Proposal for a RILEM-Recommendation for:
Testing Methods for joints with mechanical fasteners in load-bearing timber structures.
Annex 1C: Staples
RILEM-Committee 3TT

March 1981

Prof. ir. J. Kuipers

STEVIN-LABORATORIUM
HOUTCONSTRUCTIES
Rapport 4 - 81 - 4 NT - 2
Proposal for a RILEM-Recommendation for:
Testing Methods for joints with mechanical fasteners in load-bearing timber structures.
Annex 1C: Staples.
RILEM-Committee 3TT

maart 1981

Prof. ir. J. Kuipers.

Technische Universiteit Delft
Faculteit CiTG
Bibliotheek Civiele Techniek
Stevinweg 1
2628 CN Delft

Stevinweg 4
2628 CN Delft
telefoon 015-785721
RECOMMENDATION TENTATIVE 3TT-1C

TENTATIVE RECOMMENDATION 3TT-1C

3TT-1C

JOINT COMMITTEE RILEM/CIB-3TT: TESTING METHODS FOR TIMBER


Annex 1C: "Staples".

The text presented hereunder are drafts which are published in order to be submitted to comments. The final draft will be drawn by the committee above from this draft with regard to the possible comments. Comments to be sent to: J. Kuipers, Stevin Laboratorium, Stevinweg 4, 2628 CN Delft, The Netherlands; before December 31st, 1981.

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 Punched Metal Plates was published as a tentative recommendation in 1978 and it is expected that this will be finalized in 1981. The second Annex 3TT-1B about testing methods for nails will be published. This is the third Annex 3TT-1C about testing methods for staples.
C.O. INTRODUCTION

This annex was produced in order to encourage the use of standard test methods for determining the strength properties of joints with different types of staples, used in load-bearing timber structures. Standard rules for the determination of characteristic strengths and for allowable loads will be developed by CIB-W18.

C.1. DEFINITIONS

Staple : double-bent, U-shaped piece of round, square, oval or rectangular wire with pointed legs.

Staple-back : connection between the two staple-legs.

Back-centre : centre of staple-back. N.B. all end and edge distances as well as mutual distances between staples are measured from back-centres.

Staple-length : length of each staple leg, including point.

Staple-width : distance between staple legs.

Staple-diameter : smallest dimension of each staple-leg.

Back-angle \( \beta \) : smallest angle between back-direction and grain-direction.

N.B. all end and edge distances as well as mutual distances between staples are measured from back-centres.
C.2. SCOPE

C.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-1C belong together and must be used together.

C.2.2. This annex gives preferred test methods for determining
a) maximum load and load-deformation characteristics of laterally loaded stapled joints, both for wood-to-wood joints as for wood-based sheet materials stapled to wood;
b) maximum load and load-deformation characteristics for axially loaded stapled joints (withdrawal testing);
c) mechanical properties of staples and timber.

C.2.3. The maximum loads and load-deformation characteristics may be determined for various angles between the direction of the applied force and the direction of the grain of the timber.

C.3. FIELD OF APPLICATION

These recommended test procedures apply to joints with all types of staples.

For the intended use in load-bearing structures the user shall pay much attention to guaranteed materials and quality control of the staples.

C.4. MANUFACTURING AND CONDITIONING OF TEST SPECIMENS

C.4.1. Manufacturing.

Test specimens shall be made in the same way as in practice.
C.4.2. Conditioning.

The test specimens shall be manufactured with the timber at a moisture content of 18 ± 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 manufacturing before testing is started.

C.5. SAMPLING

C.5.1. The materials from which the test specimens will be made must be sampled in accordance with ISO 0000\(^2\).

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

C.6. TESTING JOINTS WITH LATERALLY LOADED STAPLES

C.6.1. TEST SPECIMENS

C.6.1.1. Wood to wood joints

\(^1\) CIB-code moisture classes are as follows:

<table>
<thead>
<tr>
<th>moist. class</th>
<th>temp.</th>
<th>relat. humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 ± 2°C</td>
<td>normally ≤ 0.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>always ≤ 0.80</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>normally ≤ 0.80</td>
</tr>
<tr>
<td>3</td>
<td>all other climatic conditions</td>
<td></td>
</tr>
</tbody>
</table>

\(^2\) to be prepared by CIB-W18.
C.6.1.1.1. Test specimens shall be made as symmetrical 3-member joints according to fig. 1 for one-section action

C.6.1.1.2. The penetration length into the central member shall be chosen so that the yield-point of the leg will be reached at or before the max. load occurs.

N.B. This penetration length can be estimated as

\[ l_h = 1.4d \sqrt{\frac{\sigma_v}{\sigma_s}} \times 1.1 \]

where \( \sigma_v \) = yield stress of the staple material and \( \sigma_s \) = crushing strength of the wood.

C.6.1.1.3. The thickness \( t_c \) of the central member must be chosen

\[ t_c = 8d + 3d = 11d \]

for one-section staples with overlapping placing in the central member (fig. 1).

C.6.1.1.4. The thickness \( t_s \) of the side members, the mutual staple distances \( d_{//} \) and \( d_{\perp} \) as well as the end and edge distances shall be chosen so, that the crushing strength of the timber rather than e.g. its shear strength or cleavage is determining the maximum load.

C.6.1.1.5. The number of staples in each contact surface between the members and placed in a row parallel to the force-direction shall be at least 3.
C.6.1.1.6. Tests shall be done with equal numbers of joints with back-angles of $\beta = 0^\circ$, $\beta = 45^\circ$ and $\beta = 90^\circ$ respectively.

C.6.1.1.7. For determination of the joint strength parallel to the grain normally tension tests should be tested.

a) If a test specimen following fig. 2a is used, attention may be given to the fact that the weakest of two joints is found; this has effects on the main value and on the standard deviation.

b) If a specimen according to fig. 2b is used the separation of the side members, in combination with pulling out of the nails, shall not be hindered by the loading-equipment.

c) If compression test specimens are used the total length of the specimen should be at least 3 times the overlapping length of the joints, fig. 3.

C.6.1.1.8. For measuring the strength perpendicular to the grain test specimens according to figure 4a or 4b shall be used.

C.6.1.1.9. For measuring the strength with another angle to the grain a test specimen as in fig. 5 shall be used.
C.6.1.2. Sheetmaterial-to-wood-joints

C.6.1.2.1. Test specimens shall be made as symmetrical 3-member joints, with a wooden central member.

C.6.1.2.2. The penetration length of the staples into the central member shall be chosen so that the yield-point of the leg will be reached at or before the max. load occurs.
N.B. See B.6.1.1.2.

C.6.1.2.3. The thickness $t_c$ of the central member shall be $8d + 3d = 11d$ (fig. 1).

C.6.1.2.4. The thickness $t_s$ of the side members is equal to the thickness of the sheet material.

Something to be said about the staple diam?

\[ d = 0.7 \sqrt{\frac{\sigma_s}{\sigma_v}} \cdot t_s \]

C.6.1.2.5. The number of staples in each contact surface between the members and placed in a row parallel to the force direction shall be at least 3.

C.6.1.2.6. See C.6.1.1.6. ... C.6.1.1.9.

C.6.1.2.9.

C.6.1.3. Steel-to-wood-joints

C.6.1.3.1. If a steel plate with a thickness less than the staple diameter $d$ is used see Annex 3TT-1A.

C.6.1.3.2. For test specimens for steel-to-wood joints with steel parts thicker than the staple diameter $d$, see B.6.1.2.
C.6.2. NUMBER OF TESTS

C.6.2.1. The number of tests must be enough to estimate with 75% confidence level the 5% lower percent. value for a certain staple diameter.

C.6.2.2. If strength values for a series of staples with different diameters must be determined it is sufficient to test a relevant number of diameters so that interpolation of the results can take place.

C.6.3. LOADING PROCEDURE

C.6.3.1. The load shall be applied and deformations recorded as recommended in 3TT-1: clause 7.

C.6.3.2. The deformation of the joint is defined as the mean value of the mutual displacements of the two side members with respect to the central member.

C.6.4. Results.

The deformation and the maximum loads for each test as well as all other relevant information shall be recorded as recommended in 3TT-1: clause 7.

C.7. TESTING OF AXIAL LOADED STAPLES I.E. WITHDRAWAL STRENGTH AND PULL-THROUGH STRENGTH

C.7.1. Test specimens.

C.7.1.1. Withdrawal strength

C.7.1.1.1. Staples shall be driven into the specified wood (species and grade) to a penetration of at least 8d.
Mutual distances of the staples will be \( d_\parallel > 15 \, d \) and \( d_\perp > 10 \, d \), the edge distances \( > 10 \, d \).

C.7.1.1.2. Withdrawal tests shall be carried out with wood at temperatures (internal) of \( 20^\circ \text{C} \) and \( 50^\circ \text{C} \).

C.7.1.2.1. Test specimens for pull-through strength shall be made with wood or with sheet material nailed to a wooden member (fig. 8-9).
Back-angles of \( 0^\circ, 45^\circ \) and \( 90^\circ \) shall be tested.

In any case the longest staple of the tested diameter must be used.
Mutual distances as well as edge distances etc. shall be at least the values as in C.7.1.1.1.

C.7.2. NUMBER OF TESTS

See C.6.2.

C.7.3. LOADING PROCEDURE

C.7.3.1. The load shall be applied and deformations recorded as recommended in 3TT-1: clause 7, but except that the pre-load cycle at the beginning of the loading sequence may be omitted.

C.7.4. RESULTS

See C.6.4.
C.8. MATERIAL PROPERTIES


The bending strength and/or the yield-point of the staple must be determined by a bending test according to fig. 10.

Values for $d$, $r$ and for the rate of deflection are given in the table below.

<table>
<thead>
<tr>
<th>d (mm)</th>
<th>$z$ (mm)</th>
<th>$r$ (mm)</th>
<th>defl. w/min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 -3</td>
<td>25</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>3.1-4.4</td>
<td>38</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>4.5-6</td>
<td>50</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>6.1-8</td>
<td>75</td>
<td>12</td>
<td>8</td>
</tr>
</tbody>
</table>

Is any test method available? "fig 10"?

C.8.2. The embedding strength of the timber and of the wood-based sheet materials must be determined following fig. 11.

C.8.3. Test report.

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

*a choice between 11a and 11b should be made.*

Fig 11a (HERON)
Dutch specimen.
Fig. 11b

(Fig. 4c). Specimen for testing embedding strength of particleboard (Mochler, Budianto, Ehlebeck, 1978).

| Dimensions (mm) of loading device |
|-----|---|---|---|---|
|    | 2 | 4 | 6 | 8 | 10 |
| d_n| 6 | 23| 21| 21| 18| 22 |
| e  | 2 | 3 | 3 | 4 | 6 |

Cross-section of loading device

Test equipment and set-up for determination of foundation modulus and embedding strength of particleboard (Mochler, Budianto, Ehlebeck, 1978).
Verwijderd uit catalogus
TU Delft Library