Proposal for a RILEM-Recommendation for:
Annex 1 A: Punched metal plate fasteners.
RILEM Committee 3TT.

januari 1981
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FOREWORD

Final recommendations 3TT-1: "Testing methods for joints with mechanical fasteners in load-bearing timber structures" were published in Vol 12 No 70 1979 of this journal. It was foreseen that Annexes should be produced for testing methods for joints with specific fasteners. A first Annex 3TT-1A was published as a Tentative Recommendation for testing Punched metal plate fasteners in Vol 11 No 64 1978 of this journal and submitted to ISO TC 165: Timber Structures. Comments have been received either directly or via the secretariat of ISO TC 165. Following consideration of these comments by the joint Committee 3TT of RILEM and CIB this revised Recommendation was produced.

A.0 INTRODUCTION

This Annex was produced in order to encourage the use of standard test methods for determining the strength properties of punched metal plate fasteners used as joints in load-bearing timber structures. Standard
rules for the determination of characteristic strengths and for allowable loads will be developed by CIB-W18 "Timber Structures".

A.1 DEFINITIONS

Punched metal plate fastener: fastener made of metal plate with thickness not less than 0.9 mm, having integral projections punched out in one direction and bent perpendicular to the plane of the plate, being used as splice plates to join two or more pieces of timber of the same thickness. For this purpose the projections of the plate are fully embedded, using a press or roller, so that the contact surface of the plate is flush with the surface of the timber.

Axis of the plate: in many cases the punching pattern of the plate gives rise to two main directions perpendicular to each other with different strength properties. The direction giving the highest joint strength is called the axis of the plate; in most cases this is also the longest dimension of the (rectangular) plate.

\[ \alpha : \text{angle between the direction of the applied force and the axis of the plate.} \]

\[ \beta : \text{angle between the direction of the applied force and the direction of the grain of the timber.} \]

\[ d : \text{nail diam.} \]

\[ t_s : \text{thickness of side member in a joint.} \]

\[ t_c : \text{thickness of central member in a joint.} \]

A.2 SCOPE

A.2.1. These recommendations are an Annex to the Recommendations 3TT-1: "Testing methods for joints with mechanical fasteners in load-bearing timber structures".

Both documents 3TT-1 and 3TT-1A belong together and must be used together.
A.2.2. This annex gives preferred test methods for determining:

a) maximum load at the contact surface area between punched metal plate and timber
   - parallel to the grain ($\beta = 0^\circ$; cf A.2.3.) and
   - perpendicular to the grain of the timber ($\beta = 90^\circ$; cf A.2.3.);

b) load-deformation characteristics of joints;

c) maximum tensile strength values of plate

d) maximum shear strength values of plate

A.2.3. The maximum loads and load-deformation characteristics may be measured at various angles between the direction of the applied force and
   - the axis of the plate (load-plate-angle $\alpha$)
   - the direction of the grain of the timber (load-grain-angle $\beta$).

A.3 FIELD OF APPLICATION

These recommended test procedures apply to punched metal plate fasteners as defined in A.1.
They may also be applied to metal plates with pre-punched holes which are separately nailed to timber to form splice plates, if the metal plate has a thickness of not less than 0.9 mm but not more than $d$ mm ($d =$ nail diam).

A.4 CONDITIONING OF TEST SPECIMENS

The test specimens shall be manufactured with the timber at a moisture content of $18 \pm 2\%$ and afterwards shall be conditioned to an equilibrium state for the moisture class specified for the test.
See CIB - Structural Timber Design Code. Clause 2.2.1).
At least one week should be waited after the manufacture until testing is started.

Reference is made to the CIB code moisture classes rather than to 3TT-1, which in any case is valid (see A.2.1) but gives only general information. I tried to simplify the CIB-classes a little bit into a table.
I would like that in any case tests should be done after conditioning to one of the classes, e.g. class 1. This could give a common base.

<table>
<thead>
<tr>
<th>moist.class</th>
<th>temp.</th>
<th>relat. humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$20 \pm 2^\circ$C</td>
<td>normally $\leq 0.65$ always $\leq 0.80$</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>normally $\leq 0.80$</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>all other climatic conditions</td>
</tr>
</tbody>
</table>
A.5 SAMPLING

A.5.1. The materials from which the test specimens will be made must be sampled in accordance with ISO 0000.

A.5.2. For determination of maximum load and load-deformation characteristics species and quality of the timber shall be as specified for the test.

A.5.3. For determination of maximum tensile strength and shear strength of plate there are no specific demands for the timber parts.

Sampling procedures should be prepared, I think by CIB-W18. Who is able to provide us with a proposal for W18?

A.6 FORM AND DIMENSIONS OF TEST SPECIMENS


Two or three sizes of plate shall be selected from the range of sizes produced by the manufacturer of the plates in such a way that the required strength values for all plates can be obtained with adequate reliability by interpretation. If the size of plate does not influence the load-bearing capacity it will be sufficient to test one size only.

A.6.2. Timber.

The timber shall have a thickness of not less than 33 mm or twice the length of the plate projections plus 5 mm if this is greater. If there are no special requirements the timber shall be planed and the difference in thickness between adjoining pieces shall not exceed 0.5 mm.

The only requirement is that failure is in the plate.

How can we know this without testing?

At this place following addition could be considered: "and so much more as is necessary to reach the wanted failure mode."

Is a minimum of 33 mm necessary?

It is suggested (Can) that "for lateral resistance specimens, only lumber shall be used in which the annual rings are primarily tangential to the wide face."

2) to be prepared by CIB-W18.
A.6.3. Test specimens

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.

A.7 MAXIMUM LOAD AT CONTACT SURFACE OF PLATE AND TIMBER;
LOAD-DEFORMATION CHARACTERISTICS OF THE JOINT.

A.7.1. Applied force parallel to grain.

A.7.1.1. Test specimen

The maximum load due to the lateral resistance of the plate projections, 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. The length of the specimen shall be such that the ends of the testing machine grips shall be 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.

It will generally be sufficient to test the longest plate for which failure of the plate projections will occur. Tests shall be made with $\alpha = 0, 30, 60$ and $90^\circ$; $\beta = 0^\circ$.

The plates must be embedded without removal of any teeth.

Knots larger than $\phi 10$ mm shall not occur in the region of the plate embedment.

At least 10 specimens of each type shall be tested to permit a statistical treatment of the results.

- Number of test specimens now in A.7.1.1 and A.7.2.1.

- It was questioned if 20 mm is not enough.

- the longest plate?

- I understand this to be questionable, but I think it is realistic.
The angles $\alpha = 30^\circ$ and $60^\circ$ will cause excentricities. It was suggested there is no need for these tests, so only $\alpha = 0$ and $90^\circ$.

The excentricity however can be reduced by an anti-symmetric arrangement of the plates.

Plate dimensions in fig. 1 more alike i.e. shorter or wider?

A.7.1.2. Loading.

The load shall be applied and deformations recorded as recommended in 3TT-1: clause 7.

A.7.1.3. Results.

The deformations and maximum load for each test specimen shall be recorded as recommended in 3TT-1: clause 7. In the case of maximum load this may be expressed as:

a) maximum load per plate;

b) maximum load per plate projection if the plate projections are identical;

c) maximum load per unit of plate area if the projections are not identical but form a repeated pattern within each unit of area.

A.7.2. Applied force perpendicular to grain.

A.7.2.1. Test specimen.

The maximum load due to the lateral resistance of the plate projections, with the load applied perpendicular to the grain of the timber shall be determined using the test specimen shown in figure 2. The length
of the abutting timber loaded in tension shall be such that the end of the testing machine grip shall be not less than 200 mm from the ends of the plates.

The plates shall be so positioned as to ensure failure of the plate projections loaded perpendicular to the grain of the timber i.e. in the cross-member. This will normally occur when \( l_1 < l_2 \) and in order to avoid splitting of the cross-member, \( l_1 \) should not be less than 0.6 \( b \). Tests shall be made with \( \alpha = 0 \) and 90°. At least 10 specimens of each type shall be tested to permit a statistical treatment of the results.

![Diagram of test setup](image)

**Fig. 2.** \( \alpha = 0°, 90°; \beta = 90°. \)

**A.7.2.2. Loading.**

The load shall be applied and deformations recorded as recommended in 3TT-1: clause 7.

**A.7.2.3. Results.**

The deformations and maximum load for each test specimen shall be recorded as recommended in 3TT-1: clause 7. In the case of maximum load this may be expressed as:

\[
F/2 - 100 - 100 - F/2
\]

The distance between the supports and the vertical member could be smaller? e.g. min. 20 mm instead of 100 mm.
a) maximum load per plate projection if the plate projections are identical;
b) maximum load per unit of plate area if the projections are not identical but form a standard pattern within the unit of area.

A.8 MAXIMUM TENSILE STRENGTH OF TRUSSPLATE

A.8.1. Test specimen.

The maximum tensile strength of the plate shall be determined using the test specimen shown in figure 3. The length of the plate and the cross-section dimensions of the timber shall be chosen on the basis of the results found in A.7 to ensure that failure occurs in the plate. The length of the specimen shall be such that the ends of the testing machine grips shall be not less than 200 mm from the ends of the plates. 200 mm? See A.7.1.1.

![Plate dimensions fig. 3: longer and/or less wide?](image)

Where necessary the ends of the specimens may be reinforced to avoid premature failure at the grips.

Tests shall be made with $\alpha = 0^0$ and $90^0$ and $\beta = 0^0$.

The minimum cross-section of the plate must occur at the joint.

At least 3 specimens of each type shall be tested.

The ends of the timber could have different angles $\gamma$. Here again (some) excentricity will occur. cf A.7.1.1.
A.8.2. Loading.

Load shall be applied generally in accordance with 3TT-1: clause 7 except that the pre-load cycle at the beginning of the loading sequence may be omitted.

A.8.3. Results.

The maximum load for each test specimen shall be recorded and may be expressed as:

a) the maximum tensile force for the particular plate tested or

b) the maximum tensile strength per unit width of plate, where the unit width encloses a repeated pattern of holes punched in the plate. The unit of plate width should be measured without subtracting the width of the holes.

A.9 MAXIMUM SHEAR STRENGTH OF PLATE

A.9.1. Test specimen.

The maximum shear strength of the plate shall be determined using test specimens as shown in figures 4, 5, 6 and 7.
Tests shall be made with the angle $\alpha$ as shown on the figures, with $\beta = 0$.
At least 3 specimens of each type shall be tested.

A.9.2. Loading.

Load shall be applied generally in accordance with 3TT-1: clause 7 except that the pre-load cycle at the beginning of the loading sequence may be omitted.

A.9.3. Results

The maximum load for each test specimen shall be recorded and may be expressed as:

a) the maximum shear force for the particular plate tested or

b) the maximum shear strength per unit width of plate where the unit width encloses a repeated pattern of holes punched in the plate. The unit of plate width should be measured without subtracting the width of the holes.
a repeated pattern of holes punched in the plate. The unit of width shall be measured without subtracting the width of the holes.

A.10 MATERIAL PROPERTIES.

A.10.1. Plates.

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.

A.10.2. Timber.

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

A.11 TEST REPORT

The test report shall include the relevant information recommended in 3TT-1: clause 8.

Is a "nail bend test" necessary?

Should it not be necessary to determine some strength properties of the timber? e.g. embedding/crushing strength.

Is it necessary to require values of $l/b$ and for what reason?

What do we want: prevent or allow buckling of the plates?

Why are angles $\alpha = 75$ and $165$ omitted?

Is a series of $0.30, 0.60, 0.90, 1.20, 1.50$ or even $0.45, 0.90, 1.35$ not enough?

Should it not be

fig. 4 = 7

fig. 5 = 5

fig. 6 = 4 old

fig. 7 = 6
Fig. 6. — $\alpha = 105^\circ$, $120^\circ$, $135^\circ$, $150^\circ$; $\beta = 0^\circ$; $l/b \leq 2$.

Fig. 7. — $\alpha = 0^\circ$; $\beta = 0^\circ$; $l/b = 2$, in each case with variation of the ratio $l/b$ by tests on additional plate sizes.

Further comments:

. Should not the long duration-loading behaviour be investigated?
. It seems not to be clear to everyone that the angles $\alpha = 15$ and $\alpha = 105$ etc. in figures 5 and 6 are not the same.