BRITISH STANDARD

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1193 : 1998

Timber structures — Structural timber and glued laminated timber — Determination of shear strength and mechanical properties perpendicular to the grain

The European Standard EN 1193 : 1997 has the status of a British Standard

ICS 79.060.99; 91.080.20

National foreword

This British Standard is the English language version of EN 1193 : 1997.

The UK participation in its preparation was entrusted by Technical Committee B/518, Structural timber, to Subcommittee B/518/1, Test methods, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Summary of pages

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English version

Timber structures — Structural timber and glued laminated timber — Determination of shear strength and mechanical properties perpendicular to the grain

Structures en bois — Bois de charpente et bois lamellé-collé — Détermination de la résistance au cisaillement et des propriétés mécaniques perpendiculaires aux fibres

Holzbauwerke — Bauholz für tragende Zwecke und Brettschichtholz — Bestimmung der Scherfestigkeit und der mechanischen Eigenschaften rechtwinklig zur Faserrichtung

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 1193 : 1997 E

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 124, Timber structures, the Secretariat of which is held by DS.

NOTE. It is considered desirable to maintain the same clause numbering throughout this series of standards. Consequently, some clauses are empty but it is envisaged that future editions may need to include text in these clauses.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 1998, and conflicting national standards shall be withdrawn at the latest by April 1998.

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Contents

1 Scope

This standard specifies test methods for determining:

– tensile and compressive strengths perpendicular to the grain of structural timber and glued laminated timber; and

– tensile and compressive moduli of elasticity perpendicular to the grain of structural timber and glued laminated timber; and

– shear strength parallel to the grain of structural timber and of the laminates used in glued laminated timber.

2 Normative references

None.

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1 compressive strength perpendicular to the grain

Stress corresponding to the load which occurs at the intersection of the line of the load/deformation curve and line 2 of figure 3.

3.2 modulus of elasticity in compression perpendicular to the grain

Property relating to the inclination of the straight line joining two points in figure 3 corresponding to the loads 0,1 $F_{c,90,max}$ and 0,4 $F_{c,90,max}$.

3.3 shear strength parallel to the grain

Maximum test load (F_{max}) per unit area of the test piece, multiplied by a factor of 0,97 (i.e. cos 14°).

4 Symbols

b	test piece width, in millimetres;
$E_{c,90}$	modulus of elasticity in compression perpendicular to the grain, in newtons per square millimetre;
$E_{t,90}$	modulus of elasticity in tension perpendicular to the grain, in newtons per square millimetre;
F	applied load, in newtons;
$F_{c,90}$	compressive load perpendicular to the grain, in newtons;
$F_{c,90,max}$	maximum compressive load perpendicular to the grain, in newtons;
$F_{c,90,max,est}$	estimated maximum compressive load perpendicular to the grain, in newtons;
$F_{t,90}$	tensile load perpendicular to the grain, in newtons;
$F_{t,90,max}$	maximum tensile load perpendicular to the grain, in newtons;
F_{max}	maximum load applied by the test machine, in newtons;
$f_{c,90}$	compressive strength perpendicular to the grain, in newtons per square millimetre;
$f_{t,90}$	tensile strength perpendicular to the grain, in newtons per square millimetre;
f_v	shear strength parallel to the grain, in newtons per square millimetre;
h	test piece height, in millimetres;
h_0	gauge length, in millimetres;
l	test piece length, in millimetres;
t	plate thickness, in millimetres;
w	deformation, in millimetres.

5 Determination of dimensions of test piece

The dimensions of the test pieces shall be measured to an accuracy of 1 %. All measurements shall be made when the test pieces are conditioned as specified in clause **7**, and planed.

NOTE. If the width or length varies, then these dimensions should be recorded as the average of three measurements on the height of the test piece.

6 Determination of density of test pieces

The density of the test pieces shall be determined prior to test from the measurements of mass and volume of the whole test piece.

7 Conditioning of test pieces

7.1 General

The tests shall be carried out on test pieces which are conditioned at the standard environment of (20 ± 2) °C and (65 ± 5) % relative humidity. The test piece is conditioned when it attains constant mass. Constant mass is considered to be attained when the results of two successive weighings, carried out at an interval of 6 h, do not differ by more than 0,1 % of the mass of the test piece.

Where the timber to be tested is not readily conditionable to the above standard environment, (e.g. for hardwoods with high densities), that fact shall be reported.

7.2 Test area environment

Unless otherwise protected, test pieces shall not be removed from the conditioning environment more than 1 h before testing.

NOTE. Test pieces can be stored in the test area for up to 24 h provided they are close piled and wrapped in vapour tight sheeting.

8 Determination of tension and compression strengths perpendicular to the grain

8.1 Requirements for test pieces

8.1.1 *Fabrication*

The fabrication of the test pieces shall be such as will allow for the application of the loads to the test piece.

NOTE 1. Suitable arrangements are shown in annexes A and B.

For tension tests, the test piece shall be glued to steel plates. The gluing process shall be capable of ensuring the specified position of the test piece during testing.

NOTE 2. A suitable adhesive for fixing the steel plates to the timber test piece is a two-part epoxy. Immediately prior to gluing, the surfaces to be joined should be prepared by planing the timber test piece surfaces and sandblasting the steel plates.

8.1.1.1 *Surface preparation*

The loaded surfaces shall be accurately prepared to ensure that they are plane and parallel to each other and perpendicular to the test piece axis. This preparation shall be carried out after conditioning.

8.1.1.2 *Structural timber*

The test pieces shall have the dimensions given in table 1 and be as shown in figure 1a.

8.1.1.3 *Glued laminated timber*

The test pieces shall have the dimensions given in table 1, with the object of achieving a volume of 0,01 m^3 for tension test pieces, and be as shown in figure 1b.

8.2 Procedure

The test piece shall be mounted vertically between the test machine platens and the appropriate compression or tension loads applied. The gauge length, h_0 (approximately 0,6 h), shall be located centrally in the test piece height and not closer than $b/3$ to the loaded ends of the test piece, (see figure 2).

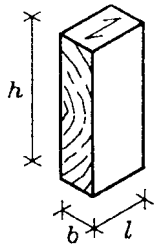


Figure 1a. Structural timber test piece

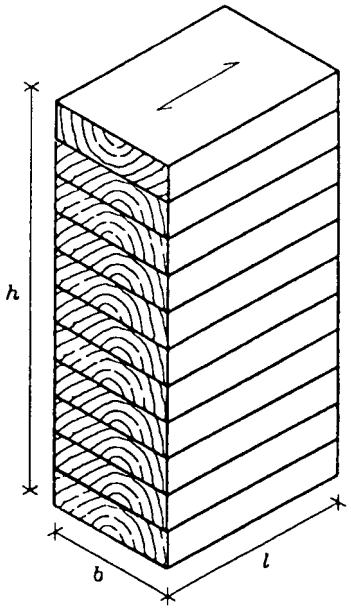


Figure 1b. Glued laminated timber test piece

Table 1. Dimensions of structural timber or glued laminated timber test pieces

Specimen characteristics						
Structural timber			**Glued laminated timber**			
b (mm)	h (mm)	l (mm)	Volume	bl (mm^2)	$b \geq$ (mm)	h (mm)
Tension						
45	180	70	0,01 m^3	25000	100	400
Compression						
45	90	70	—	25000	100	200

The symbols are as given in clause **4**.

The permissible tolerances of the test piece dimensions b, h and l shall be 1 %.

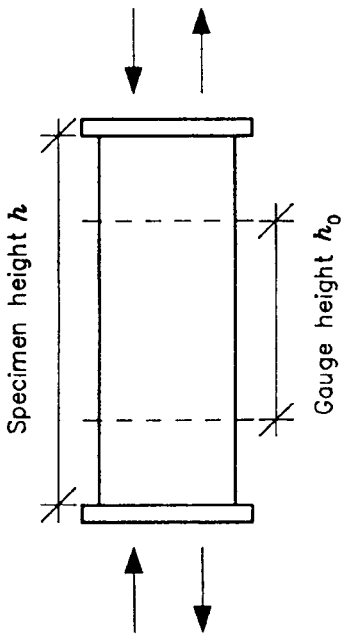


Figure 2. Test principle

The loading equipment used shall be capable of measuring the load to an accuracy of 1 % of the load applied to the test piece or, for loads less than 10 % of the maximum load, with an accuracy of 0,1 % of the maximum load.

The test piece shall be loaded concentrically.

NOTE 1. This can be achieved using spherically seated loading-heads (see also annexes A and B).

In the case of the compression test, after an initial load has been applied, the loading-heads shall be locked to prevent rotation or angular movement during the test.

NOTE 2. Suitable devices are shown in annex A.

In the case of either a tension test or a compression test the longitudinal axis of the test piece shall be aligned with the axis of the machine and fixed in such a way that no initial stresses in the test piece are introduced, except those due to the weight of the test piece and the equipment.

In the case of tension tests on solid timber the test piece shall have pinned ends, with the axis of the pin parallel to the grain direction of the test piece.

The load F shall be applied at a constant rate of cross head movement throughout the test. The rate of loading shall be adjusted so that the maximum load $F_{c,90,max,est}$ or $F_{t,90,max}$ is reached within (300 ± 120) s.

NOTE 3. This rate should be determined from the results of preliminary tests. The objective is that the time to reach F_{max} for each test piece is 300 s.

NOTE 4. The relationship between $F_{c,90,max,est}$ and $F_{c,90,max}$ is discussed in **9.3.1**.

8.3 Expression of results

8.3.1 *Compression perpendicular to the grain*

The compressive strength $f_{c,90}$ shall be determined from the equation:

$$f_{c,90} = \frac{F_{c,90,max}}{bl}$$

The compressive strength shall be calculated to an accuracy of 1 %. The method for determining $F_{c,90,max}$ is given in **9.3**.

The symbols are as given in clause **4**.

8.3.2 *Tension perpendicular to the grain*

The tensile strength $f_{t,90}$ shall be determined from the equation:

$$f_{t,90} = \frac{F_{t,90,max}}{bl}$$

The tensile strength shall be calculated to an accuracy of 1 %.

The symbols are as given in clause **4**.

The result of a test shall be disregarded where failure occurs on the system used to connect the test piece to the testing machine (e.g. in the glue line between the steel plates and the timber of the test piece). If the failure occurs partly in the glued area of the test piece/steel plate interface, the result is valid only if this area is less than 20 % of the area of failure.

9 Determination of modulus of elasticity perpendicular to the grain

9.1 Requirements for test pieces

The shape and dimensions of the test pieces shall comply with **8.1**.

9.2 Procedure

The test pieces shall be mounted in the loading equipment as specified in **8.2**, and the loading procedure described in **8.2** shall be followed.

Two extensometers shall be used, and shall be positioned to minimize the effects of distortion. The extensometers shall measure the deformations which shall be determined to an accuracy of 1 %. The deformation in the load direction refers to the centre of the loaded section and is calculated on the basis of measurements on two opposite sides of the test piece.

The data from each extensometer shall be recorded separately.

9.3 Expression of results

9.3.1 *Compression perpendicular to the grain*

The modulus of elasticity $E_{c,90}$ shall be calculated from the equation:

$$E_{c,90} = \frac{(F_{40} - F_{10})h_0}{(w_{40} - w_{10})bl}$$

where:

$F_{40} - F_{10}$ is an increment of load on the straight line portion of the load-deformation curve, in newtons. F_{10} shall be 10 % and F_{40} shall be 40 % of $F_{c,90,max}$.

$w_{40} - w_{10}$ is the increment of deformation corresponding to $F_{40} - F_{10}$, in millimetres.

The other symbols are as given in clause **4**.

The modulus of elasticity shall be calculated to an accuracy of 1 %.

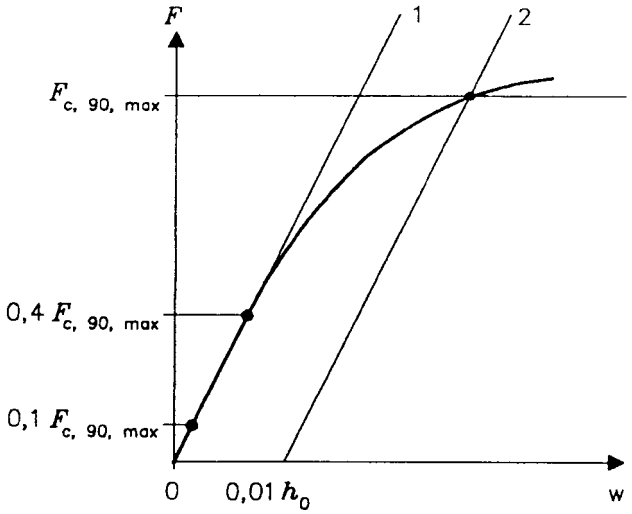


Figure 3. Load-deformation diagram (compression)

The determination of $F_{c,90,max}$ may be carried out using the iterative process as follows.

Estimate a value for the load $F_{c,90,max}$. Using the test results, plot the load/deformation curve in the form shown in figure 3. Calculate 0,1 $F_{c,90,max}$ and 0,4 $F_{c,90,max}$ and determine where these two values intersect the load/deformation curve. Through these two points draw the straight line 1 as shown in figure 3. Parallel to line 1, draw line 2 having its origin at load $F = 0$ and at a distance from it equivalent to a deformation of 0,01 h_0 as shown in figure 3. Where line 2 intersects the curve of the test results is $F_{c,90,max}$. If the value of $F_{c,90,max}$ as determined is within 5 % of $F_{c,90,max,est}$ then that value may be used to determine the compressive strength; otherwise, repeat the procedure until a value of $F_{c,90,max}$ within that tolerance is obtained.

9.3.2 *Tension perpendicular to the grain*

The modulus of elasticity $E_{t,90}$ shall be calculated from the equation:

$$E_{t,90} = \frac{(F_{40} - F_{10})h_0}{(w_{40} - w_{10})bl}$$

where:

$F_{40} - F_{10}$ is an increment of load on the straight line portion of the load-deformation curve, in newtons. F_{10} shall be 10 % and F_{40} shall be 40 % of $F_{t,90,max}$.

$w_{40} - w_{10}$ is the increment of deformation corresponding to F_{40} —F_{10}, in millimetres.

The other symbols are as given in clause **4**.

The modulus of elasticity shall be calculated to an accuracy of 1 %.

10 Determination of shear strength parallel to the grain

10.1 Requirements for test pieces

10.1.1 *Fabrication*

The test piece shall be glued to steel plates. The steel plates shall be tapered as shown in figure 4.

NOTE. A suitable adhesive for fixing the steel plates to the timber test piece is a two-part epoxy. Immediately prior to gluing, the surfaces to be joined should be prepared by planing the timber test piece surfaces and sandblasting the steel plates.

10.1.2 *Surface preparation*

All surfaces shall be accurately prepared to ensure that adjacent surfaces are perpendicular and opposite surfaces are parallel to each other. This preparation shall be carried out after conditioning.

The test pieces shall satisfy the requirements shown in figure 4. The values of the dimensions shall be as follows:

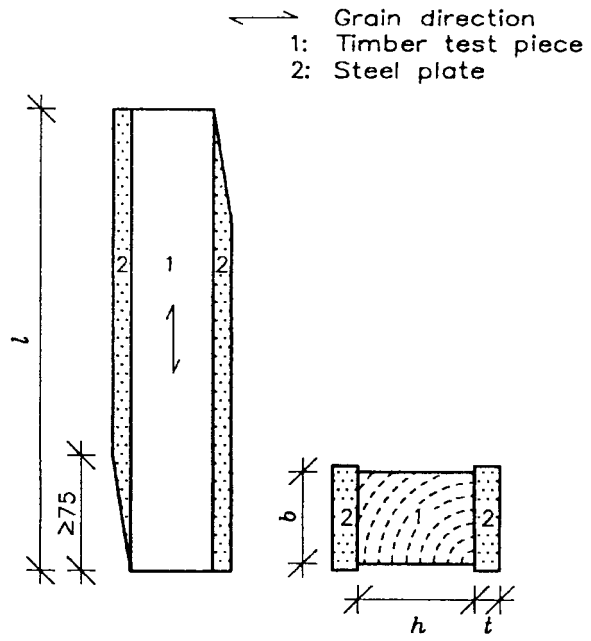
$l = (300 \pm 2)$ mm

$b = (32 \pm 1)$ mm

$h = (55 \pm 1)$ mm

The steel plate thickness shall be (10 ± 1) mm.

NOTE. Variations in these dimensions are permissible within the stated tolerances, to achieve the object of an angle of 14° in the test.



Dimensions in millimetres

Figure 4. Timber test piece shown glued to steel plates

10.2 Procedure

The test piece shall be mounted in a test machine as shown in figure 5. The test piece shall be aligned such that continuous contact is maintained where the line loads F are applied. The angle between the load direction and the longitudinal axis of the test piece shall be 14°.

The loading equipment used shall be capable of measuring the load to an accuracy of 1 % of the load applied to the test piece or, for loads less than 10 % of the maximum load, with an accuracy of 0,1 % of the maximum load.

If the failure occurs partly in the glued area of the test piece/steel plate interface, the result is valid only if this area is less than 20 % of the area of failure.

Load F shall be applied at a constant rate of loading-head movement so adjusted that the load F_{max} is reached within (300 ± 120) s.

NOTE. This rate should be determined from the results of preliminary tests. The objective is that the time to reach F_{max} for each test piece is 300 s.

Single test pieces diverging more than 120 s from the target of 300 s shall be reported. The time to failure shall be recorded and its average reported.

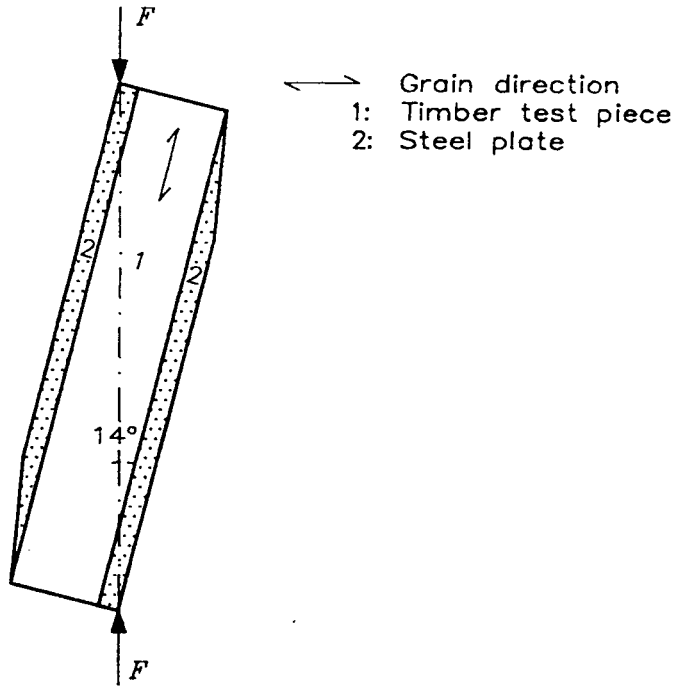


Figure 5. Loading arrangement

10.3 Expression of results

The shear strength f_v shall be determined from the equation:

$$f_v = \frac{F_{max} \cos 14°}{lb}$$

and shall be calculated to an accuracy of 1 %.

The symbols are as given in clause **4**.

11 Test report

11.1 General

The test report shall include details of the test piece, the test method used and the test results.

11.2 Test piece

The following information shall be given:

a) description of the test piece, specification and quality of material: species or type, grade, density. Deviations from specifications, strength reducing characteristics, size of defects;

b) size of test piece. In addition, for glued laminated timber, the type of glue used and the orientation and the number of laminations;

c) country, region or mill of origin of the material sampled. In addition, for glued laminated timber, the factory of origin;

d) method of selection of test pieces;

e) method of conditioning;

f) any other information which may have influenced the test results, for example drying history.

11.3 Test method

The following information shall be given:

a) methods of test used;

b) temperature and relative humidity at the time of test;

c) description of the load testing device, the test equipment and the measuring instruments used;

d) any other information which may influence the use of the test results.

11.4 Test results

The following information for each test piece shall normally be given:

a) moisture content at time of test;

b) density;

c) actual dimensions;

d) moduli of elasticity and/or strength values;

e) location and mode of failure. Any parts of glued areas in the failure section shall be recorded;

f) times to reach the maximum load;

g) any other information which may influence the use of the test results.

Annex A (informative)

Example of compression test arrangement

The load can be transferred to the test piece through steel plates. To ensure uniform deformation from the beginning of the load application, a pair of steel wedges can be inserted between the steel plate and the pressure disc of the testing machine. This enables the equalization of small deviations in parallelity.

The use of the devices shown in figure A.2 will:

– facilitate the correct alignment of the test piece between the platens of the test machine; and

– facilitate full contact between the end surfaces of the test piece and the platens of the test machine; and

– following the initial loading, prevent any further rotation of the platens.

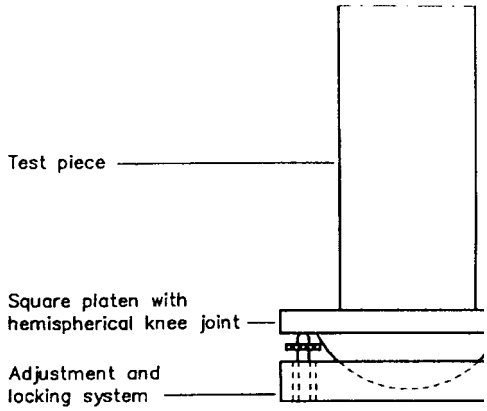


Figure A.2 Compression test locking device

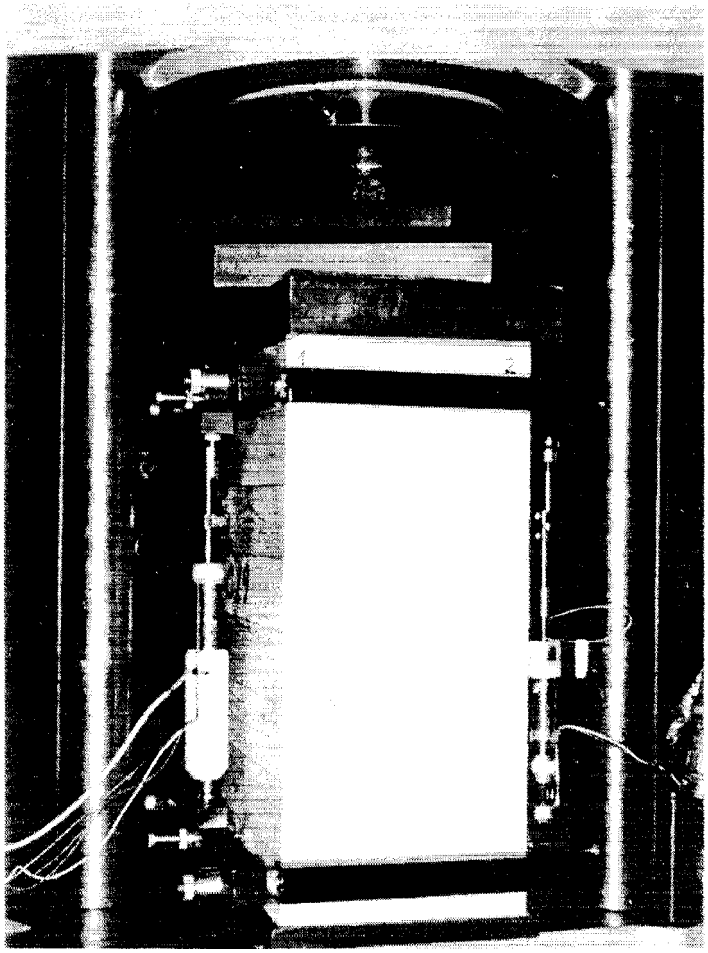


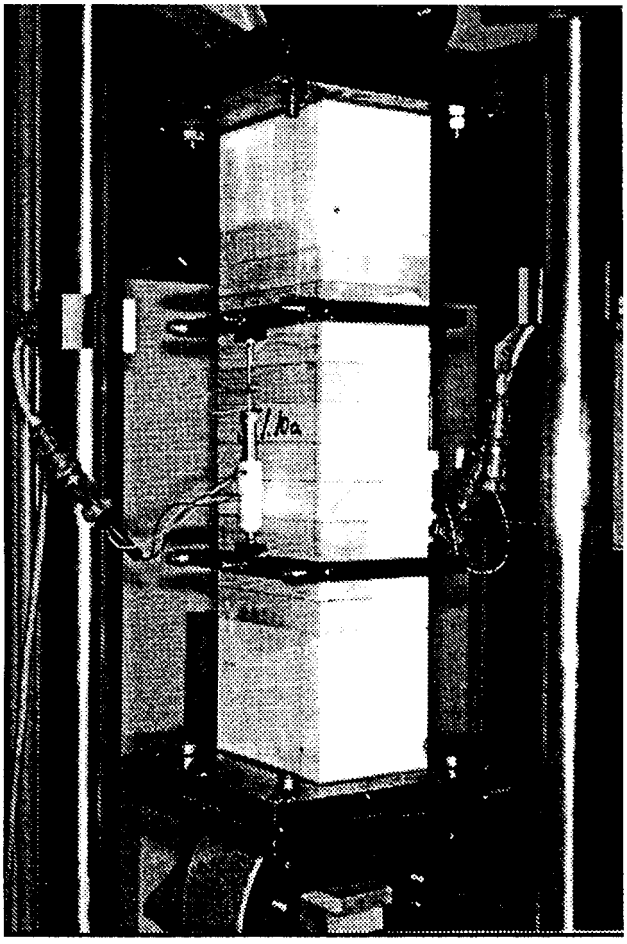
Figure A.1 Compression test arrangement

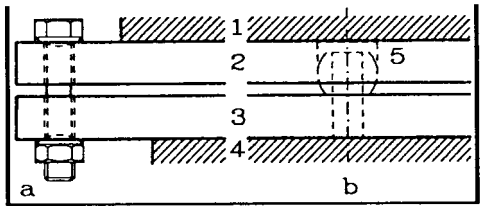
Annex B (informative)

Example of tension test arrangement with rigid fixings

The load can be transferred to the test piece through steel plates glued to the test piece. A suitable adhesive is a two-component epoxy. Just before the gluing, the interface surfaces should be prepared by sandblasting the steel and planing the wood.

To better ensure failure in the wood away from the glue plane, a block of wood with grain parallel to the load direction can be inserted between it and the steel plate. An example of the arrangement is shown below.





1 Test piece

2 Steel plate

3 Steel plate rigidly connected to grip of testing machine

4 Grip of testing machine

5 Hole in plate 2 for tight-fitting spherical dowel fixed to plate 3

a Bolt-connection at corner. The spherical washers resting in conical counter-sinkings allow mutual rotation of the steel plates

b Dowel-connection of steel plates allows mutual vertical and rotational movements of the steel plates, but prevents horizontal movement

Figure B.1 Tension test arrangement

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