INTERNATIONAL STANDARD

ISO 16572

First edition
2008-06-01

Timber structures — Wood-based panels — Test methods for structural properties

Structures en bois — Panneaux à base de bois — Méthodes d'essai pour la détermination des propriétés structurelles

Reference number
ISO 16572:2008(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16572 was prepared by Technical Committee ISO/TC 165, *Timber structures*.

Introduction

For each type and grade of panel product, as defined (for example in a wood-based panel standard), it is necessary to determine characteristic values of structural properties to enable it to be used for structural purposes. This International Standard details the necessary testing, which may only need to be carried out once for each type and grade of product unless there is a reason to suspect a significant change has occurred in its properties.

This International Standard is not intended for quality control testing.

Timber structures — Wood-based panels — Test methods for structural properties

1 Scope

This International Standard specifies test methods for determining the structural properties of commercial wood-based and lignocellulosic fibrous panel products for use in load-bearing timber structures. These properties are intended for the calculation of characteristic values.

NOTE Bamboo is an example of a lignocellulosic fibrous material.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9424, *Wood-based panels — Determination of dimensions of test pieces*

ISO 9427, *Wood-based panels — Determination of density*

ISO 16979, *Wood-based panels — Determination of moisture content*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
knife check
separation of the fibres which does not extend through the thickness of the veneer

3.2
length
⟨wood-based panels⟩ long dimension of the test piece in the plane of the panel

3.3
specimen
⟨wood-based panels⟩ piece of the panel from which a test piece will be fabricated

3.4
test area
⟨wood-based panels⟩ that portion of the test piece from which the structural property is being evaluated

3.5
test piece
⟨wood-based panels⟩ specimen or aggregate of parts from a sample fabricated to the size and shape required for testing

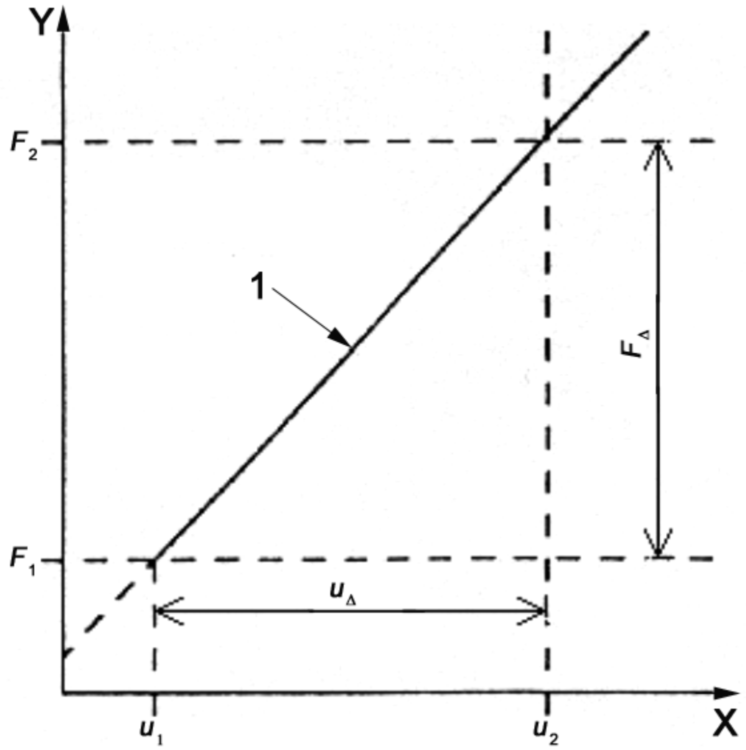
3.6
width
⟨wood-based panels⟩ short dimension of the test piece in the plane of the panel

4 Symbols and abbreviated terms

A	cross-sectional area of the test piece within the gauge length, equal to bt, in square millimetres
b	measured width of test piece, in millimetres
E	modulus of elasticity, in megapascals
F	load, in newtons
F_{max}	maximum load applied to the test piece, in newtons
F_{Δ}	increment of load on the linear portion of the load-deflection curve, in newtons (see Figure 1)
f	strength, in megapascals
G	modulus of rigidity, in megapascals
I_a	second moment of area, in millimetres to the fourth power
k	slope of the linear portion of the load versus deformation or deflection curve, in newtons per millimetre (see Figure 1)
l	length of test piece, in millimetres
l_1	gauge length, in millimetres
l_2	distance between an inner load point or line and the nearest support, in millimetres
M	moment, in newton millimetres
t	measured thickness of test piece, in millimetres
t_1	nominal thickness of the panel being tested, in millimetres
u	deflection or deformation, in millimetres
u_{Δ}	increment of deflection corresponding to F_{Δ}, in millimetres (see Figure 1)
W	section modulus, in millimetres to the third power

Subscripts applied to loads, capacities, strengths, stiffnesses, and moduli of elasticity:

app	apparent
c	compression
edge	edgewise
m	bending
s	planar shear
t	tension
true	true bending
v	panel shear



Key

X deflection or deformation

Y load

1 slope $= k$

NOTE Experience has demonstrated that suitable values of F_1 and F_2 are approximately 10 % and 40 % of F_{max}, respectively.

Figure 1 — Load-deflection or deformation graph within the linear range

5 Sampling

5.1 Sampling of panels

All panels in a sample shall be of the same type, grade, thickness range and composition and/or lay-up as defined in a standard or product specification. The sample shall be representative of the product as defined.

5.2 Sampling of specimens

The position of the specimens within the panels shall be selected to ensure the sampling of specimens is unbiased. The specimens for each type of test in each direction shall be from a different position in different panels of the same sample.

NOTE An example of a cutting schedule based on a sample of four panels, each with a minimum area of 1 200 mm × 2 400 mm, is given in Annex B.

6 Preparation of test pieces

6.1 Conditioning

6.1.1 Standard conditioning

With the exception of 6.1.2, all test pieces shall be conditioned to constant mass in an atmosphere of relative humidity (65 ± 5) % and temperature (20 ± 2) °C. Constant mass is deemed to be attained when the results of at least three successive weighings indicate the moisture content has stabilized to within ± 0,5 % for at least a 48 h period.

If the conditions of the testing room are not the same as those in the conditioning chamber, test pieces shall remain in the conditioning chamber until testing.

6.1.2 Alternative conditionings

Test pieces may be differently conditioned and/or unconditioned.

Unless otherwise noted in the test report, results from Clauses 7 to 11 shall be corrected to reflect conditioning as specified in 6.1.1. The procedure for correcting structural properties shall be technically sound, using moisture content results from 6.3, and shall be recorded in the test report.

6.2 Dimensions of test pieces

6.2.1 Method of measurement

The dimensions shall be determined in accordance with ISO 9424.

6.2.2 Measurements to be taken

The thickness of the test pieces shall be measured at the four corners of the test area and averaged. With the exception of panel shear, methods A and B, the width of the test pieces shall be measured at two points along each edge of the test area and averaged. The length of the test pieces for panel shear, method A, and planar shear, method A, tests shall be measured at two points along each edge of the test area and averaged. The length of the test pieces for panel shear, method B, shall be measured along the centreline of the test area (including the radius section), as shown in Figure 9.

If the thicknesses of individual plies or layers in plywood or composite panels are required, then each shall be measured to the nearest 0,1 mm at the four edges of the test piece and averaged.

6.3 Moisture content

6.3.1 Method of measurement

The moisture content shall be determined in accordance with the procedures of ISO 16979.

6.3.2 Measurements to be taken

The moisture content shall be determined from at least one test piece per panel and measured at the time of testing.

6.4 Density

6.4.1 Method of measurement

The density shall be determined in accordance with the procedures of ISO 9427.

6.4.2 Measurements to be taken

The density shall be determined from at least one test piece per panel and measured at the time of testing.

7 Bending properties

7.1 True bending properties flatwise

7.1.1 Test piece

The test piece shall be rectangular in cross-section. The depth of the test piece shall be equal to the thickness of the panel, and the width shall be not less than 300 mm. The total length of the test piece shall be the span between the supports plus an overhang sufficiently long to prevent the test piece from slipping off the supports during testing.

7.1.2 Loading equipment

The loading equipment shall be capable of measuring the load to an accuracy of 1 % of the maximum load.

7.1.3 Loading method

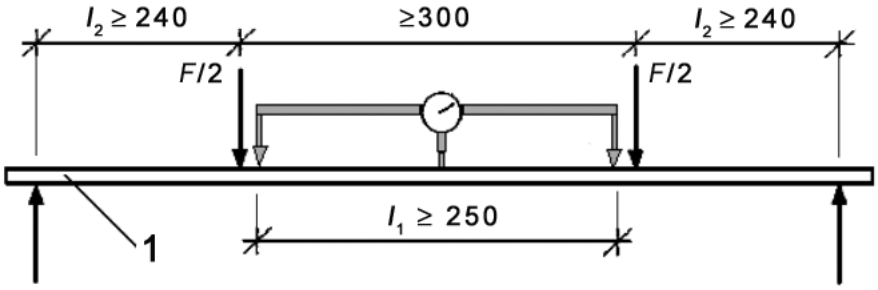
The application of the load shall be as shown in Figure 2, with minimum dimensions as noted. Contact points for loads and reaction forces shall be continuous across the width of the test piece and (30 ± 1) mm in diameter. The test hardware shall include appropriate mechanisms, such as rollers or pivots, to minimize the development of axial forces in the test piece and to allow the test piece to deflect freely under load. The application of the load shall create a zone of uniform bending moment between the load points, free of shear stresses.

The recommended distance for l_2 is $16t_1$ to preclude shear failures outside the zone of uniform bending moment.

NOTE 1 Large deflections may occur when test pieces with small bending stiffness are tested to failure, thus alternative test arrangements may be required. In general, the test configuration described in this subclause is suitable for a test piece with a thickness greater than 9 mm (corresponding to a bending stiffness per unit width of about 300 kN·mm^2/mm). Smaller thicknesses may be tested by using smaller-diameter supports and proportionally reducing the distances between them.

NOTE 2 Thick and/or wide test pieces may require larger-diameter supports.

Dimensions in millimetres



Key

1 test piece

Figure 2 — True bending modulus of elasticity and stiffness test configuration

7.1.4 Test procedure

7.1.4.1 Rate of application of load

The load, F, shall be applied at a constant rate so that the maximum load is reached within (300 ± 120) s.

7.1.4.2 Measurement of length and deformation

The lengths l_1 and l_2 shall be measured to the nearest 1 mm. The deflection of the test piece shall be measured between two parallel lines, perpendicular to the span, located in the zone of uniform moment, as shown in Figure 2. This distance (the gauge length) shall be not less than 250 mm. Deflection measurements may be referenced relative to the top or bottom of the test piece. Test pieces exhibiting excessive twist/warp may require two points of deflection measurement, in which case the average of the two readings shall be used in the calculations. The deflection over the gauge length shall be measured to the nearest 0,01 mm.

For t_1 less than 9 mm thick, the minimum 250 mm gauge length may be proportionally reduced, but should be as large as possible while maintaining adequate clearance between the gauges and the loading equipment.

7.1.5 Expression of results

7.1.5.1 True modulus of elasticity and bending stiffness

The true bending modulus of elasticity of the test piece shall be calculated from the linear portion of the load versus deflection graph, as given in Equation (1) or (2):

$$E_{\mathrm{m,true}} = \frac{F_\Delta l_1^2 l_2}{16 u_\Delta I_\mathrm{a}} \qquad (1)$$

or

$$E_{\mathrm{m,true}} = \frac{k l_1^2 l_2}{16 I_\mathrm{a}} \qquad (2)$$

The true bending stiffness, $E_{\mathrm{m,true}}I_\mathrm{a}$, of the test piece shall be calculated from the linear portion of the load versus deflection graph, as given in Equation (3) or (4):

$$E_{\mathrm{m,true}} I_\mathrm{a} = \frac{F_\Delta l_1^2 l_2}{16 u_\Delta} \qquad (3)$$

or

$$E_{\mathrm{m,true}} I_\mathrm{a} = \frac{k l_1^2 l_2}{16} \qquad (4)$$

7.1.5.2 Bending strength and moment capacity

The bending strength of the test piece shall be calculated as given in Equation (5):

$$f_{\mathrm{m,true}} = \frac{F_{\mathrm{max}} l_2}{2W} \qquad (5)$$

The moment capacity of the test piece shall be calculated as given in Equation (6):

$$M_{\mathrm{max,true}} = \frac{F_{\mathrm{max}} l_2}{2} \qquad (6)$$

7.2 Apparent bending properties flatwise

7.2.1 Test piece

The test piece shall be rectangular in cross-section. The depth of the test piece shall be equal to the thickness of the panel, and the width shall be 300 mm. The total length of the test piece shall be 48 times t_1 plus an overhang sufficiently long to prevent the test piece from slipping off the supports during testing.

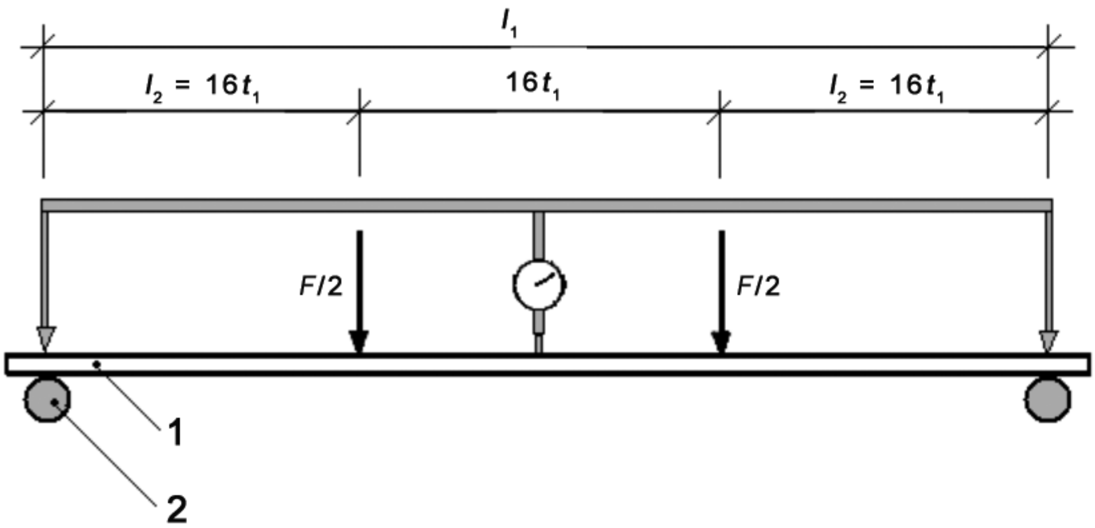
7.2.2 Loading equipment

The loading equipment shall be capable of measuring the load to an accuracy of 1 % of the maximum load.

7.2.3 Loading method

The application of the loads shall be as shown in Figure 3 and accurate to the nearest 1 mm. Contact points for loads and reaction forces shall be continuous across the width of the test piece and (30 ± 1) mm in diameter. The test hardware shall include appropriate mechanisms, such as rollers or pivots, to minimize the development of axial forces in the test piece and to allow the test piece to freely deflect under load.

NOTE Thick test pieces may require larger-diameter supports.



Key

1 test piece

2 support

Figure 3 — Apparent bending modulus of elasticity and stiffness test configuration

7.2.4 Test procedure

7.2.4.1 Rate of application of load

The load, F, shall be applied at a constant rate so that the maximum load is reached within 300 ± 120 s.

7.2.4.2 Measurement of length and deformation

The effective gauge length, l_1, shall be measured to the nearest 1 mm. The deflection of the test piece shall be measured at mid-width and mid-span. Test pieces exhibiting excessive twist/warp may require two points of deflection measurement near the outer edges of the test piece at mid-span, in which case the average of the two readings shall be used in the calculations.

Deflection measurement may be from the top or bottom of the test piece and shall be referenced relative to the top of the test piece, above the outside supports. If referencing deflection measurements from test hardware, steps shall be taken to reduce error due to crushing at contact points and hardware settling/movement.

The deflection over the gauge length shall be measured to the nearest 0,01 mm.

7.2.5 Expression of results

7.2.5.1 Apparent modulus of elasticity and bending stiffness

The apparent bending modulus of elasticity of the test piece shall be calculated from the linear portion of the load versus deflection graph, as given in Equation (7) or (8):

$$E_{\text{m,app}} = \frac{23 F_{\Delta} l_1^3}{1\,296 u_{\Delta} I_{\text{a}}} \tag{7}$$

or

$$E_{\text{m,app}} = \frac{23 k l_1^3}{1\,296 I_{\text{a}}} \tag{8}$$

The apparent bending stiffness, $E_{\text{m,app}} I_{\text{a}}$, of the test piece shall be calculated from the linear portion of the load versus deflection graph, as given in Equation (9) or (10):

$$E_{\text{m,app}} I_{\text{a}} = \frac{23 F_{\Delta} l_1^3}{1\,296 u_{\Delta}} \tag{9}$$

or

$$E_{\text{m,app}} I_{\text{a}} = \frac{23 k l_1^3}{1\,296} \tag{10}$$

7.2.5.2 Bending strength and moment capacity

The bending strength of the test piece shall be calculated as given in Equation (11):

$$f_{\text{m,app}} = \frac{F_{\text{max}} l_2}{2W} \tag{11}$$

The moment capacity of the test piece shall be calculated as given in Equation (12):

$$M_{\text{max,app}} = \frac{F_{\text{max}} l_2}{2} \tag{12}$$

7.3 Bending properties edgewise

7.3.1 Test piece

The test piece shall be rectangular in cross-section and shall have a width, b, of 50 mm, a length, l, of 915 mm and a thickness, t, equal to the thickness of the panel, as shown in Figure 4.

7.3.2 Loading equipment

The loading equipment shall be capable of measuring the load to an accuracy of 1 %.

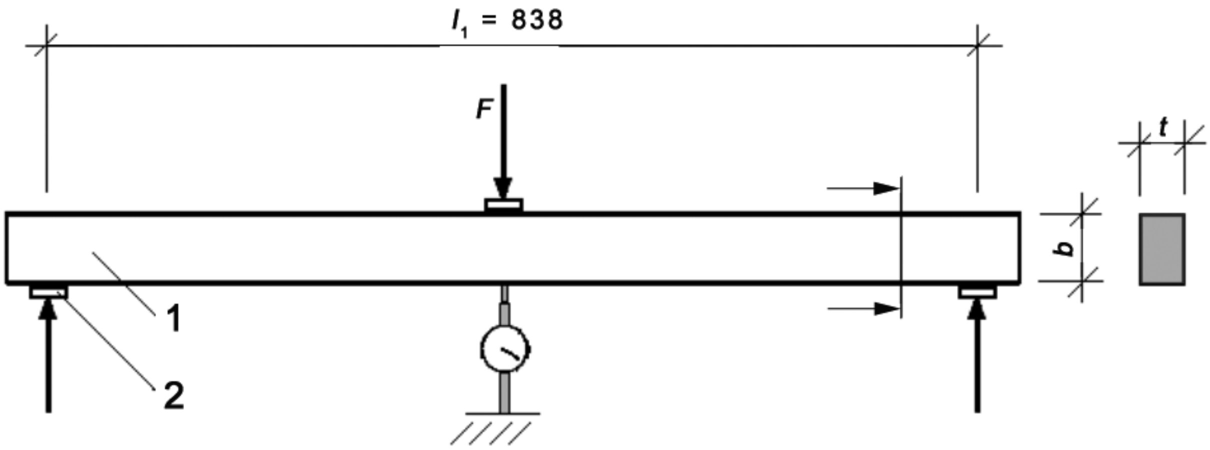
7.3.3 Loading method

The load and reaction forces shall be applied to the nearest 1 mm, as shown in Figure 4. The test piece shall be oriented on edge, with the plane of the panel parallel to the load, F. The load, F, shall be applied mid-span. The contact points for the load and the reaction forces shall be continuous across the width of the test piece and shall be sufficient in area to prevent crushing of the test piece. The test hardware shall include appropriate mechanisms, such as rollers or pivots, to minimize the development of axial forces in the test piece and to allow the test piece to freely deflect under load.

Test pieces having a b/t ratio of three or greater are subject to lateral instability during loading. Lateral supports, if used, shall allow movement of the test piece in the direction of load application and have minimal frictional restraint.

Bearing plates at least 25 mm in length are recommended to preclude crushing of the test piece.

Dimensions in millimetres



Key

1 test piece

2 support

Figure 4 — Edgewise bending test configuration

7.3.4 Test procedure

7.3.4.1 Rate of application of load

The load, F, shall be applied at a constant rate so that the maximum load is reached in not less than 10 s and not more than 300 s.

7.3.4.2 Measurement of deformation and ultimate load

Deformation shall be measured as the deflection at the load point with respect to the end reaction plates, to the nearest 0,01 mm.

If, because of the design of the apparatus, the deflection measurement includes extraneous components, the deflection data may be adjusted for such extraneous components. Any such adjustments shall be detailed in the test report.

7.3.5 Expression of results

7.3.5.1 Bending modulus of elasticity and stiffness capacity

The edgewise bending modulus of elasticity of the test piece shall be calculated from the linear portion of the load versus deflection graph, as given in Equation (13) or (14):

$$E_{\text{m,edge}} = \frac{F_\Delta l_1^3}{48 u_\Delta I_\text{a}} \tag{13}$$

or

$$E_{\text{m,edge}} = \frac{k l_1^3}{48 I_\text{a}} \tag{14}$$

The edgewise bending stiffness capacity, $E_{\text{m,edge}} I_\text{a}$, of the test piece shall be calculated from the linear portion of the load versus deflection graph, as given in Equation (15) or (16):

$$E_{\text{m,edge}} I_\text{a} = \frac{F_\Delta l_1^3}{48 u_\Delta} \tag{15}$$

or

$$E_{\text{m,edge}} I_\text{a} = \frac{k l_1^3}{48} \tag{16}$$

7.3.5.2 Bending strength and moment capacity

The bending strength of the test piece shall be calculated as given in Equation (17):

$$f_{\text{m,edge}} = \frac{F_{\text{max}} l_1}{4W} \tag{17}$$

The moment capacity of the test piece shall be calculated as given in Equation (18):

$$M_{\text{max,edge}} = \frac{F_{\text{max}} l_1}{4} \tag{18}$$

8 Compression properties

8.1 General

Compression tests shall be in accordance with 8.2 for small-size test pieces or 8.3 for large-size test pieces.

8.2 Compression test for small test pieces

8.2.1 Test piece

8.2.1.1 General

The preparation of the test pieces will depend on the nominal thickness, t_1, of the panel to be tested. If t_1 is 40 mm or greater, the test piece shall consist of one piece of the panel being tested, and be as described in

8.2.1.2. If t_1 is less than 40 mm, the test piece shall consist of several pieces of the panel being tested and be fabricated as per 8.2.1.3.

8.2.1.2 Panels having a thickness of 40 mm or greater

For panels with a t_1 of 40 mm or greater, the test piece shall have a width, b, of 200 mm, a length, l, of between five and six times t_1 and a thickness, t, equal to the thickness of the panel.

8.2.1.3 Panels having a thickness of less than 40 mm

For panels with a t_1 of less than 40 mm, the test piece shall be formed from the bonding together of specimens of adjacent positions within the panel until the thickness, t, of the test piece is not less than 40 mm. The specimens shall be oriented to make the test piece as symmetrical as possible. The test piece shall be fabricated oversized and, after the necessary bonding, machined to a minimum width, b, of 40 mm and a length, l, of between five and six times t_1. The end surfaces of the test pieces shall be smooth and parallel to each other and at right angles to the test piece length.

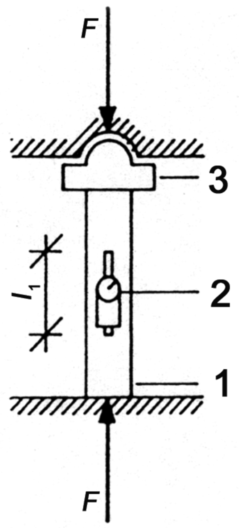
NOTE The forms of typical test pieces are shown in Figure A.1.

8.2.2 Loading equipment

The loading equipment shall be capable of measuring the load to an accuracy of 1 % of the maximum load.

8.2.3 Loading method

The load shall be applied through a spherical connection on the upper head of the test machine to allow for any deviation from parallel of the ends of the test piece and permit adjustment to match the ends of the test piece (see Figure 5).



Key

1 test piece

2 transducer

3 spherically seated platen

Figure 5 — Compression test configuration for small-size test pieces

8.2.4 Test procedure

8.2.4.1 Rate of application of load

The load, F, shall be applied at a constant rate so that the maximum load is reached within (300 ± 120) s.

8.2.4.2 Measurement of length and deformation

Data for load-deformation curves shall be taken to determine the modulus of elasticity and the compression stiffness.

The deformation shall be measured over the central portion on two opposing faces of the test piece, using a gauge length, l_1, of (100 ± 25) mm. The average of the two readings shall be used in the calculation of the stiffness and modulus of elasticity of the test piece.

The deformation shall be measured to the nearest 0,005 mm.

8.3 Compression test for large-size test pieces

8.3.1 Test piece

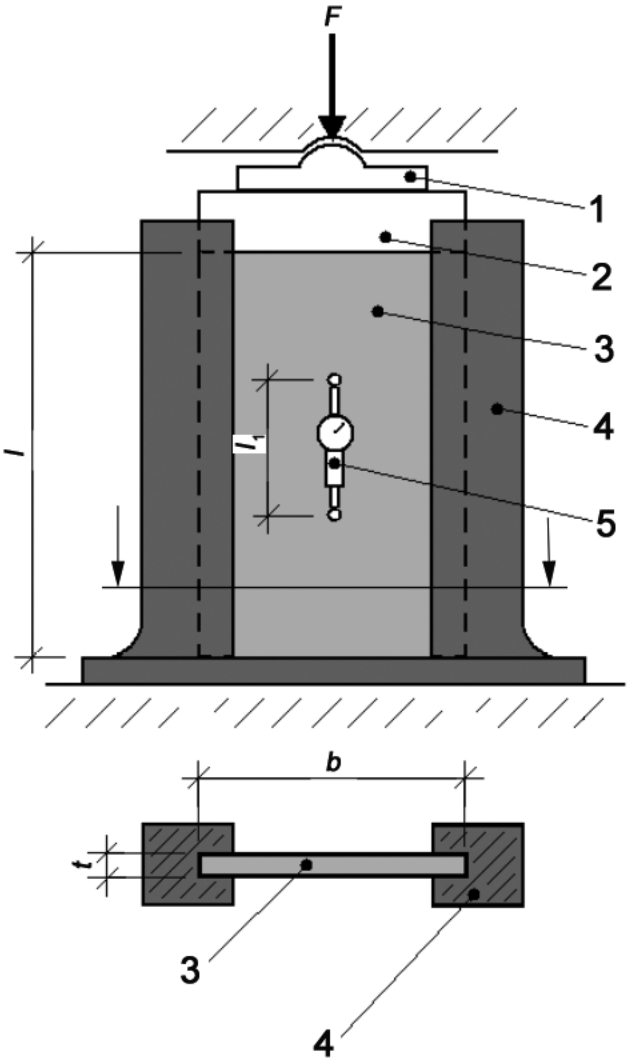
The test piece shall be precisely cut with all adjacent edges at right angles. The test piece shall be 190 mm wide and 380 mm long. A length-to-thickness ratio of 20 or less shall be used except that, if only strength data are required, a ratio of 10 or less shall be used. It may be necessary to glue two or more specimens together to obtain the specified length-to-thickness ratio. Bonded specimens shall be oriented to make the test piece as symmetrical as possible and shall be oversized to allow machining to the correct dimensions after bonding.

8.3.2 Loading equipment

The loading equipment shall be capable of measuring the load to an accuracy of 1 % of the maximum load.

8.3.3 Loading method

The load shall be applied through a spherical connection on the upper head of the test machine to allow for any deviation from parallel of the ends of the test piece and permit adjustment to match the ends of the test piece (see Figure 6). The lateral supports shall loosely hold the test piece and shall be adjustable to the thickness of each test piece.



Key

1 spherically seated platen
2 loading block
3 test piece
4 lateral support adjustable to test piece thickness
5 transducer

Figure 6 — Compression test configuration for large-size test pieces

8.3.4 Test procedure

8.3.4.1 Rate of application of load

The load, F, shall be applied at a constant rate so that the maximum load is reached within (300 ± 120) s.

8.3.4.2 Measurement of length and deformation

Data for load-deformation curves shall be taken to determine the modulus of elasticity and compression stiffness.

The deformation shall be measured over the central portion on two opposing faces of the test piece, using a gauge length, l_1, of (125 ± 10) mm. The average of the two readings shall be used in the calculations.

The deformation shall be measured to the nearest 0,002 mm.

8.4 Expression of results

8.4.1 General

The following equations shall be used to calculate the compression modulus of elasticity, stiffness and strength from the results from both 8.2 and 8.3. A is defined as the total cross-sectional area of the plies parallel to the compression load within the gauge length when the parallel-ply theory is used in the evaluation.

8.4.2 Compression modulus of elasticity and stiffness

The compression modulus of elasticity of the test piece shall be calculated from the linear portion of the load versus deformation graph, as given in Equation (19) or (20):

$$E_c = \frac{F_\Delta l_1}{u_\Delta A} \tag{19}$$

or

$$E_c = \frac{k l_1}{A} \tag{20}$$

The compression stiffness, $E_c A$, of the test piece shall be calculated from the linear portion of the load versus deformation graph, as given in Equation (21) or (22):

$$E_c A = \frac{F_\Delta l_1}{u_\Delta} \tag{21}$$

or

$$E_c A = k l_1 \tag{22}$$

8.4.3 Compression strength

The compression strength of the test piece shall be calculated as given in Equation (23):

$$f_c = \frac{F_{max}}{A} \tag{23}$$

9 Tension properties

9.1 Test piece

The test piece shall be rectangular in cross-section with a thickness equal to the thickness of the board and an overall width of not less than 150 mm (see Figure 7). The overall length of the test piece will depend on the equipment used to apply the load. The length of the test area shall be not less than 250 mm. The width of the test piece outside the test area may be increased (as shown by dotted lines in Figure 7) to help isolate failures to the test area. The width of the test area shall be constant.

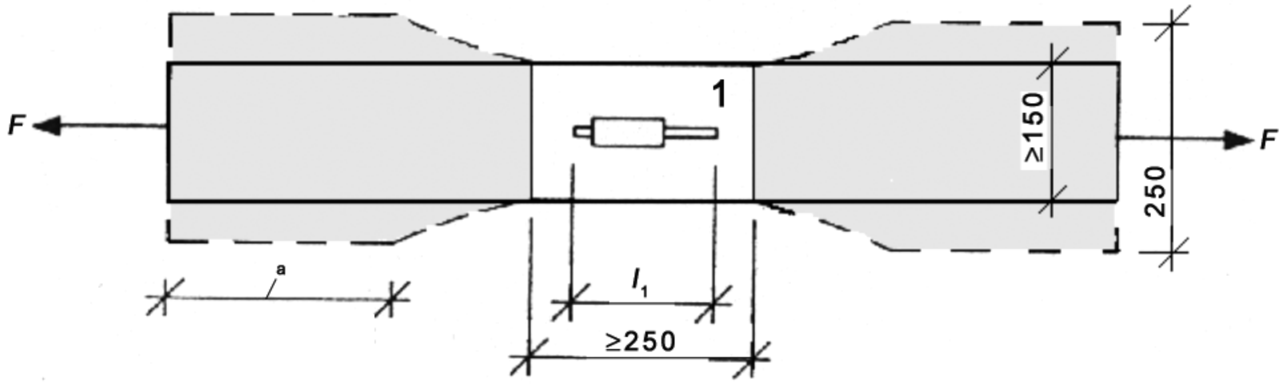
9.2 Loading equipment

The loading equipment shall be capable of measuring the load to an accuracy of 1 %.

9.3 Loading method

The test piece shall be held in grips which apply the required loads to the test piece with a minimum influence on failure load and position of failure.

Dimensions in millimetres



Key

1 test area

a Length to suit jaws of test machine.

Figure 7 — Tension test configuration

The grips shall not apply a bending moment to the test piece, nor allow slippage under load.

The grips shall be self-aligning. The type of grips used shall be reported.

9.4 Test procedure

9.4.1 Rate of application of load

The load, F, shall be applied at a constant rate so that the maximum load is reached within (300 ± 120) s.

9.4.2 Measurement of length and deformation

Data for load-deformation curves shall be taken to determine the tension modulus of elasticity and stiffness.

The deformation shall be taken over the central portion on the two opposing faces of the test piece, using a gauge length, l_1, of (100 ± 25) mm. The average of the readings shall be used in the calculation of the modulus of elasticity and stiffness.

The deformation shall be measured to the nearest 0,005 mm.

9.5 Expression of results

9.5.1 General

The following equations shall be used to calculate the tension modulus of elasticity, stiffness and strength from the results from 9.1 to 9.4. A is defined as the total cross-sectional area of the plies parallel to the tension load within the gauge length when the parallel-ply theory is used.

9.5.2 Tension modulus of elasticity and stiffness

The tension modulus of elasticity of the test piece shall be calculated from the linear portion of the load versus deformation graph, as given in Equation (24) or (25):

$$E_t = \frac{F_\Delta l_1}{u_\Delta A} \tag{24}$$

or

$$E_t = \frac{k l_1}{A} \tag{25}$$

The tension stiffness, $E_t A$, of the test piece shall be calculated from the linear portion of the load versus deformation graph, as given in Equation (26) or (27):

$$E_t A = \frac{F_\Delta l_1}{u_\Delta} \tag{26}$$

or

$$E_t A = k l_1 \tag{27}$$

9.5.3 Tension strength

The tension strength of the test piece shall be calculated as given in Equation (28):

$$f_t = \frac{F_{max}}{A} \tag{28}$$

If the fracture of a test piece occurs at or within the grips, or in the transition zone outside the test area, the test result for this test piece shall be reported separately.

10 Panel shear

10.1 Panel shear — Method A

10.1.1 Test piece

The test piece shall be rectangular in cross-section with a thickness, t, equal to the thickness of the panel. The overall width of the test piece will depend on the equipment used to apply the load. The test area shall have a width of (200 ± 10) mm and length of (600 ± 10) mm.

NOTE With certain panel materials, panel buckling may occur, depending on construction, thickness and orientation. Valid results may only be obtainable with the test piece oriented with the strongest in-plane bending property perpendicular to the rails.

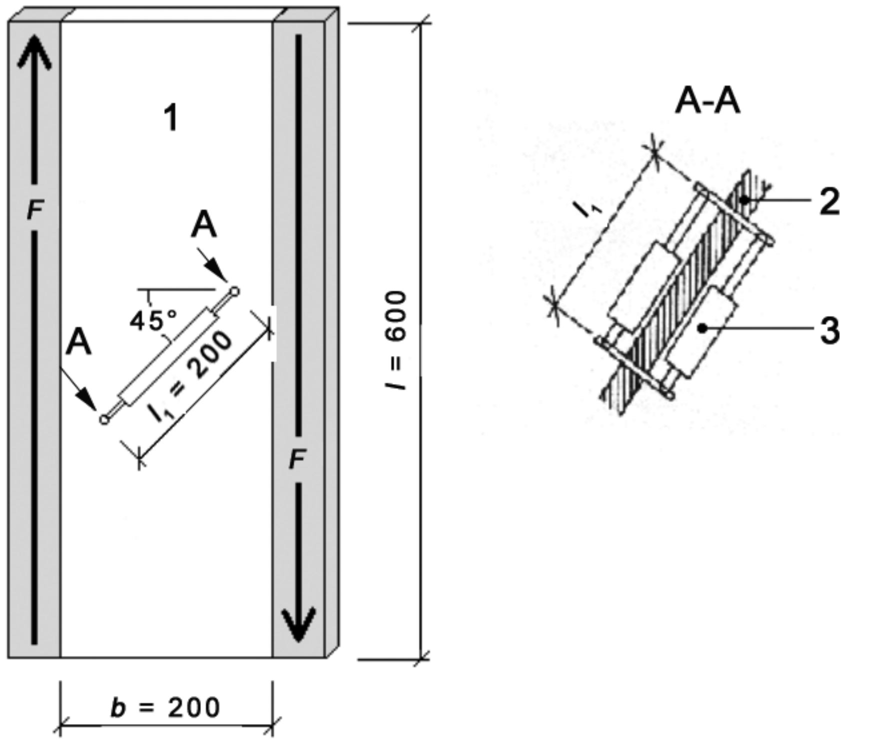
10.1.2 Loading equipment

The loading equipment shall be capable of measuring the load to an accuracy of 1 % of the maximum load.

10.1.3 Loading method

Load shall be applied to the test piece so that the resultant of the forces is a single force, F, acting along the edges of the test area, as shown in Figure 8. Not shown in Figure 8 are the secondary forces necessary to maintain equilibrium of the test configuration. These loads shall be such that the moment is zero near the centre of the test area. The short ends of the test area shall not be loaded or restrained. Test equipment shall be appropriately chosen to ensure an equal and uniform loading by F along both edges of the test piece.

Dimensions in millimetres



Key

1 test area

2 test piece

3 linear displacement transducers

Figure 8 — Panel shear test configuration — Method A

10.1.4 Test procedure

10.1.4.1 Rate of application of load

The load, F, shall be applied at a constant rate so that the maximum load is reached within (300 ± 120) s.

10.1.4.2 Measurement of length and deformation

Deformation shall be measured along a (200 ± 10) mm gauge length on each side of the test piece (see Figure 8, section A-A) and averaged. The gauge length shall be orientated on the compression diagonal, at 45° to the edges of the test area, and centred about the test area.

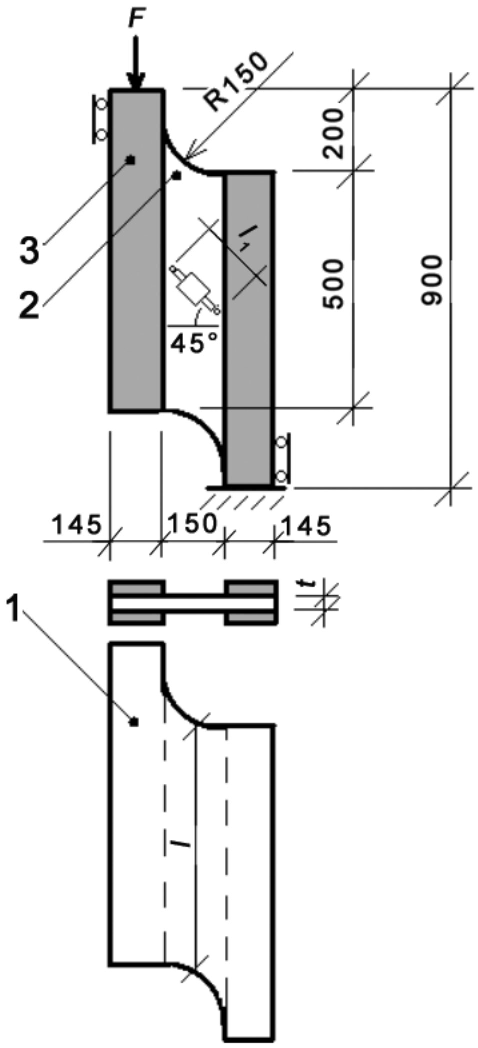
Equipment for deformation measurement shall give values accurate to 2 % of the total measured elongation.

10.2 Panel shear — Method B

10.2.1 Test piece

The test piece shall be rectangular in cross-section with a thickness, t, equal to the thickness of the panel. Other dimensions of the test piece shall be as shown in Figure 9.

Dimensions in millimetres



Key

1 test piece

2 test area

3 rail

Figure 9 — Panel shear test piece and set-up for method B

The loaded surfaces of the test piece shall be smooth and parallel to each other and at right angles to the test piece length, l.

NOTE 1 With certain panel materials, panel buckling may occur, depending on construction, thickness and orientation. Valid results may only be obtainable with the test piece oriented in either the longitudinal or lateral direction.

Timber rails having minimum dimensions of 35 mm × 145 mm × 700 mm long shall be bonded to both sides of the test piece at each edge. The width of the rails may be increased to eliminate a shear failure between the rails and the test piece. The rails shall be spaced (150 ± 2) mm apart with their ends even with the test piece at two diagonally opposite corners, as shown in Figure 9. Prior to bonding, the rails and the test piece shall be conditioned to the approximate moisture content at which the test piece is to be tested.

NOTE 2 Previous experience has shown that rails should be of “good quality” material with a minimum compression strength parallel to the grain of 35 MPa and a minimum bending modulus of elasticity of 9 000 MPa. This is to ensure that the stiffness of the rails is greater than that of the test panels and to ensure the stresses in the rails remain below 40 % of the ultimate value.

A suitable PRF adhesive shall be used to attach the rails.

NOTE 3 Some panel materials have a high panel shear strength but insufficient internal bond and planar-shear strength to transfer the stresses from the rails into the panel. In these cases, the rail may separate from the test piece. This may be prevented by applying lateral pressure to the rails, for example by the use of bolts.

Steel rails may be substituted for timber rails and clamping may be substituted for bonding, provided that no crushing of the test piece or slippage between rail and test piece occurs.

NOTE 4 Special rail facings may be needed to develop adequate friction between the rails and the test piece. The clamping method is particularly well suited to reconstituted panel materials that would otherwise require bolting to prevent planar shear in the test piece under the rails.

10.2.2 Loading equipment

The loading equipment shall be capable of measuring the load to an accuracy of 1 % of the maximum load applied to the test piece.

10.2.3 Loading method

The load shall be applied evenly over the top surface of the uppermost rail as single force acting along the longitudinal axis of the test piece, parallel to the rails.

NOTE A suitable apparatus for applying equal loads to the rails is shown in Annex C.

10.2.4 Test procedure

10.2.4.1 Rate of application of load

The load, F, shall be applied at a constant rate so that the maximum load is reached within (300 ± 120) s.

10.2.4.2 Measurement of length and deformation

When shear modulus of rigidity, G_V, is to be determined, deflection gauges shall be attached to both sides of the test piece, parallel to each other, as shown in Figure 9. The gauge length, l_1, along which deformation is measured shall be the compression diagonal at 45° to the rails, passing through the centre of the test area. The gauge length shall be between 120 mm and 150 mm and centred between the rails along this line.

Attachment of the gauges may be with pins inserted in 3 mm diameter drilled holes (see Figure 8, section A-A) or by glued mounts with the contact area being less than 5 mm in diameter.

The deformation shall be determined as the average of the measurements taken on each side of the test piece, using measuring devices (e.g. transducers) attached to the test piece. Equipment for deformation measurement shall give values accurate to 1 % of the total measured elongation.

10.2.4.3 Failure mode

The failure mode of the specimen shall be recorded. Any piece that fails in any manner other than by panel shear of the face of the test piece between the rails shall be reported separately.

NOTE Because shear stresses applied by the rails also produce tensile stresses at 45° to the rails, panels having a tensile strength less than or approaching their shear strength will usually display one or more tension breaks at approximately 45° to the rails and often extended beneath them. Such results are not abnormal.

10.3 Expression of results

10.3.1 General

The following equations shall be used to calculate the panel shear rigidity and strength from the results from both 10.1 and 10.2.

10.3.2 Panel shear rigidity

The modulus of panel shear rigidity shall be calculated from the straight-line portion of the load versus deformation graph, as given in Equation (29):

$$G_v = \frac{kl_1}{2lt} \quad (29)$$

If quantified, a correction factor to compensate for the effects of non-uniform shear stress distribution near the ends of the test area may be applied. The test report shall clearly state whether or not the correction has been applied.

10.3.3 Panel shear strength

The panel shear strength of the test piece shall be calculated as given in Equation (30):

$$f_v = \frac{F_{max}}{lt} \quad (30)$$

If the failure of a test piece occurs outside the test area or at the transition zone, the test result for this test piece shall be reported separately.

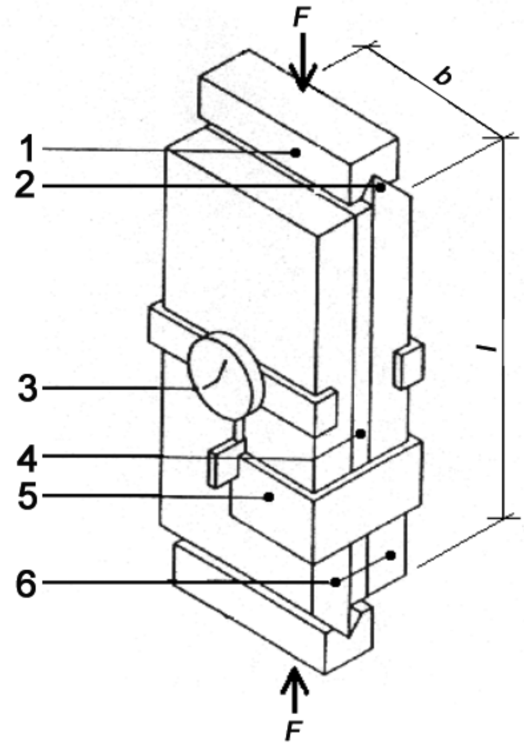
11 Planar shear

11.1 Method A — Loaded by plates

11.1.1 Test piece

The test piece shall be rectangular in cross-section with a thickness, t, equal to the thickness of the panel. Test pieces from material that is expected to vary significantly within the test piece due to growth or manufacturing features, or from other causes, shall be at least 150 mm wide by 450 mm long. This size is recommended for uniform material as well. However, smaller specimens of uniform material may be used if these are not less than four times t_1 in width and twelve times t_1 in length.

The test piece shall be bonded between two plates (see Figure 10) with an adhesive sufficient to preclude a significant contribution of adhesive creep to the measured deformation. Each plate shall have a knife edge projecting 6 mm beyond the end of the test piece, with the knife edges parallel to each other.



Key

1 V-block
2 knife edge
3 dial gauge or transducer
4 test piece
5 bracket attached to back of plate
6 plates

Figure 10 — Planar-shear test configuration

Planar-shear properties of panels containing veneer can be affected by the orientation of knife checks within the veneer. Knife check orientation shall be recorded as open or closed (see Figure 11) and included in the report.

11.1.2 Loading equipment

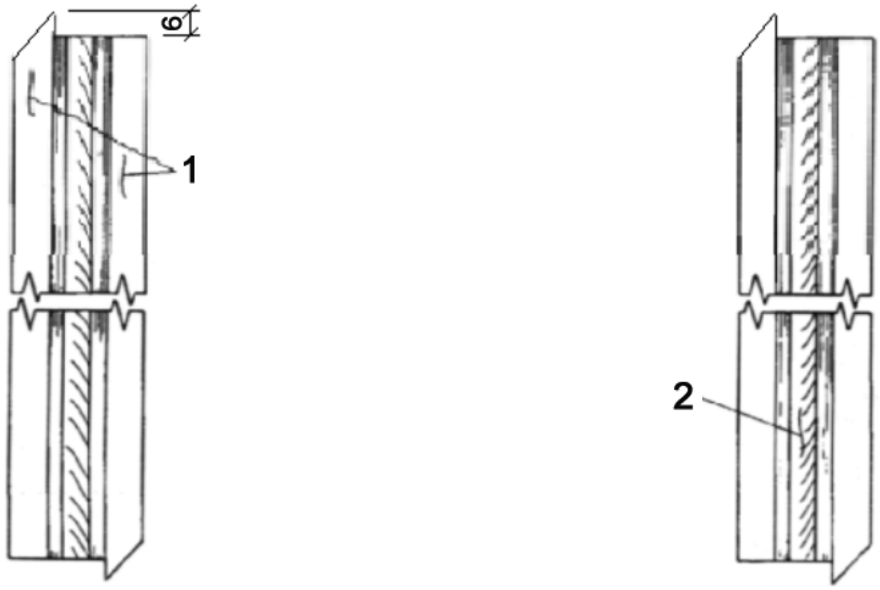
The loading equipment shall be capable of measuring the load to an accuracy of 1 % of the maximum load.

11.1.3 Loading method

The load shall be applied as shown in Figure 10. V-blocks shall be used to uniformly distribute the load along the knife edges. The V-blocks shall be positioned such that the forces applied to the test piece are in direct opposition to each other and parallel to the axis of the machine. The plates shall be appropriately chosen to ensure the load is transferred uniformly over the entire test piece.

WARNING — Pivots permitting rotation about an axis parallel to the knife edge or spherical seats free to pivot in this manner should not be used, as they create unstable loading which may cause violent ejection of the test piece from the machine and a hazard to operating personnel.

Dimensions in millimetres



a) Knife checks open

b) Knife checks closed

Key

1 plates

2 knife checks

Figure 11 — Orientation of knife checks in plywood

11.1.4 Test procedure

11.1.4.1 Rate of application of load

The load, F, shall be applied at a constant rate so that the maximum load is reached within (300 ± 120) s.

11.1.4.2 Measurement of length and deformation

Data for load-deformation curves shall be taken to determine the planar-shear modulus of rigidity. A suitable method of measuring the slip between the plates is shown in Figure 10.

The deformation shall be measured to the nearest 0,002 mm.

11.1.5 Expression of results

11.1.5.1 Planar-shear rigidity

The modulus of planar-shear rigidity shall be calculated from the linear portion of the load versus deformation graph, as given in Equation (31):

$$G_{\mathrm{s}} = \frac{kt}{lb} \tag{31}$$

11.1.5.2 Planar-shear strength

The planar-shear strength shall be calculated as given in Equation (32):

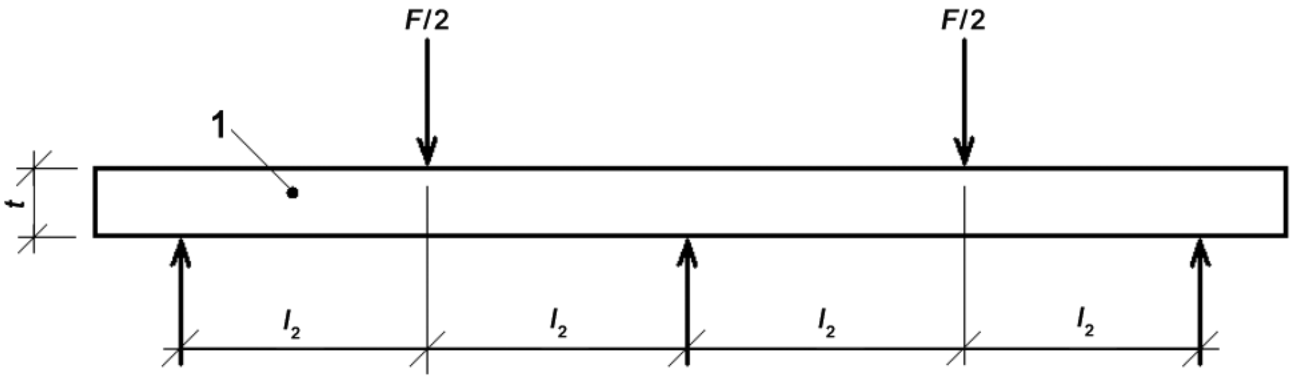
$$f_s = \frac{F_{max}}{lb} \tag{32}$$

Failures may occur anywhere within the thickness of the test piece, but any test assembly that fails wholly or partially in the bond between the test piece and plate shall be reported separately.

11.2 Method B — Five-point bending

11.2.1 General

Test pieces are tested in a two-span continuous beam support configuration with line loads applied at the mid-point of each span as shown in Figure 12. Induced shear stresses are consistent with those developed in conventional panel applications under transverse loading.



Key

1 test piece

Figure 12 — Five-point bending test configuration

11.2.2 Test piece

The test piece shall be rectangular in cross-section with a thickness, t, equal to the thickness of the panel. The width of the test piece shall be at least 115 mm but no greater than 255 mm.

Test piece width may be modified for practical purposes. It shall be reported with the shear strength results, since shear strength may vary slightly with test piece width.

11.2.3 Loading equipment

The loading equipment shall be capable of measuring the load to an accuracy of 1 % of the maximum load.

11.2.4 Loading method

The load shall be applied as shown in Figure 12. The test span, l_2, shall be calculated as given in Equation (33), if the average ultimate bending and planar-shear stress estimates are available.

$$l_2 = (11/24)t \times (f_m/f_s) > 11t \tag{33}$$

If the average bending and shear stress estimates are not available, the test span shall be at least 16 times the nominal panel thickness for testing in the longitudinal direction, and 11 times the nominal panel thickness for the lateral direction.

The supports shall be rounded to minimize friction between the supports and test pieces. The supports shall be free to rotate laterally to compensate for distortion of the test piece. Loading heads shall be rounded with a radius of curvature comparable to that of the supports.

11.2.5 Test procedure

11.2.5.1 Rate of application of load

The load, F, shall be applied at a constant rate so that the maximum load is reached within (300 ± 60) s.

A 1,3 mm/min loading rate is recommended as an initial rate for the purpose of establishing an appropriate rate for tests of record.

11.2.5.2 Data collection

The maximum load reached shall be recorded along with the failure location and the failure mode (shear or bending). Data from test pieces failing in bending shall be reported separately.

11.2.6 Expression of results

The planar-shear strength shall be calculated as given in Equation (34):

$$f_{\text{s}} = \frac{33F_{\text{max}}}{64bt} \qquad (34)$$

12 Test report

12.1 General

The test report shall include details of the test material, the method of test used and the test results. The amount of detail given under each of these headings will depend on the purpose of the tests.

12.2 General data

The following data shall be given:

a) the name of the testing organization;

b) the name(s) of the supplier(s) of the test material;

c) a general description of the test material;

d) the place and date of sampling (see also 12.7).

12.3 Data on the material

The following data shall be given on the material:

e) the type, thickness, grade and composition or lay-up;

f) the relevant product specification;

g) the surface treatment, if any;

h) the type of glue used, if any, between specimens in the compression test pieces;

i) the method of conditioning.

12.4 Data on individual test pieces

For individual test pieces, the following data shall be given:

j) the test piece dimensions;

k) the calculated values of strength and/or capacity, stiffness or modulus of elasticity (in bending, compression and tension), and modulus of rigidity (in panel and planar-shear tests), to three significant figures.

12.5 Data on physical properties

Data shall be given on the following physical properties:

l) the moisture content of the test piece(s) at the time of testing;

m) the density of the test piece(s) at the time of testing.

12.6 Additional information

Additional data may be required in some cases. These may include the following:

n) details of the method of fabrication of the test pieces;

o) details of any natural characteristics or manufacturing features which may have influenced the test results;

p) a description of the test;

q) the temperature or relative humidity at the time of testing.

12.7 Sampling data

The following data shall be given:

r) a copy of the cutting schedule used;

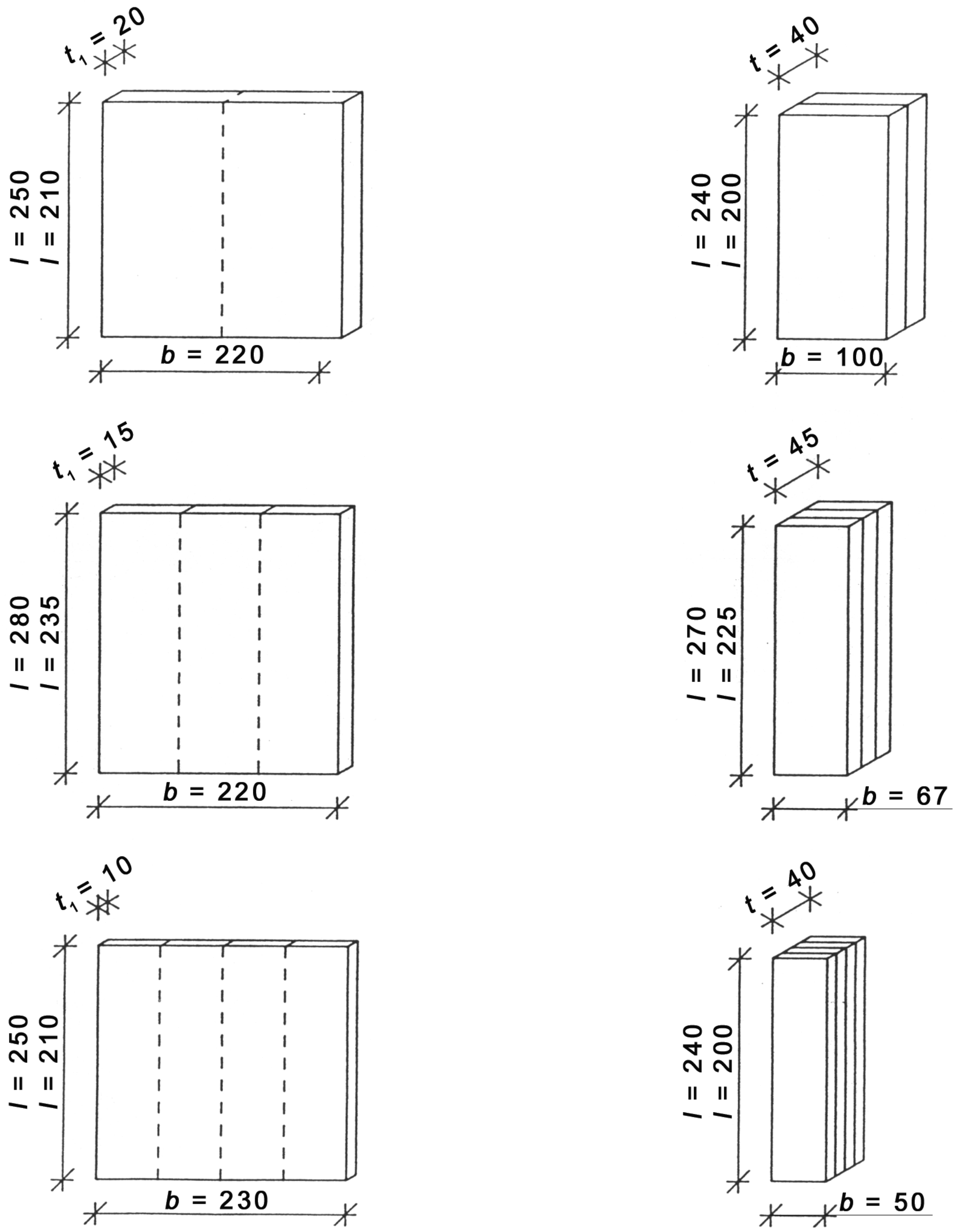
s) the number of panels sampled for each property;

t) the number of test pieces tested for each property.

Annex A
(informative)

Small-size compression test pieces

Dimensions in millimetres



a) Specimens **b) Test pieces**

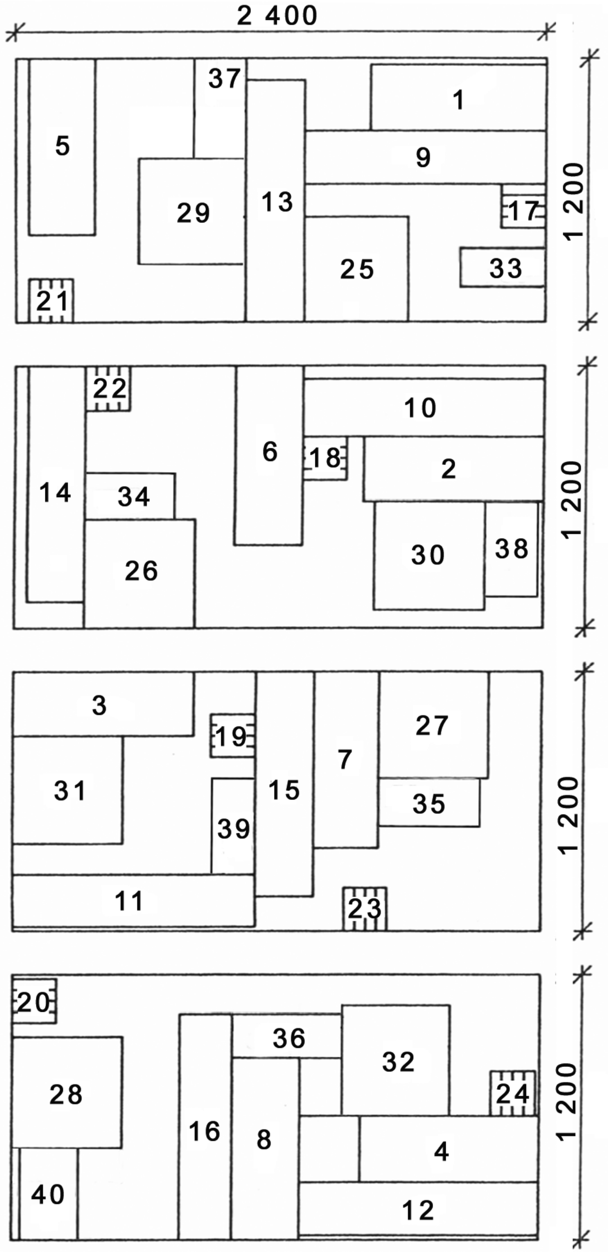
Figure A.1 — Examples of test pieces from panels having a thickness of less than 40 mm

Annex B
(informative)

Example of cutting schedule

Figure B.1 contains an example of a cutting schedule based on a sample of four panels with minimum dimensions of 1 200 mm × 2 400 mm, the positions of the specimens within the panels being chosen to produce an unbiased sample.

Dimensions in millimetres



Test	Specimen Nos.
Bending	
longitudinal	1 to 4
lateral	5 to 8
Tension	
longitudinal	9 to 12
lateral	13 to 16
Compression	
longitudinal	17 to 20
lateral	21 to 24
Panel shear	
longitudinal	25 to 28
lateral	29 to 32
Planar shear	
longitudinal	33 to 36
lateral	37 to 40

Figure B.1 — Example of a cutting schedule

Annex C
(informative)

Panel shear — Method B

Dimensions in millimetres

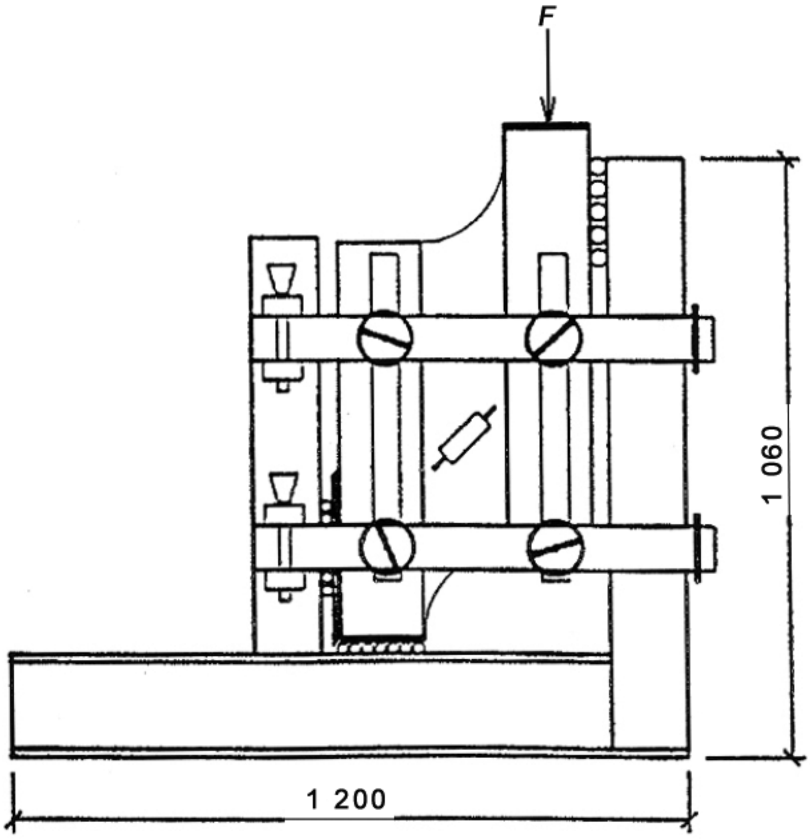


Figure C.1 — Example of a suitable loading arrangement for panel shear, method B

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