INTERNATIONAL STANDARD

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Timber structures — Testing of unilateral punched metal plate fasteners and joints

Structures en bois — Essai des connecteurs métalliques de fixation à dents embouties unilatéralement et des assemblages

INTERNATIONAL ISO

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8969 was prepared by Technical Committee ISO/TC 165, *Timber structures.*

Annex A forms an integral part of this International Standard.

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Timber structures — Testing of unilateral punched metal plate fasteners and joints

1 Scope

This International Standard specifies test methods for determining the strength and stiffness of joints made with punched metal plate fasteners in load-bearing timber structures, as follows:

a) load-slip characteristics and maximum load resulting from the lateral resistance of the embedded projections, at various angles between the direction of the applied force and

— the axis of the plate (load-plate angle α),

— the direction of the grain of the timber (load-grain angle β);

b) the tensile strength of the plate at various angles α;

c) the compression strength of the plate at various angles α;

d) the shear strength of the plate at various angles α.

This International Stnadard is linked to ISO 6891, which gives general test requirements.

In addition, a method for testing the nail root in alternate bending is specified in annex A.

NOTE — This International Standard is based on the recommendations of the joint committee RILEM/CIB 3TT (Working Commission W 18, *Timber structures*, of the International Council for Building Research, Studies and Documentation, and Commission 3TT, *Testing methods for timber*, of the International Union of Testing and Research Laboratories for Materials and Structures respectively) published (in English and French) in *Matériaux et Constructions*, Vol. 15, No. 88, 1982.

The nail bend test is based on European Union of Agrément M.O.A.T. No. 16:1979.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3130:1975, *Wood — Determination of moisture content for physical and mechanical tests.*

ISO 3131:1975, *Wood — Determination of density for physical and mechanical tests.*

ISO 6891:1983, *Timber structures — Joints made with mechanical fasteners — General principles for the determination of strength and deformation characteristics.*

ISO 8970:1989, *Timber structures — Testing of joints made with mechanical fasteners — Requirements for wood density.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 punched metal plate fastener: Fastener made of metal plate of thickness not less than 0,9 mm and not more than 2,5 mm, having integral projections punched out in one direction and bent perpendicular to the plane of the plate, being used as a splice plate to join two or more pieces of timber of the same thickness. For this purpose the projections of the plate are fully embedded in the timber, using a press or roller, so that the contact surface of the plate is flush with the surface of the timber.

3.2 axis of plate: Direction giving the highest tensile strength of the plate (since in many cases the punching pattern of the plate gives rise to two main directions perpendicular to each other with different strength properties).

4 Symbols

The following symbols are used in this International Standard:

b width of plate, in millimetres;

h depth of specimen, in millimetres;

l, l_1, l_2 lengths of area covered by plate, in millimetres;

F force, in newtons;

α angle between the direction of the applied force and the major axis of the plate;

β angle between the direction of the applied force and the direction of the grain of the timber;

 denotes the grain direction of the timber;

 denotes the major axis of the plate.

5 Materials

5.1 Timber

5.1.1 The timber shall be selected in accordance with ISO 8970.

5.1.2 For determination of the tensile strength, compression strength and shear strength of the plate, the timber shall be sufficiently strong for failure to occur in the plate.

5.1.3 The timber shall have a thickness of not less than 33 mm or twice the length of the plate projections plus 5 mm, whichever is greater.[1)]

5.1.4 For each specimen, the two individual members to be joined shall be cut from the same plank to ensure a specimen of balanced density. In each group of similar specimens, the timber for each specimen shall be cut from a different plank.

5.1.5 Timber members for the specimens shall be cut so that the areas into which the fasteners are embedded are free from knots, local grain disturbance, fissures and wane. Elsewhere the members shall be free from major defects which could lead to premature failure in the timber.

5.1.6 If there are no special requirements the timber shall be planed; the difference in thickness between adjoining pieces shall not exceed 0,5 mm.

5.1.7 The moisture content of the timber shall be determined in accordance with ISO 3130, and its density in accordance with ISO 3131.

5.1.8 The identity of the species shall if necessary be confirmed by botanical examination.

5.2 Plates

5.2.1 The sizes of plate to be used for the various tests shall be selected from the range of sizes produced by the plate manufacturer in such a way that the strength values for all sizes can be obtained with adequate reliability by interpolation or extrapolation.

5.2.2 The tensile strength, yield stress, elongation and hardness of the steel used to manufacture the plates, and before punching, should be determined using standard test procedures.

5.2.3 The ductility of the fasteners at the nail root position shall be determined in accordance with annex A.

6 Test specimens

6.1 General

6.1.1 Each test specimen shall be made with two punched metal plate fasteners positioned parallel to each other and symmetrically on opposite faces of the joint. The size and geometry of the specimens will depend upon plate size and the property being measured.

6.1.2 The specimens shall be assembled using the method (e.g. press or roller) normally used with the particular fasteners in the commercial production of structural timber components.

6.1.3 If complementary nails are used in normal production to locate fasteners during assembly of the joints, such nails shall either be omitted from the test specimens or withdrawn prior to the test.

6.1.4 The plates shall be embedded without removal of any teeth.

6.1.5 The test specimens shall be manufactured with the timber at an equilibrium moisture content corresponding to

1) Test data should not be applied to joints with members thinner than those tested, but may be applied to joints with thicker members.

20 °C ± 2 °C and (80 ± 5) % relative humidity (r.h.) and shall afterwards be conditioned for at least one week[1] at 20 °C ± 2 °C and (65 ± 5) % r.h. For certain investigations other moisture conditions may be appropriate.

6.1.6 There should be a sufficient number of test specimens to permit statistical treatment of the results.[2]

6.2 Load-slip characteristics of contact surface of plate and timber : load parallel to grain

6.2.1 The maximum load due the lateral resistance of the plate projections and the load-slip characteristics, with the load applied in a direction parallel to the grain of the timber, shall be determined using the test specimen shown in figure 1.

6.2.2 Tests shall be carried out with angles α = 0°; 30°; 60° and 90°.

6.2.3 The length of the specimen shall be such that the ends of the test machine grips shall be not less than 200 mm from the ends of the plates. Where necessary, the ends of the specimen may be reinforced to avoid premature failure at the grips.

6.2.4 Generally punched metal plate fasteners have multiple projections in a modular arrangement and it will be sufficient to test one size of fastener at each angle α. The size of the fastener shall be such that its dimension in the direction of the applied force is the largest for which failure at the embedded projections will occur.[3]

Dimensions in millimetres

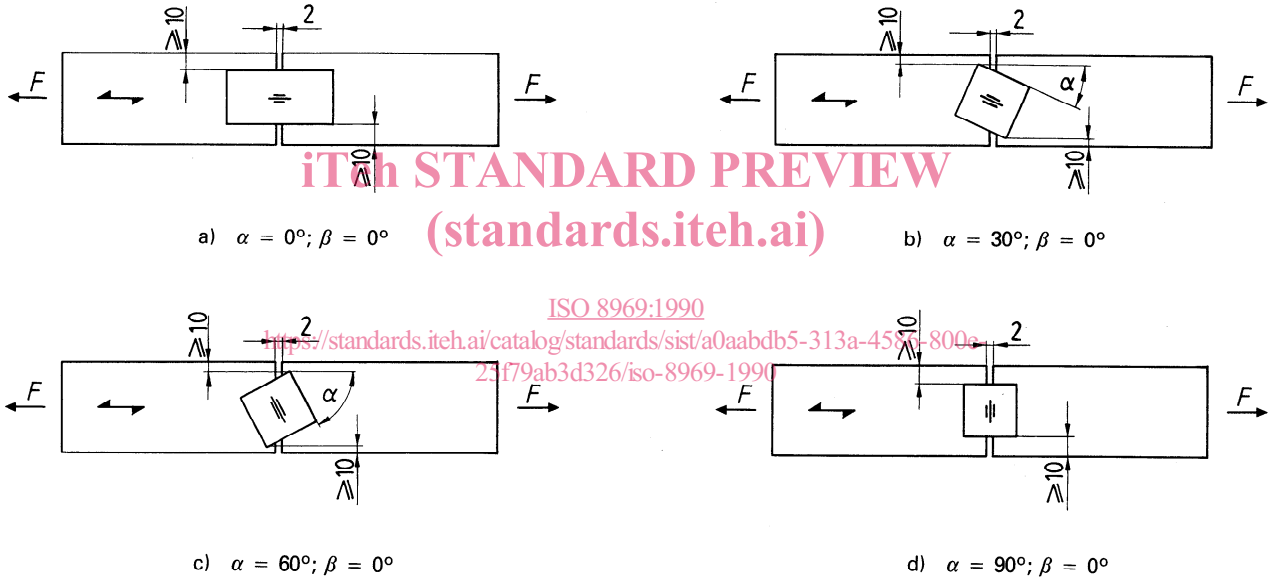


Figure 1 — Specimen for load-slip characteristics of contact surface; load parallel to grain

1) For some hardwoods a much longer conditioning period may be necessary or the specimens should be made with appropriate gaps.

2) Normally at least ten specimens of each type should be tested. For plate strength (tension, compression and shear) however, three specimens of each type should be sufficient, provided all achieve the same mode of failure.

3) The selection of the appropriate size of plate may often be made on the basis of experience with similar fasteners. However, preliminary tests may sometimes be required.

6.3 Load-slip characteristics of contact surface of plate and timber: load perpendicular to grain

6.3.1 The maximum load due to the lateral resistance of the plate projections and the load-slip characteristics, with the load applied perpendicular to the grain of the timber, shall be determined using the test specimen shown in figure 2.

6.3.2 Test shall be carried out with angles $\alpha = 0°$ and 90°.

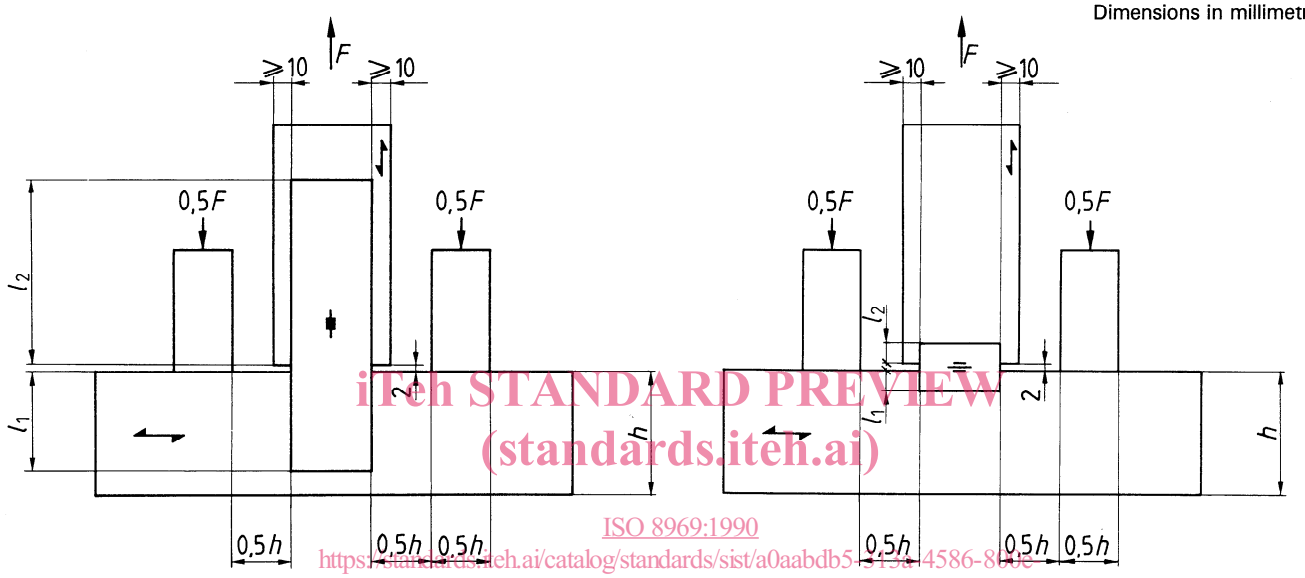
6.3.3 The length of the abutting timber loaded in tension shall be such that the end of the test machine grip shall be not less than 200 mm from the ends of the plates.

6.3.4 The plates shall be positioned to favour failure at the plate projections embedded in the member loaded perpendicular to the grain of the timber, i.e. in the cross-member. This will normally occur when $l_1 < l_2$.

6.4 Plate tensile strength

6.4.1 Plate tensile strength shall be determined using the test specimen shown in figure 3.

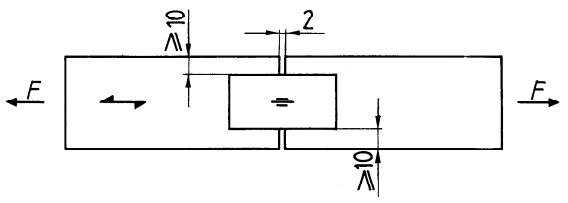
Dimensions in millimetres



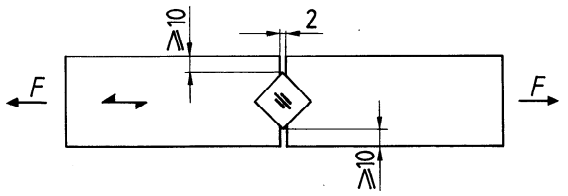
a) $\alpha = 0°; \beta = 90°$ b) $\alpha = 90°; \beta = 90°$

Figure 2 — Specimen for load-slip characteristics of contact surface : load perpendicular to grain

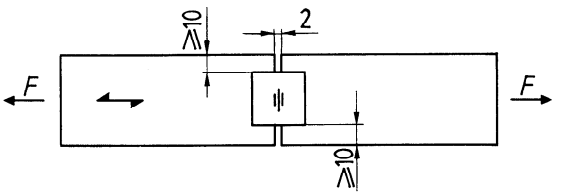
Dimensions in millimetres



a) $\alpha = 0°; \beta = 0°$



b) $\alpha = 45°; \beta = 0°$



c) $\alpha = 90°; \beta = 0°$

Figure 3 — Specimen for plate tensile strength

6.4.2 Tests shall be carried out with angles $\alpha = 0°$; 45° and 90°; $\beta = 0°$.

6.4.3 The length of the plate and the cross-section dimensions of the timber shall be chosen on the basis of the results found from testing the specimens described in 6.2 to ensure that failure occurs in the plate.

6.4.4 The weakest cross-section near the plate centreline should be over the gap between the timber members of the joint.

6.5 Plate compression strength

6.5.1 Plate compression strength shall be determined using the test specimen shown in figure 4. The length of the plate and the cross-section dimensions of the timber shall be chosen on the basis of the results found from testing the specimens described in 6.2 to ensure that failure of the plate will occur.

6.5.2 Tests shall be carried out with angles $\alpha = 0°$; 45° and 90°; $\beta = 0°$.

6.5.3 The weakest cross-section near the plate centreline should be over the gap between the timber members of the joint.

Dimensions in millimetres

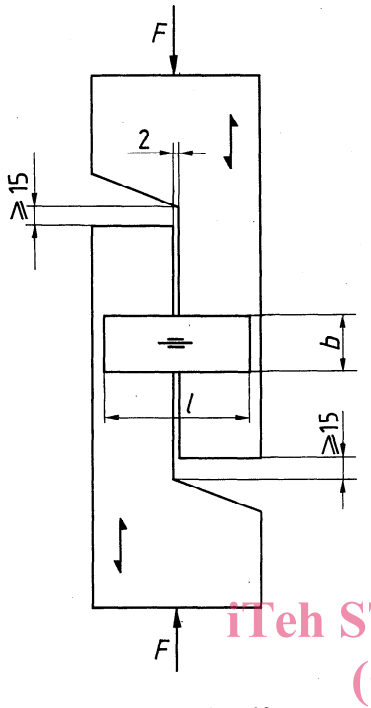
$\alpha = 0°; \beta = 0°$ $\alpha = 90°; \beta = 0°$

Figure 4 — Specimen for plate compression strength

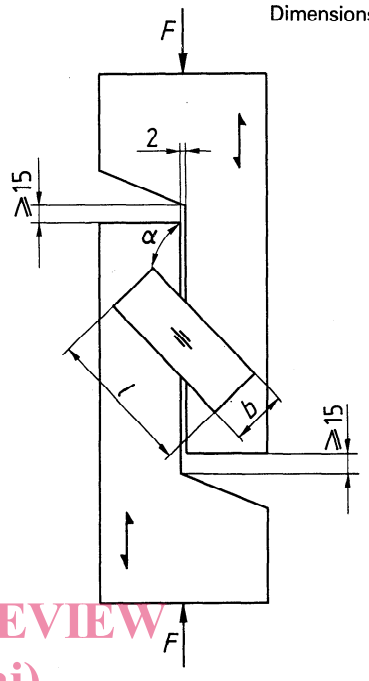
6.6 Plate shear strength

6.6.1 The plate shear strength and the load-slip characteristics shall be determined using test specimens as shown in figure 5.[1] The thickness of the timber members should be chosen so that failure will occur in the plate.

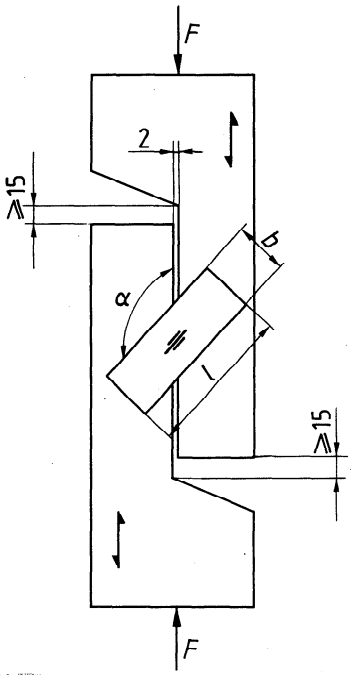
Dimensions in millimetres



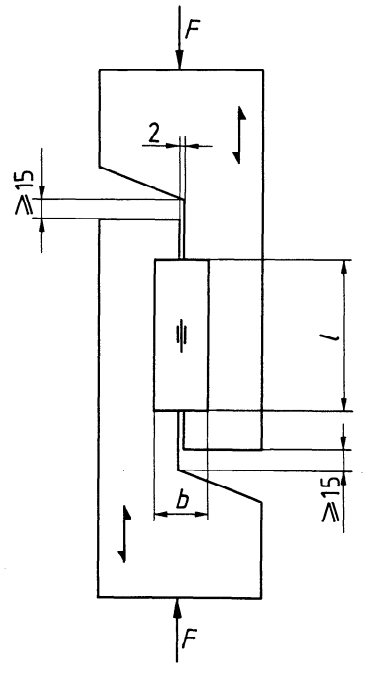
a) $\alpha = 90°$; $\beta = 0°$



b) $\alpha = 15°$; $30°$; $45°$; $60°$ and $75°$; $\beta = 0°$



c) $\alpha = 105°$; $120°$; $135°$; $150°$ and $165°$; $\beta = 0°$



d) $\alpha = 0°$; $\beta = 0°$

Figure 5 — Specimen for plate shear strength

1) The results may depend on the ratio l/b, especially for $\alpha = 0°$ and $\alpha = 90°$. For the test specimens shown in figures 5a) and 5d) therefore, the influence of the variation of the ratio l/b should be investigated by tests on additional plate sizes.

6.6.2 In general, tests should be carried out with the angle α as shown on the figures, and $\beta = 0°$. However, where adequate analytical methods are available, the tests may be limited to $\alpha = 0°$ and 90°.

7 Test procedure

7.1 General

Testing should be carried out in accordance with ISO 6891 with the modifications given in 7.2 and 7.3.

7.2 Loading

The pre-load cycle at the beginning of the loading sequence may be omitted for

— plate tensile strength;

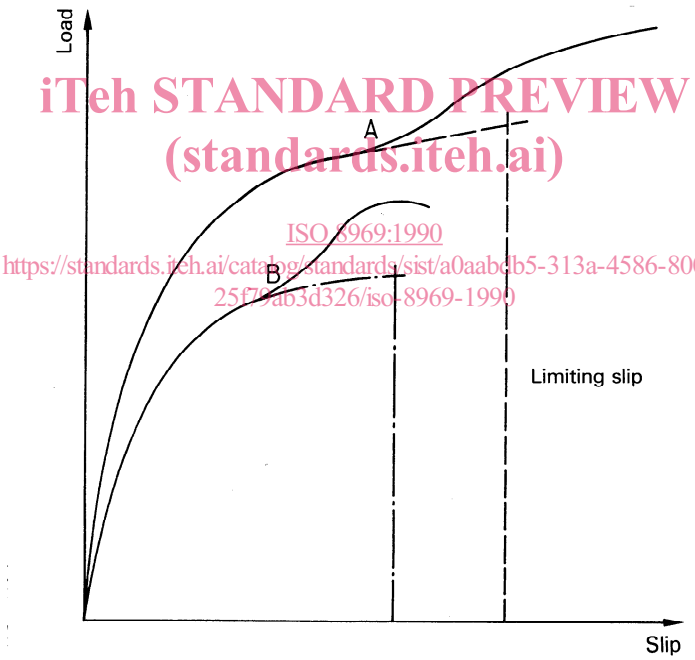
— plate compression strength;

— plate shear strength.

7.3 Maximum load

7.3.1 For plate compression, the strength shall be taken as the maximum load required to close the gap between the timber members.

7.3.2 For plate shear, the strength shall be taken as the highest load reached for a slip between the joint members less than 6 mm or six times the plate thickness, whichever is the larger. However, if a distinct "yield point" occurs in the load-slip curve (most likely with $\alpha = 90°$), the subsequent rise in load shall not be taken into account but the load-slip curve shall be extrapolated in a smooth curve to the appropriate slip limit and the load value at this point taken as the maximum. This adjustment is shown in figure 6.



NOTE — The curves are extrapolated from yield to give assumed values of maximum load : A where the maximum load is not recorded before the appropriate limiting slip is reached and B where the test maximum load is recorded at a slip less than the limiting value.

Figure 6 — Load-slip curves for shear test