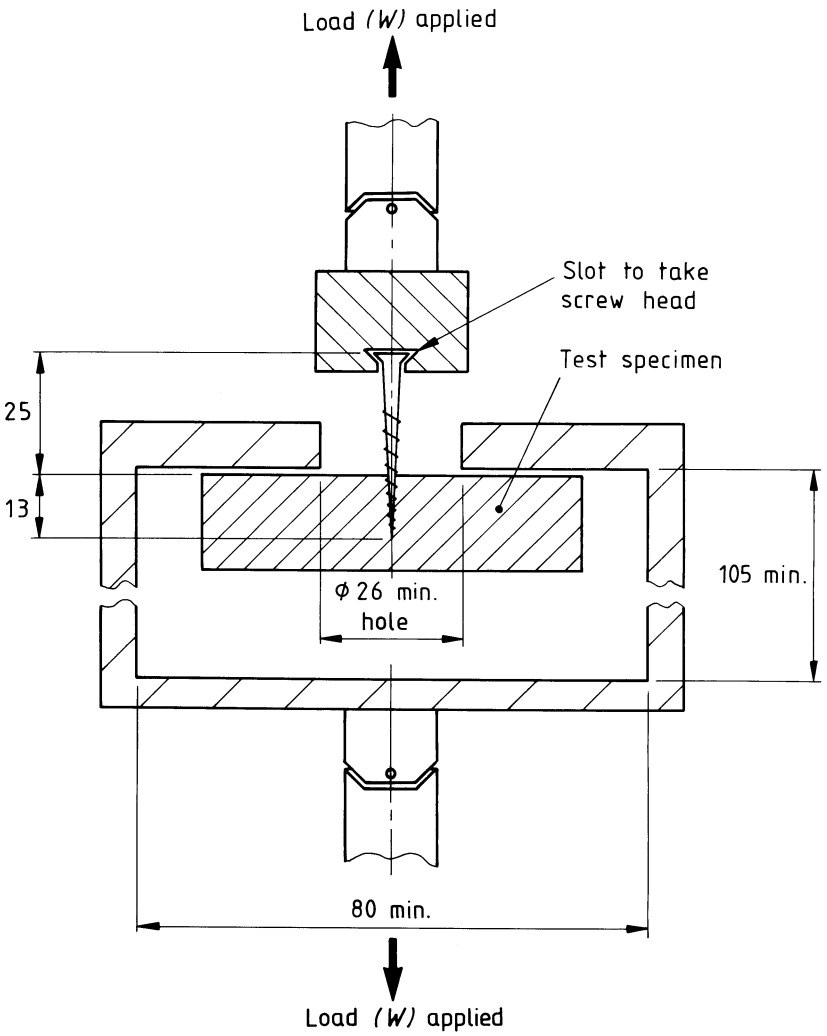


Figure 14 — Stirrups for supporting the test specimen and applying a load to the screw head

19.1.3 ***Apparatus***

19.1.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

19.1.3.2 *Balance* as described in **6.1.5**.

19.1.3.3 *Flat bottomed container* not less than 140 mm deep and 130 mm wide.

19.1.4 *Procedure.* Weigh each test specimen and record the mass to the nearest 0.1 g.

Immerse the test specimens in water at 20 ± 2 °C in the flat bottomed container for either 1 h or 24 h with their 100 mm faces vertical. They shall be separated by at least 15 mm from each other and supported by a wire mesh screen or narrow bars at least 15 mm from the base of the container. The depth of water above the test specimens shall be maintained between 25 mm and 30 mm.

Remove the test specimens from the water after either 1 h or 24 h, as appropriate, and remove excess water with a cloth. Immediately weigh each test specimen and record the mass to the nearest 0.1 g.

19.1.5 *Calculation and expression of results.* The water absorption, O, expressed as a percentage after either 1 h O_1 or 24 h O_{24} shall be calculated from the equation

$$O = \frac{(M_2 - M_1)}{M_1} \ 100$$

where

M_1 is the mass of the test specimen before immersion (in g);

M_2 is the mass of the test specimen after immersion for either 1 h or 24 h (in g).

The result shall be expressed to the nearest 0.1 %.

19.2 Determination of increase in thickness (swelling)

19.2.1 *Principle.* The increase in thickness due to general absorption of water is determined from the differences in thickness of the test specimen before and after immersion in water for either 1 h or 24 h.

19.2.2 *Test specimens.* Test specimens shall be in accordance with **19.1.2**.

19.2.3 ***Apparatus***

19.2.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

19.2.3.2 *Micrometer* as described in **6.1.2**.

19.2.3.3 *Flat bottomed container* as described in **19.1.3.3**.

19.2.4 *Procedure.* Mark the four measuring points on each test specimen in accordance with **16.2.4** and record the mean thickness in accordance with **8.4**.

Immerse the test specimens in water in the flat bottomed container in accordance with **19.1.4**. Remove the test specimens from the water after either 1 h or 24 h, as appropriate, and remove excess water with a cloth. Immediately remeasure and record the mean thickness, using exactly the same points as before.

Immersion causes considerable roughening of the surface of the test specimen. To reduce the effect of this on the result, it is essential to measure the test specimen at exactly the same place, before and after soaking. For simplicity, a square template 100 mm × 100 mm, with 18 mm diameter holes located at the four points indicated in Figure 4, may be used to mark the measuring points on the test specimens.

19.2.5 *Calculation and expression of results.* The swelling of the test specimen λ, expressed as a percentage, after either 1 h λ_1 or 24 h λ_{24} shall be calculated from the equation

$$\lambda = \frac{(T_2 - T_1)}{T_1} \ 100$$

where

T_1 is the mean thickness of the test specimen before immersion (in mm);

T_2 is the mean thickness of the test specimen after immersion for either 1 h or 24 h (in mm).

The result shall be expressed to the nearest 0.1 %.

20 Determination of changes in length, thickness and mass after conditioning at 35 % r.h. and 85 % r.h.

NOTE Certain particleboards have different property levels along the length of the original board and across its width. Where it is required to test the properties of such boards, two sets of test specimens should be prepared. One set should have its major axis parallel to the maximum strength dimension and the other should have its major axis at right angles to that dimension.

20.1 Principle

The length, thickness and mass of the test specimens are determined after conditioning at 25 °C and 65 % r.h. and the length, thickness and mass are determined following the subsequent reconditioning at 25 °C and 35 % r.h. and 25 °C and 85 % r.h. The results are expressed as a percentage increase (+) or decrease (–) of the original value.

20.2 Test specimens

Test specimens shall be 200 mm × 13 mm × board thickness. Positions for measuring changes in thickness shall be clearly marked in the longitudinal centreline of each face, at midlength and at 10 mm from each end. Test specimens shall be conditioned and prepared in accordance with clauses **4** and **5**.

NOTE It is possible to use a single set of test specimens for determination of all three types of change (length, thickness and mass) but see also **20.4**.

20.3 Apparatus

20.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

20.3.2 *Micrometer* as described in **6.1.2**.

20.3.3 *Balance* as described in **6.1.5**.

20.3.4 *Measuring instrument* as shown in Figure 15, which is not to be made of aluminium or other material with a high thermal expansion rate unless the fixture is kept at constant temperature.

20.3.5 *Dial gauge* capable of measuring changes in length of ± 0.05 mm.

20.4 Procedure

20.4.1 *Changes in length.* Insert the test specimen in the measuring instrument (**20.3.4**) and record the dial gauge reading.

Recondition one each of a pair of test specimens to constant mass (see clause **4**) at 25 ± 2 °C and 35 ± 5 % r.h. and 25 ± 2 °C and 85 ± 5 % r.h. respectively. Reposition the test specimen in the jig and observe the new reading of the dial gauge, and record the value to the nearest 0.05 mm.

20.4.2 *Changes in thickness.* Measure the thickness of each test specimen at the marked points described in **20.2** to the nearest 0.05 mm using the micrometer (**20.3.2**) and record the mean as the thickness of the test specimen.

Recondition one of a pair of test specimens to constant mass (see clause **4**) at 25 ± 2 °C and 35 ± 5 % r.h., and 25 ± 2 °C and 85 ± 5 % r.h. Remeasure the thickness of the test specimens at exactly the same points and calculate the mean thickness as before.

20.4.3 *Changes in mass.* Weigh the test specimens to the nearest 0.1 g and record the result.

Recondition one of a pair of test specimens to constant mass (see clause **4**) at 24 ± 2 °C and 35 ± 5 % r.h., and 25 ± 2 °C and 85 ± 5 % r.h. respectively and record the result.

20.5 Calculation and expression of results

20.5.1 The increase in length of the test specimens after reconditioning to 85 % r.h. I_l and the decrease in length after reconditioning to 35 % r.g. D_l, expressed as percentages, shall be calculated from the equations

$$I_{l85} = \frac{\Delta L_1}{200}\ 100$$

$$D_{l35} = \frac{\Delta L_2}{200}\ 100$$

where

ΔL_1 is the difference in dial gauge readings at 25 °C, 65 % r.h. and 25 °C, 85 % r.h.;

ΔL_2 is the difference in dial gauge readings at 25 °C, 65 % r.h. and 25 °C, 35 % r.h.

The results shall be expressed as a positive value (+ %) for I_{l85}, and as a negative value (– %) for D_{l35} to the nearest 0.05 %.

20.5.2 The increase in the mean thickness of the test specimens after reconditioning to 85 % r.h. I_{t85} and the decrease in the mean thickness of the test specimens after reconditioning to 35 % r.h.D_{t35}, expressed as percentages, shall be calculated from the equations

$$I_{t85} = \frac{(T_2 - T_1)}{T_1}\ 100$$

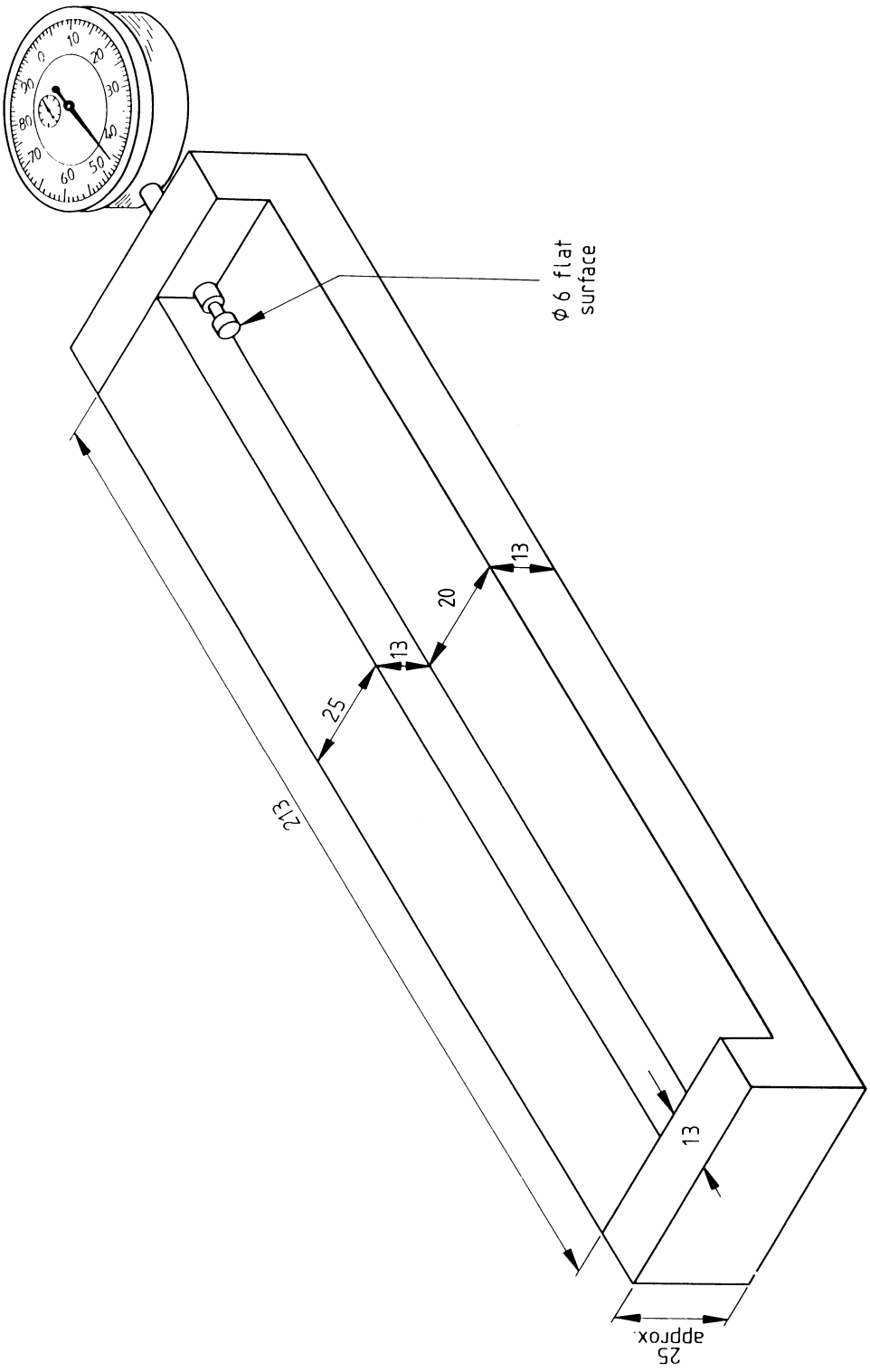
$$D_{t35} = \frac{(T_2 - T_1)}{T_1}\ 100$$

where

T_1 is the mean thickness of the test specimen conditioned at 20 °C and 65 % r.h. (in mm);

T_2 is the mean thickness of the test specimen conditioned at either 25 °C and 85 % r.h. or 25 °C and 35 % r.h. (in mm).

The results shall be expressed as a positive (+ %) value for I_{t85} and as a negative value (– %) for D_{t35} to the nearest 0.05 %.



All dimensions are in millimetres.

Figure 15 — Metal fixture for measuring change in length

20.5.3 The increase in mass of the test specimens after reconditioning at 85 % r.h. I_{m85} and the decrease in mass after reconditioning at 35 % r.h. D_{m35}, expressed as percentages, shall be calculated from the equations

$$I_{m85} = \frac{(M_2 - M_1)}{M_1} 100$$

$$D_{m35} = \frac{(M_2 - M_1)}{M_1} 100$$

where

M_1 is the mass of the test specimen after conditioning at 20 °C and 65 % r.h. (in g);

M_2 is the mass of the test specimen after conditioning to either 25 °C and 85 % r.h. or 25 °C and 35 % r.h. (in g).

The results shall be expressed as a positive value (+ %) for I_{m85} and as a negative value (– %) for D_{m35} to the nearest 0.05 %.

21 Determination of resistance to impact (impact strength)

21.1 Principle

A body of defined mass and shape is dropped from a series of increasing heights onto a rigidly clamped test specimen. The height from which the body is dropped is progressively increased until the test specimen is penetrated by the falling body.

21.2 Test specimens

21.2.1 For square-edged boards, and for tongued and grooved boards which are recommended only for use with glued joints, test specimens shall be 305 × 305 × board thickness and conditioned in accordance with clause **4**.

21.2.2 For tongued and grooved boards recommended for use with unglued joints, the following two types of test specimen shall be tested:

a) as described in **21.2.1**;

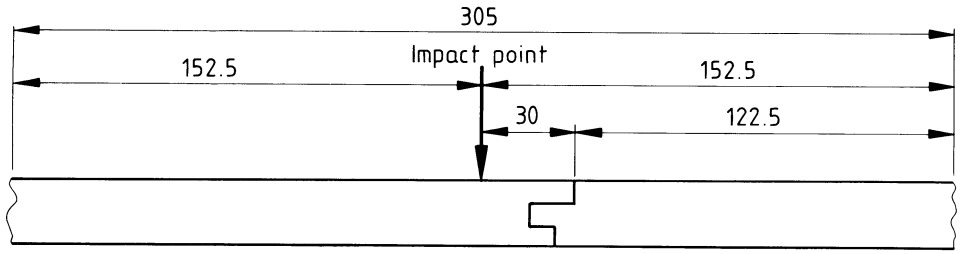
b) a jointed test specimen, assembled so that the point of impact will be on the grooved component and 30 mm from the joint line on the upper surface of the test specimen as shown in Figure 16.

21.3 Apparatus

The apparatus shall be as shown in Figure 17. Each guide shall consist of a ball race to ensure minimum friction. Details of the test specimen holder and clamping arrangement are shown in Figure 18.

The falling body shall have a hemispherical mild steel end of 25 ± 0.5 mm radius and a mass, including any associated falling parts, of 4.5 ± 0.05 kg.

NOTE It is convenient if the guide rod (see Figure 17) is marked circumferentially at intervals of 25 mm to enable the height from which the body is dropped to be measured.



All dimensions are in millimetres.

Figure 16 — Point of impact test for testing jointed boards

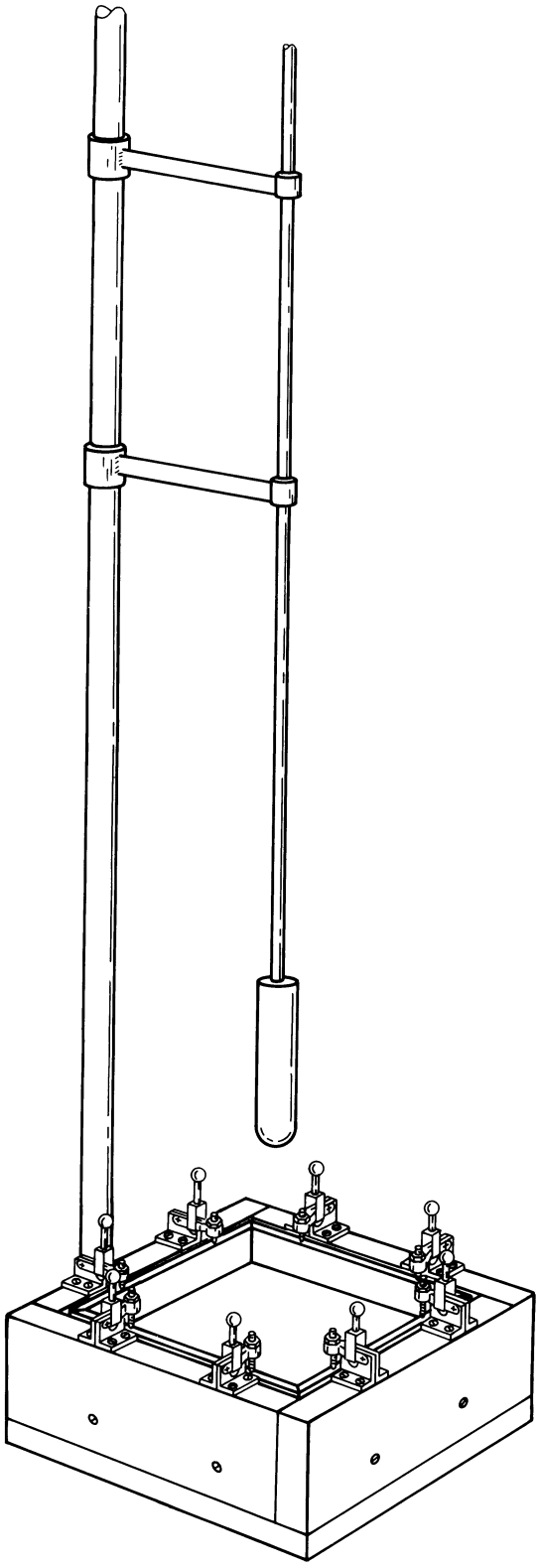
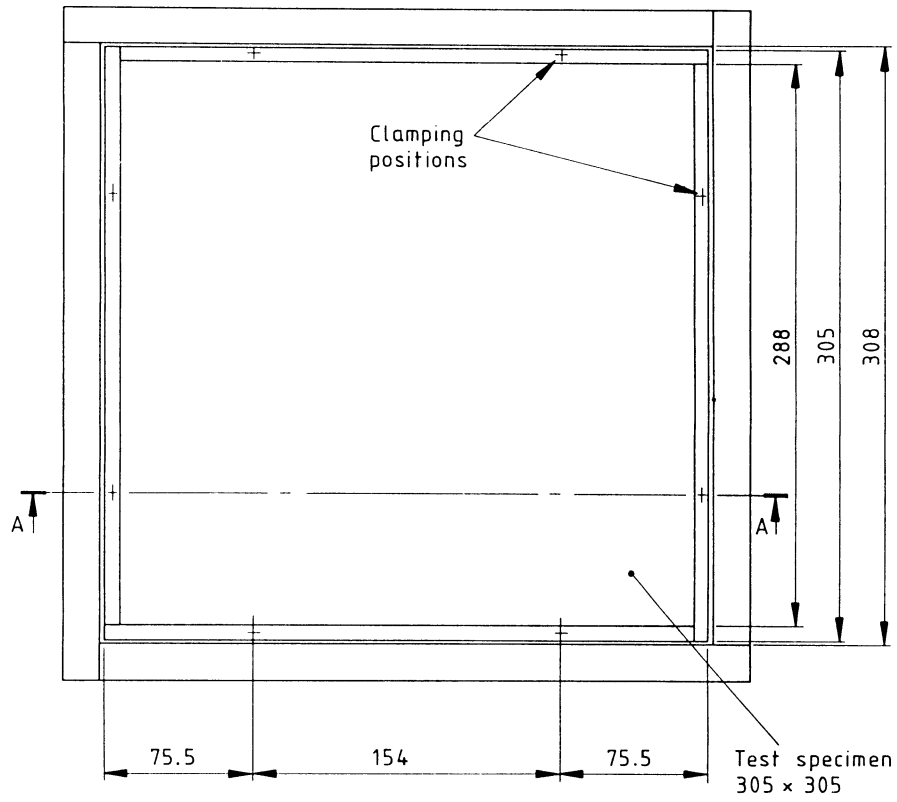
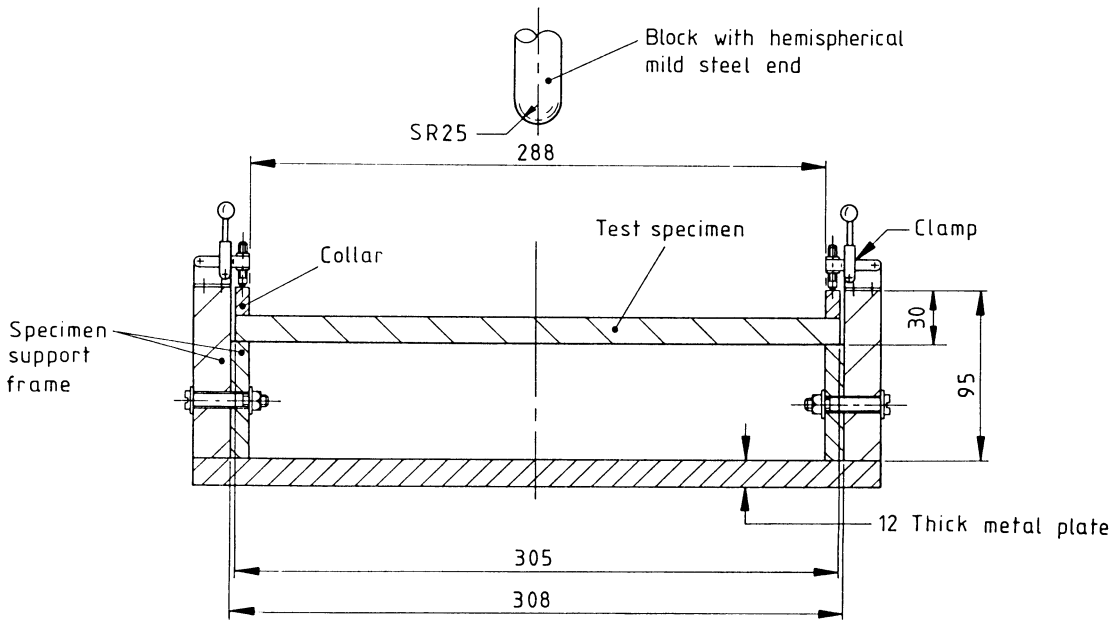


Figure 17 — General view of impact test apparatus



(a) Supporting frame for test specimens. Plan



Section A-A

(b) Supporting frame for test specimens. Section
All dimensions are in millimetres.

Figure 18 — Impact test: supporting frame for test specimen and test apparatus

21.4 Procedure

Position the test apparatus on a concrete floor. Clamp the test specimen in the supporting frame as shown in Figure 18(b). In the case of jointed, unglued test specimens ensure the joint line is offset from the point of impact by 30 mm as shown in Figure 16.

Raise the falling body 25 mm above the surface of the test specimen and allow it to drop freely. The body, or its guide rod, should be caught after impact so that the body shall not bounce and strike the test specimen a second time.

Repeat this step, but increase the drop-height by 25 mm each time until the falling body penetrates the test specimen leaving a clearly visible hole or series of cracks (see note 3).

NOTE 1 The most usual types of failure are shown in Figure 19.

NOTE 2 Penetration has occurred if light can be seen through the board at any point around the hemispherical indentation produced by the falling body.

NOTE 3 Exceptionally with boards greater than 10 mm in thickness, and usually with boards of less than 10 mm in thickness, cracks may appear, radiating from the point of impact, before the test specimen is penetrated. The drop-height that first produces such cracks is taken as the end point in these cases.

21.5 Calculation and expression of results

The impact strength of the test specimen θ (in millimetres per millimetre of thickness) shall be calculated from the equation

$$\theta = \frac{H}{T}$$

where

H is the drop-height required to produce failure of the test specimen by Penetration (in mm);

T is the nominal thickness of the test specimen (in mm).

The result shall be expressed to the nearest 1 mm/mm.

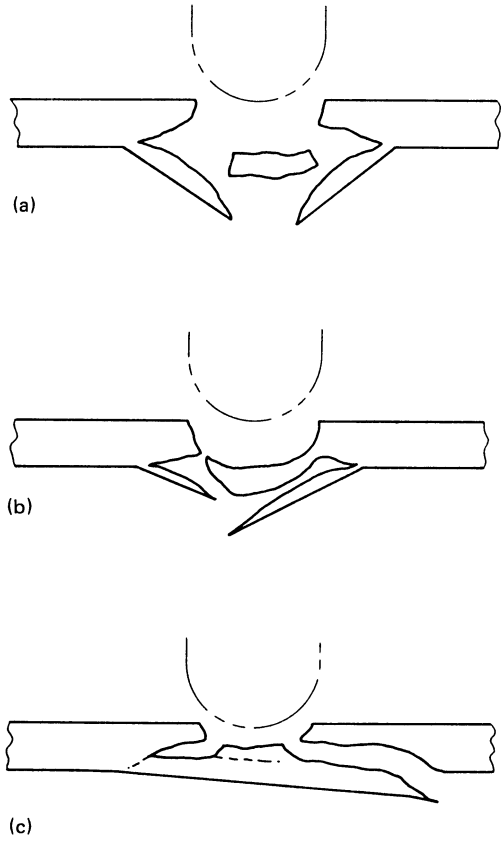


Figure 19 — End points of failure in impact test

22 Determination of extractable formaldehyde

Extractable formaldehyde shall be determined by the method given in BS EN 120.

Table 1 — *Table deleted*

Figure 20 — *Figure deleted*

23 Determination of relative creep, fractional recovery and permanent set

NOTE Certain particleboards have different property levels along the length of the original board and across its width. Where it is required to test the properties of such boards, two sets of test specimens should be prepared. One set should have its major axis parallel to the maximum strength dimension and the other should have its major axis at right angles to that dimension.

23.1 Principle

Creep is determined by applying a bending force to a test specimen over a prolonged period and measuring the increased deflection at the centre of the test specimen. Permanent set is determined by measuring the residual centre-span deflection after the load on the test specimen has been removed.

23.2 Test specimens

Test specimens shall be conditioned in accordance with clause **4**. They shall be 50 mm wide with a length of 16 T + 25 mm to the nearest 25 mm, where T is the board thickness in millimetres.

23.3 Apparatus

23.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

23.3.2 *Micrometer* as described in **6.1.2**.

23.3.3 *Sliding caliper* as described in **6.1.3**.

23.3.4 *Steel rule* as described in **6.1.4**.

23.3.5 *Dial gauge,* or other device capable of measuring midspan deflection to 0.01 mm.

23.3.6 *Testing machine* as described in **10.3.4**.

23.3.7 *Four point bending fixture* as shown in Figure 21.

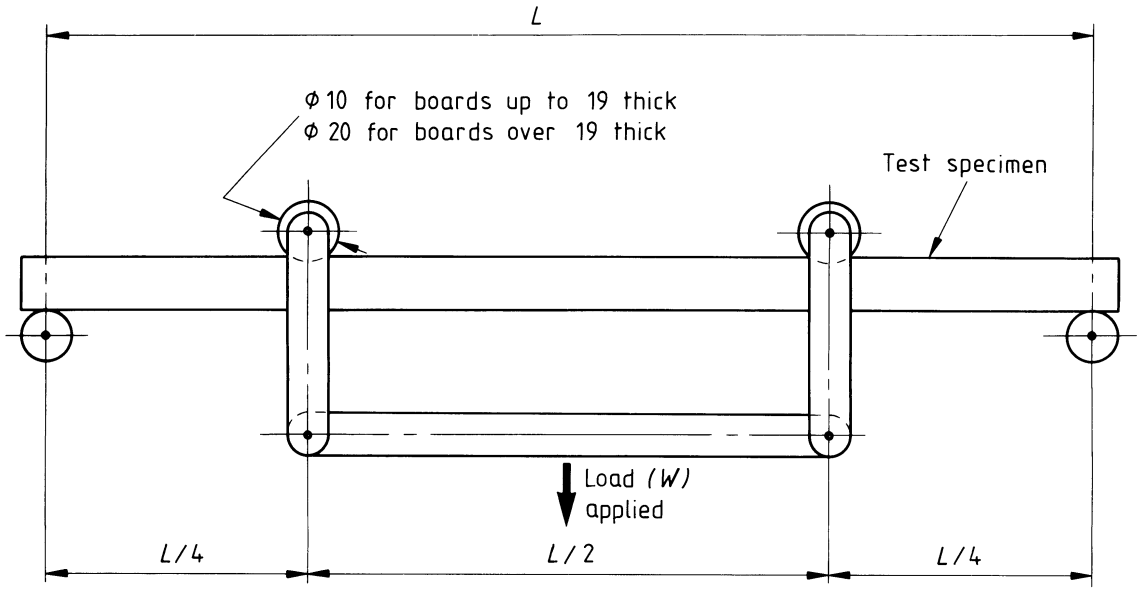
The metal rollers shall be 10 mm in diameter for test specimens up to 18 mm thick, and 25 mm in diameter for test specimens over 20 mm thick. The span of the specimen Y (in mm) = 16 T + 25, where T is the board thickness in millimetres.

23.3.8 *Weights* for applying load.

23.4 Procedure

23.4.1 *General.* Prepare matched pairs of test specimens and measure their width and length with the steel rule (**23.3.4**) and mean thickness, using the micrometer (**23.3.2**) at the three locations shown in Figure 22. Where boards with a pronounced degree of orientation are being tested, prepare two pairs of specimens; one pair with their major axes parallel to the length of the original board and the other pair with their major axes at right angles to the length of the original board.

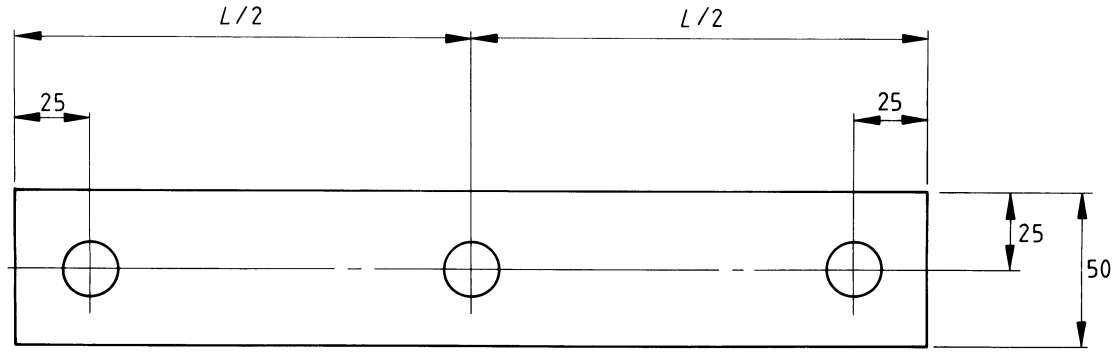
23.4.2 *Determination of static bending strength.* Place one of a pair of test specimens in the jig shown in Figure 21. The ends shall overlap the extreme support rolls by about 12 mm. Set the cross head speed of the testing machine to approximately 5 mm/min. Apply an increasing load, via the linkage to the two inner rollers, until the maximum applied load is attained. Record the maximum applied load as the failing load of the test specimen.



All dimensions are in millimetres.

NOTE To reduce the total mass of the weights required to produce a given load and to make the equipment more compact, the central rollers may be connected to a lever through a suitable linkage which multiplies the force exerted by the applied mass.

Figure 21 — Jig for applying load for static bending and creep tests with test specimen in position



All dimensions are in millimetres.

Figure 22 — Measurement of width and length of test specimens for determination of relative creep, fractional recovery and permanent set

23.4.3 *Determination of relative creep.* Place the second of the pair of test specimens in the jig in accordance with **23.4.2**, allow the central rollers and their linkage to rest on the test specimen for 1 min and measure the deflection at midspan to the nearest 0.01 mm. Record this value as the "zero deflection".

Attach an additional mass to the linkage, taking care to avoid rapid loading, especially at high stress levels.

NOTE 1 Smooth application of load may be achieved by supporting the weights with a stand which can be smoothly lowered until the weight is fully supported by the test specimen.

NOTE 2 The additional load may correspond to between 15 % and 80 % of the ultimate failing load of the paired test specimen, determined in accordance with **23.4.2**. The recommended value is 30 %.

Measure the deflection at midspan to the nearest 0.01 mm, 1 min after initial application of load. Record this deflection as the "elastic deflection".

Measure the deflection again after 2 min, 5 min, 10 min, 20 min, 50 min, 100 min and 200 min and thereafter at 24 h intervals.

NOTE 3 These intervals are suitable for moderate stress levels. At high stress levels or where time to failure is to be determined, shorter intervals may be appropriate.

23.4.4 *Determination of fractional recovery and permanent set.* Smoothly remove the weights at the completion of the test and immediately measure the midspan deflection to the nearest 0.01 mm. Record the result as the unloaded deflection.

Remeasure the midspan deflection at the same time intervals as given in **23.4.3** and record the results.

23.5 Calculation and expression of results

23.5.1 *Static bending strength.* The static bending strength P_s (in N/mm^2) shall be calculated from the equation

$$P_s = \frac{3WY}{4BT^2}$$

where

W is the maximum applied load for the test specimen (in N);

Y is the span between the supports (in mm);

B is the width of the test specimen (in mm);

T is the mean thickness of the test specimen (in mm).

The result shall be expressed to the nearest 0.1 N/mm^2.

23.5.2 *Relative creep.* Relative creep r at a given time shall be calculated from the equation

$$r = \frac{d-e}{e}$$

where

d is the deflection at a given time (in mm);

e is the elastic deflection (in mm).

The result shall be expressed to the nearest 0.1 mm.

23.5.3 *Fractional recovery and permanent set.* Fractional recovery f at a given time shall be calculated from the equation

$$f = \frac{d_f - u}{d_f}$$

where

d_f is the final deflection under load at a given time (in mm);

u is the residual unloaded deflection at the same time (in mm).

The result shall be expressed to the nearest 0.1.

Permanent set p at a given time (in mm) shall be calculated from the equation

$$P_s = u - z$$

where

u is the residual unloaded deflection at a given time (in mm);

z is the zero deflection measured in accordance with **23.4.3** (in mm).

The result shall be expressed to the nearest 0.1 mm.

24 Determination of compression strength

24.1 Determination of compression strength parallel to the plane of the board

NOTE 1 Certain particleboards have different property levels along the length of the original board and across its width. Where it is required to test the properties of such boards, two sets of test specimens should be prepared. One set should have its major axis parallel to the maximum strength dimension and the other should have its major axis at right angles to that dimension.

NOTE 2 For convenience, this test can be carried out simultaneously with the determination of modulus of elasticity in compression (see **11.3**) but it is essential that care be taken so that the transducers are not damaged.

24.1.1 *Principle.* An increasing compressive load is applied to a test specimen until failure occurs.

NOTE Failure is normally indicated by reaching a maximum compressive load.

24.1.2 *Test specimens.* Test specimens shall be prepared in accordance with **11.3.2** and conditioned in accordance with clause **4**.

24.1.3 *Apparatus.* The apparatus shall be as described in **11.3.3**, except that the transducers (**11.3.3.4**) are not required.

24.1.4 *Procedure.* The procedure shall be as described in **11.3.4**, but measurement of cross head displacement is not required.

24.1.5 *Calculation and expression of results.* The compression strength in the plane of the board K_p (in N/mm^2) shall be calculated from the equation

$$K_p = \frac{W}{A}$$

where

W is the maximum applied load for the test specimen (in N);

A is the cross-sectional area of the test specimen (in mm^2).

The result shall be expressed to the nearest 0.1 N/mm^2.

25 Determination of grit content

25.1 Principle

The mass of incombustible, acid-insoluble residue remaining after ignition of the test specimen is measured.

25.2 Test specimens

Test specimens shall consist of strips approximately 20 mm wide with a total mass of 200 ± 10 g conditioned and prepared in accordance with clauses **4** and **5**.

25.3 Apparatus

25.3.1 *General.* Where the accuracy of the apparatus is specified, the apparatus shall be periodically calibrated.

25.3.2 *Flat bottomed stainless steel pan,* approximately 1 L.

25.3.3 *Gas ring.*

25.3.4 *Balance* as described in **6.1.5**.

25.3.5 *Glass beaker,* 150 mL.

25.3.6 *Oven* as described in **9.3.3**.

25.3.7 *Mesh metal gauze,* 0.5 mm.

NOTE A convenient size is 150 mm × 150 mm.

25.4 Reagents

25.4.1 *Hydrochloric acid solution,* one part concentrated hydrochloric acid to one part distilled water, by volume.

25.5 Procedure

Weigh the strips comprising the test specimen and record the mass to the nearest 1.0 g. Place the test specimen in the pan (**25.3.2**) over the lighted gas ring (**25.3.3**), continue heating until the strips and pieces are reduced to ash and free from carbon, and allow to cool.

Transfer the ash residue to the beaker (**25.3.5**) and cover with 75 mL of the hydrochloric acid solution (**25.4.1**), boil gently for 2 min. Allow to cool. Decant as much liquid as possible without loss of solid residue and add 75 mL of distilled water.

WARNING. Hydrochloric acid is corrosive. Suitable skin and eye protection should be worn when carrying out this procedure.

Decant as much water as possible without loss of solid residue, dry the residue in the oven (**25.3.6**) and determine the mass to the nearest 0.01 g. Place the dried residue on a piece of the 0.5 mm mesh metal gauze (**25.3.7**) and shake the gauze gently. Note the presence of any particles that will not pass through the gauze.

25.6 Calculation and expression of results

The grit content of the test specimen H, expressed as a percentage by mass, shall be calculated from the equation

$$H = \frac{M_o}{M_i} \quad 100$$

where

M_i is the mass of the test specimen before ignition (in g);

M_o is the mass of the residue after drying (in g).

The result shall be expressed to the nearest 0.005 %.

NOTE The presence of any individual grit particles that will not pass the 0.5 mm mesh metal gauze should be noted in the report.

26 Determination of performance of flooring boards: large scale test

NOTE 1 This test was introduced into BS 1811 and mean quality levels derived from it were specified in BS 2604, for flooring grade boards. It was a type test. When BS 5669:1979 superseded these two standards the specification for flooring grade boards was based on routine measurements of elasticity in bending and impact strength (see **11.1** and clause **21**).

NOTE 2 This test has been reintroduced to allow new products to be evaluated and is not a requirement for any of the board types specified in BS 5669-2 to BS 5669-4.

26.1 Principle

A joisted floor (typically 1.2 m × 2.4 m) is constructed and subjected to static point loads and impact loads at particular points.

26.2 Test specimens

Test specimens shall be constructed from a whole board not less than 2 400 mm × 1 200 mm when unjointed boards are used, or not less than 2 400 mm × 600 mm when jointed boards are used. The board shall be supported on softwood joists of nominal dimensions 100 mm × 50 mm, and spaced at centres to be determined at the time of test. The unsupported edges of the boards shall be supported by 100 mm × 50 mm (nominal) hoggings [see Figure 23(a) and (b)]. The board shall be fixed to the joists and noggings with circular plain round-wire nails of a length of not less than 2.5 times the board thickness. The nails shall be spaced as follows:

a) around the edges of the specimen: 200 mm to 300 mm;

b) along the intermediate joists: 400 mm to 500 mm.

This description applies to particleboards with equal strength with respect to the length and width of the original whole board. Where boards do not have this characteristic, e.g. oriented strand board, the direction of maximum strength and stiffness shall be aligned across the joists as shown in Figure 23(b).

For jointed boards, intended for use with unsupported joists, test specimens shall be built up as shown in Figure 23(c).

Square edged boards shall be laid with all joints tightly butted. Tongued and grooved boards shall be edge-glued at the time of laying.

NOTE 1 The above procedure applies to assessing boards for domestic flooring applications. For non domestic use, the board supplier should provide a suitable engineering design for the test floor.

NOTE 2 PVAC adhesives of either one or two part types are suitable for edge-gluing tongued and grooved boards.

26.3 Apparatus

26.3.1 *General.* Where the accuracy of the apparatus is specified, apparatus shall be periodically calibrated.

26.3.2 *Impact loading device,* having a hemispherical end of 25 ± 0.5 mm radius and a mass, including any associated falling parts of 8 ± 0.05 kg. The head shall be attached to a rod which runs through guides shown in Figure 24.

NOTE It is convenient if the rod is marked circumferentially at intervals of 25 mm to enable the height from which the body is dropped to be measured.

26.3.3 *Static loading device* comprising a hydraulic or pneumatic cylinder, capable of applying an increasing load at an approximately uniform rate of 45 N/s through a hemispherical head of 100 mm radius. The loading device shall be attached to a rigid framework as for **26.3.2**, so that the load is applied vertically.

26.3.4 *Load gauge* or other means of measuring load.

26.3.5 *Dial gauge or transducer* capable of measuring deflection of the test specimen to an accuracy of 0.01 mm.

26.4 Procedure

26.4.1 ***Unjointed boards***

26.4.1.1 *General.* Place the complete test specimen below the loading devices on an essentially flat concrete floor. The floor space shall be sufficiently large to allow the test specimen to be moved to bring each loading point under the appropriate loading device.

Clamp the test specimen firmly to the floor and ensure that the joints and noggings are in contact over most of their length.

NOTE Contact can be assessed by applying a static load of 1 kN to several points along the line of the joists. No movement should be obtained.

26.4.1.2 *Static loading.* Apply a steadily increasing load at 45 N/s to one of the four points shown in Figure 23(a) or Figure 23(b). Measure the deflection at the loading point, using either the dial gauge or a suitable transducer (**26.3.4**) coupled to a plotter. Continue loading until failure occurs or the load starts to fall off considerably. Record the maximum load applied to points 1, 2, 3 and 4.

Construct a load/deflection curve for each 0.4 kN increment of load or obtain a continuous curve using the transducer/plotter. Read off the deflection in millimetres, to the nearest 0.1 mm, corresponding to a load of 1.11 kN. Record the reading. Repeat this procedure for each of the remaining three loading points.

26.4.1.3 *Impact loading.* Clamp the test specimen to the floor in accordance with **26.4.1.1** so that one of the impact points shown in Figure 23(a) or Figure 23(b) is directly below the head.

Raise the impact head 25 mm above the surface of the test specimen and let it fall freely onto the board. Allow the body to bounce until it has come to rest.

Repeat this procedure, but increase the drop height by a further 25 mm each time, until the falling body penetrates the board producing failure as described in **21.4** and as shown in Figure 19 and record the maximum drop height as the impact value in millimetres.

26.4.2 *Boards intended for use with unsupported joints.* Place the complete test specimen of the type shown in Figure 23(c) below the loading device and clamp it to the floor in accordance with **26.4.1**.

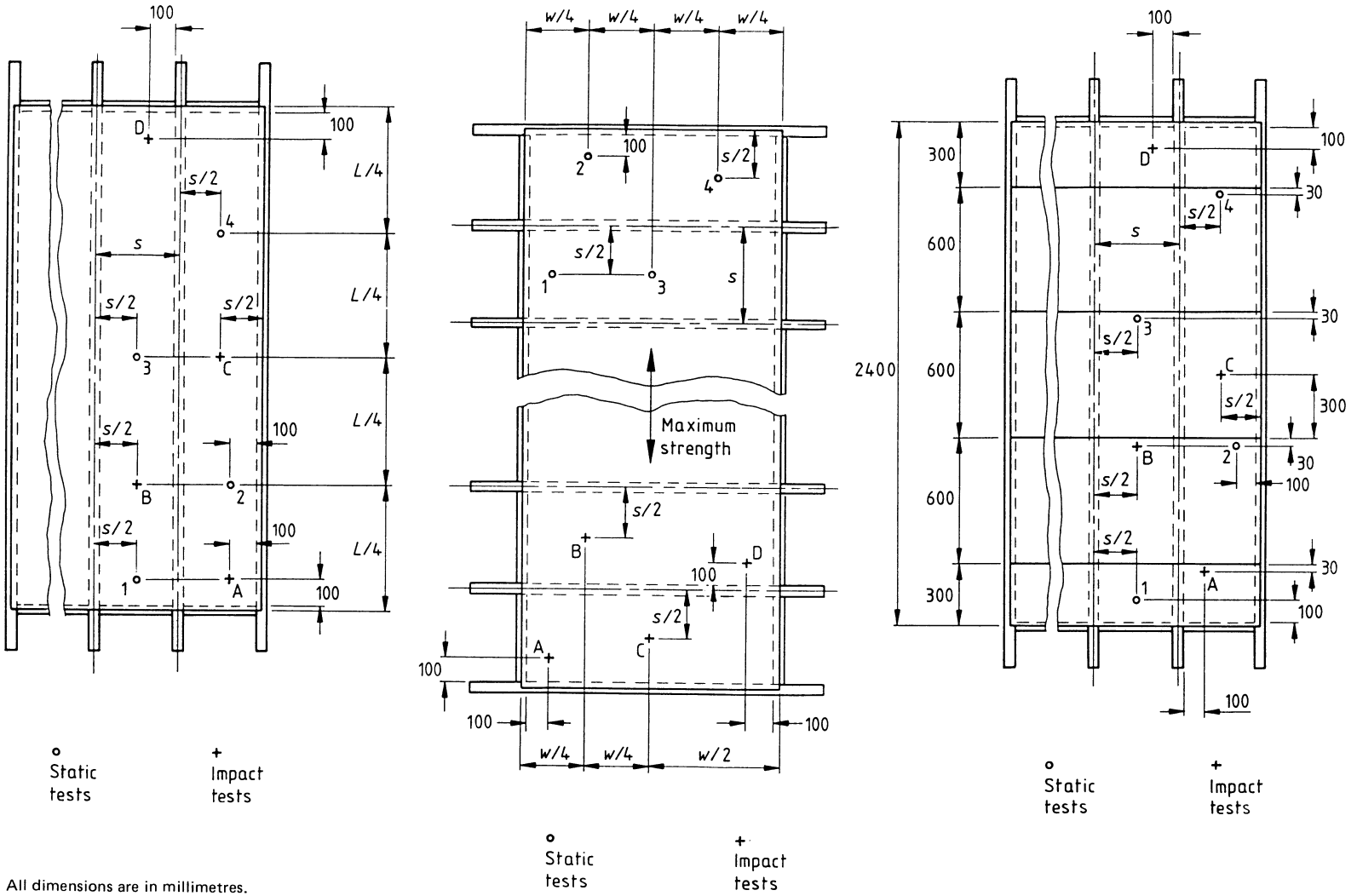
Apply static and impact loads, in accordance with **26.4.1.2** and **26.4.1.3** respectively, but use the loading points shown in Figure 23(c).

26.5 Calculation and expression of results

26.5.1 The mean drop height shall be calculated in millimetres from the two lowest recorded impact values and shall be expressed to the nearest 25 mm.

26.5.2 The deflection shall be expressed in millimetres at 1.11 kN for each of the four determinations to the nearest 0.1 mm.

26.5.3 The maximum load shall be expressed in kilonewtons for each of the four determinations to the nearest 25 kN.



(a) Arrangement of joists, noggings and loading points for flooring test on unjointed boards

(b) Arrangement of joists, noggings and loading points for flooring test on unjointed boards where the direction of maximum strength and stiffness is aligned across the joints

(c) Arrangement of boards for flooring test with unsupported boards

Figure 23 — Layout of flooring members

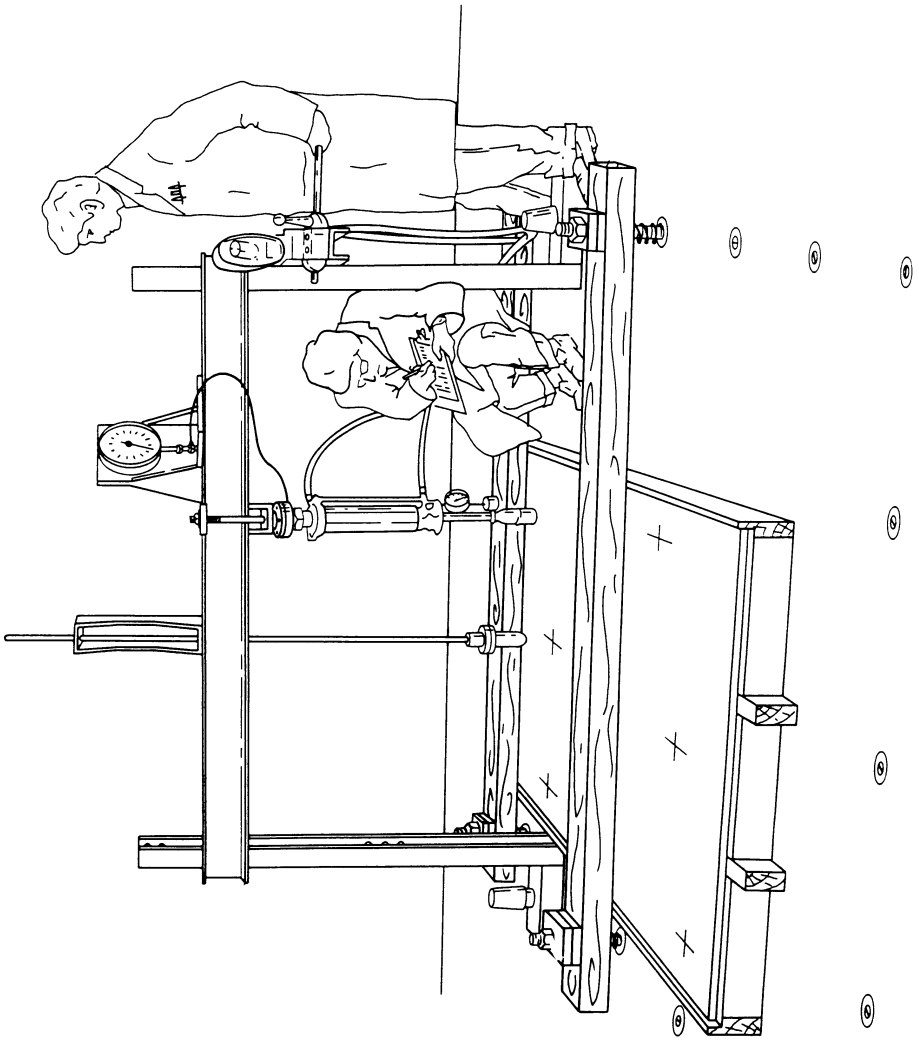


Figure 24 — Typical large-scale flooring test arrangement

27 Determination of moisture resistance under cyclic exposure

27.1 Principle

The increase in thickness of a test specimen, as a result of it having been subjected to cycles of pretreatment comprising soaking in cold water, freezing and drying at elevated temperature, is measured and expressed as a percentage of the original thickness. The tensile strength perpendicular to the plane of the board is determined using the same test specimen.

27.2 Test specimens

Test specimens shall be 50 ± 1 mm × 50 ± 1 mm × board thickness and prepared and conditioned in accordance with clauses **4** and **5**.

27.3 Apparatus

27.3.1 *Micrometer* as described in **6.1.2**.

27.3.2 *Sliding caliper* as described in **6.1.3**.

27.3.3 *Testing machine* as described in **10.3.4**, fitted with grips and self-aligning linkage as illustrated in Figure 8(b).

NOTE A suitable linkage is shown in Figure 8(b). Other designs are also suitable, provided a universal joint is incorporated to ensure alignment.

27.3.4 *Metal blocks* as illustrated in Figure 8(a).

NOTE Plywood or hardwood blocks may be used as an alternative to metal, provided they are strong enough to ensure failure takes place in the specimen.

27.3.5 *Freezer cabinet* capable of maintaining a temperature equal to or less than – 16 °C under steadystate conditions.

27.3.6 *Ventilated oven* with forced air circulation, capable of maintaining a temperature of 70 ± 3 °C.

27.3.7 *Water bath* capable of maintaining a temperature of 20 ± 1 °C and regaining this temperature in not more than 2 h after inserting a set of specimens. The dimensions of the water bath shall enable the compliance with **27.4.2.1**.

27.4 Procedure

27.4.1 *Measurement of specimens.* Measure the length and width of specimen to the nearest 0.1 mm using the sliding caliper, and calculate the area of the specimen to the nearest 1.0 mm^2.

Mark the diagonals on one face of the specimen and measure the thickness at their intersection to the nearest 0.01 mm using the micrometer.

27.4.2 *Cyclic test procedure.* Subject the specimens to three soaking, freezing, drying cycles as follows (approximately 3 weeks total duration):

Cycle 1

a) immerse in water at 20 ± 1 °C for 72 ± 1 h as described in **27.4.2.1**.

b) freeze at less than – 16 °C for 24 ± 0.25 h as described in **27.4.2.2**.

c) dry at 70 ± 1 °C for 72 ± 1 h as described in **27.4.2.3**.

Cycles 2 and 3

a) cool in a normally heated and ventilated room for 3 ± 0.25 h as described in **27.4.2.4**.

b) immerse in water at 20 ± 1 °C for 69 ± 1 h as described in **27.4.2.1**.

c) and d) as described in cycle 1 b) and c) respectively.

At the start of cycles 2 and 3 the specimens shall be rotated through 180° in the vertical plane in such a way that the original bottom edge of the specimen in steps a) to c) in cycle 1 becomes the top edge of the specimen in cycle 2 and the bottom edge in cycle 3.

27.4.2.1 *Water immersion.* Immerse the specimens, with their faces vertical, in fresh clean water with a pH of 7 ± 1. The specimens shall be separated from one another and from the bottom and sides of the water bath and covered by 25 ± 5 mm of the water throughout the test period. Fresh water shall be used for each cycle.

27.4.2.2 *Freezing.* Remove the specimens from the water bath. Wipe off excess water with a cloth or absorbent paper and place the specimens with their faces vertical in the freezer cabinet at less than – 16 °C. The specimens shall be separated from one another.

27.4.2.3 *Drying.* Remove the specimens from the freezer cabinet and place them immediately in the ventilated oven at 70 ± 1 °C. They shall be well separated from one another with their faces vertical. The total volume of the specimens shall not exceed 10 % of the internal volume of the oven.

27.4.2.4 *Cooling.* Stand the specimens, with their faces vertical, on a flat, non-absorbent surface in a normally heated and ventilated room.

27.4.3 *Reconditioning, measuring and testing.* After subjecting the specimens to the cyclic procedure, recondition them to constant mass in accordance with clause **4**.

Measure the thickness of the specimen in accordance with **27.4.1**.

Bond loading blocks to the specimens as described in **12.2.2** and determine the tensile strength perpendicular to the plane of the board according to **12.2.4**.

27.5 Calculation and expression of the results

Calculate the percentage increase in thickness in accordance with **16.2.5** and the tensile strength perpendicular to the plane of the board in accordance with **12.2.5**.

Appendix A Cross-references for test methods and requirements specified in BS 5669-2, BS 5669-3 and BS 5669-4

Table 2 gives the test methods for the requirements specified in BS 5669-2, BS 5669-3 and BS 5669-4.

Table 2 — Test methods for the requirements specified in BS 5669-2, BS 5669-3 and BS 5669-4.

Property	Reference for test method	Part of BS 5669 in which requirements are specified		
		Part 2	Part 3	Part 4
Dimensions of boards	clause **7**	✓	✓	✓
Density	clause **8**	—	—	—
Moisture content	clause **9**	✓	✓	✓
Bending strength[a]	clause **10**	✓	✓	✓
Modulus of elasticity[a]	clause **11**	✓	✓	✓
Tensile strength[a]	clause **12**	✓	✓	✓
Panel shear strength and shear modulus	clause **13**	✓[b]	—	—
Transverse shear strength	clause **14**	✓[b]	—	—
Concentrated load strength	clause **15**	✓[b]	—	—
Bond durability	clause **16**	✓	✓	✓
Surface soundness	clause **17**	✓	—	—
Axial withdrawal of wood screws	clause **18**	✓	—	✓
Increase in mass and thickness due to general absorption of water	clause **19**	✓	✓	✓
Changes in length, thickness and mass after conditioning at 35 % r.h. and 85 % r.h.	clause **20**	✓	—	—
Resistance to impact	clause **21**	✓	✓	✓
Extractable formaldehyde	clause **22**	✓	✓	—
Relative creep, fractional recovery and permanent set	clause **23**	—	—	—
Compression strength[a]	clause **24**	✓[b]	—	—
Grit content	clause **25**	✓	—	—
Performance in large scale flooring test	clause **26**	—	—	—
Determination of moisture resistance under cyclic exposure	clause **27**	✓	—	—
Thermal conductivity	BS 874	✓	✓	✓
Surface spread of flame	BS 476-7	✓	✓	✓
Reaction to fire	BS 476-5 and BS 476-6	—	—	✓
Frost resistance	clause **17** of BS 4624:1981	—	—	✓
Water permeability	clause **15** of BS 4624:1981	—	—	✓

[a] These properties may be determined in different planes and axes. Reference should be made to BS 5669-2, BS 5669-3 and BS 5669-4 to determine which subclauses are specific for certain board types.

[b] Specified only for type C5 boards.

Appendix B Guidance on the use of quality control charts and methods of sampling for certain properties

B.1 Use of quality control charts

B.1.1 *General*

The provisions of this standard are intended to take advantage of the principles of quality control, which are dealt with at length in BS 600 and BS 2564.

The manufacturer is expected to take samples from his current production and measure their properties at such intervals as will give adequate and timely warning of any failure to control production at the required level of quality. The method and frequency of sampling will depend upon the uniformity of production and can not be specified in advance but will have to be determined in the light of experience. A recommended sample size is given and qualifying limits based upon this are given in the tables of manufacturers' control chart limits in BS 5669-2, BS 5669-3 and BS 5669-4. Where the manufacturer takes a different sample size he should calculate new limits accordingly. BS 600 gives the appropriate factors for these calculations. The test results for each property are recorded consecutively on control charts, two charts being kept for each property, one showing the sample mean ($\bar{x}$) and the other the sample range (w).

As the manufacturer accumulates data he can calculate from time to time the grand mean ($\bar{\bar{X}}$), which will give an estimate of the average value of the property in question for the production as a whole over the product under review, and similarly he can calculate the mean range ($\bar{w}$).

The probability limits given in the tables of manufacturers' control chart limits in BS 5669-2, BS 5669-3 and BS 5669-4 are one in 40; in other words a test result outside the limits should be obtained on average only once in every 40 tests. The tests will be in accordance with this Part of BS 5669 if the following are true:

a) the value of the grand mean is not worse than that given in the appropriate table of quality levels in BS 5669-2, BS 5669-3 and BS 5669-4;

b) the value of the mean range is not greater than that given in the appropriate table of quality levels in BS 5669-2, BS 5669-3 and BS 5669-4;

c) the test results for both sample means and ranges do not fall, on average, more frequently than once in 40 tests outside the limits for sample means ($\bar{x}$) and upper limits for range (w) given in the appropriate table of quality levels in BS 5669-2, BS 5669-3 and BS 5669-4.

The purchaser may make use of the manufacturer's control charts to satisfy himself by inspection that the requirements given in BS 5669-2 and BS 5669-4 are being complied with. This method is to be preferred to testing by purchasers and is strongly recommended.

The purchaser may carry out his own testing, in which case the values given in the tables of consumers' minimum acceptance limits in BS 5669-2 and BS 5669-4 apply.

B.1.2 *Statistical definitions and calculations*

B.1.2.1 sample mean ($\bar{x}$). The sum of the individual test results (x) divided by the number in the sample (n), i.e. as follows:

$$\bar{x} = \frac{\Sigma x}{n}$$

B.1.2.2 grand mean ($\bar{\bar{X}}$). The overall level of quality.

B.1.2.3 within-sample standard deviation (s). The square root of the mean of the squares of the deviations of the individual test results from the sample mean.

$$s = \sqrt{\frac{\Sigma (\bar{\bar{X}} - \bar{x})^2}{n}}$$

where

n is the number of test pieces in the test sample.

B.1.2.4 sample range (w). The difference between the maximum and minimum test results in a sample.

B.1.2.5 mean range ($\bar{w}$). The grand mean of the sample ranges.

B.1.2.6 within-board standard deviations (σ_w). This is calculated from the following equations:

a) $$\sigma_w = \sqrt{\left(\frac{n}{mn - m}\right) \Sigma (s)^2}$$

where

m is the number of observations of s;
n is the number of test pieces in the test sample.

b) $$\sigma_w = \left(\frac{1}{b_n}\right)\bar{s}$$

c) $$\sigma_w = \left(\frac{1}{d_n}\right)\bar{w}$$

The appropriate values of $\frac{1}{b_n}$ and $\frac{1}{b_n}$ factors based on BS 600 are given in Table 3.

B.1.2.7 between-board standard deviation (σ_B). This is calculated from the equation

$$n\sigma_B^2 + \sigma_w^2 = \frac{1}{(m-1)} \left\{ n \Sigma \bar{x}^2 - \frac{n(\Sigma \bar{x})^2}{m} \right\}$$

where

m is the number of boards;

n is the number of test specimens from each board;

$\bar{x}$ is the individual board means.

B.2 Procedure for random sampling for quality control tests during manufacture

The method and frequency of sampling for quality control tests depends on the particular circumstances in the factory. Guidance on sampling may be found, for example, in BS 5701, BS 5703, BS 6000, BS 6001 and BS 6002.

Table 3 — Factors based on BS 600

Values of $\frac{1}{b_n}$ and $\frac{1}{d_n}$ based on BS 600.											
n	2	3	4	5	6	7	8	9	10	11	12
$\frac{1}{b_n}$	1.77	1.38	1.25	1.19	1.15	1.13	1.11	1.09	1.08	1.08	1.07
$\frac{1}{d_n}$	0.886	0.591	0.486	0.430	0.395	0.370	0.351	0.337	0.325	0.315	0.307

Publications referred to

BS 476, *Fire tests on building materials and structures.*
BS 476-5, *Method of test for ignitability.*
BS 476-6, *Methods of test for fire propagation for products.*
BS 476-7, *Method for classification of the surface spread of flame of products.*
BS 600, *The application of statistical methods to industrial standardization and quality control.*
BS 700, *Graduated pipettes.*
BS 700-2, *Specification for pipettes for which waiting time is specified.*
BS 846, *Specification for burettes.*
BS 1210, *Specification for wood screws.*
BS 1610, *Materials testing machines and force verification equipment.*
BS 1610-1, *Specification for the grading of the forces applied by materials testing machines.*
BS 1792, *Specification for one-mark volumetric flasks.*
BS 1811, *Methods of test for wood chipboards and other particleboards*[3)].
BS 2564, *Control chart techniques when manufacturing to a specification with special reference to articles machined to dimensional tolerances.*
BS 2604, *Resin-bonded wood chipboard*[3)].
BS 4624, *Methods of test for asbestos-cement building products.*
BS 5268, *Structural use of timber.*
BS 5268-2, *Code of practice for permissible stress design, materials and workmanship.*
BS 5669, *Particleboard.*
BS 5669-2, *Specification for wood chipboard.*
BS 5669-3, *Specification for oriented strand board (OSB).*
BS 5669-4, *Specification for cement bonded particleboard.*
BS 5669-5, *Code of practice for the selection and application of particleboards for specific purposes.*
BS 5701, *Guide to number-defective charts for quality control.*
BS 5703, *Guide to data analysis and quality control using cusum techniques.*
BS 6000, *Guide to the use of BS 6001, sampling procedures and tables for inspection by attributes.*
BS 6001:Supplement 1, *Sampling procedures and tables for inspection by attributes.*
BS 6002, *Specification for sampling procedures and charts for inspection by variables for percent defective.*
BS 6100, *Glossary of building and civil engineering terms.*
BS 6100-4, *Forest products.*
BS 6100-4.3, *Wood based panel products.*
BS 6696, *Methods for Use and testing of capacity of volumetric glassware.*
BS EN 120, *Wood-based panels. Determination of formaldehyde content.*
BS EN 120, *Extraction method called the perforator method.*

[3)] Withdrawn and referred to in the foreword only.

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