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Timber structures — Dowel-type fasteners —

Part 1: Determination of yield moment

Structures en bois — Éléments de fixation de type cheville —

Partie 1: Détermination du moment plastique

Reference number
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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.

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ISO 10984-1 was prepared by Technical Committee ISO/TC 165, *Timber structures*.

ISO 10984 consists of the following parts, under the general title *Timber structures — Dowel-type fasteners*:

— *Part 1: Determination of yield moment*

— *Part 2: Determination of embedding strength*

Introduction

Dowel-type fasteners are those mechanical fasteners that are most widely used for timber structures. Their characteristics, such as yield moment, have a great effect on the mechanical performance of joints made with dowel-type fasteners under loads.

The purpose of this part of ISO 10984 is to define methods to measure the yield moment of a fastener as one of the basic parameters to interpret the behaviour of joints under loads. The requirements are necessary to replicate the same conditions as those for timber structures in the field. This part of ISO 10984 contains two testing methods: method A, based on EN 409, by applying a four-points loading principle, and method B, based on ASTM F1575, by applying a three-points loading principle. The user can choose whichever method is relevant for the test to measure the yield moment of fasteners.

ISO 10984-2 provides the test method to obtain other basic information on the behaviour of mechanical joints under loads.

Timber structures — Dowel-type fasteners —

Part 1: Determination of yield moment

1 Scope

This part of ISO 10984 specifies a laboratory method for determining the yield moment of dowel-type fasteners.

2 Terms and definitions

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

2.1
dowel-type fastener
nail, staple, bolt, screw, dowel or the like with plain or patterned surfaces

2.2 Fastener section dimension

2.2.1
fastener section dimension
⟨plain round or profiled fastener⟩ diameter of the shank without coating

2.2.2
fastener section dimension
⟨square fastener⟩ length of one side of the section

2.2.3
fastener section dimension
⟨oval or rectangular fastener⟩ minimum dimension of the section

2.3 Yield moment

2.3.1
yield moment
⟨method A⟩ the bending moment at the maximum load sustained by a dowel-type fastener under test, or the bending moment at which the fastener has deformed through an angle of 45°, whichever is the lesser

2.3.2
yield moment
⟨method B⟩ the bending moment calculated using the load at the intersection of the load and deformation curve with a line represented by the initial tangent modulus offset by 5 % of the fastener diameter

3 Symbols

d	fastener nominal section dimension as defined in 2.2, expressed in millimetres
F_1, F_3	maximum support loads on the fastener, expressed in newtons
F, F_2, F_4	test loads applied to the fastener, expressed in newtons
F_y	yield load determined from the load and deformation curve, expressed in newtons; see Figure 6
l	length of fastener, expressed in millimeters
l_1, l_3	distances between loading points and the nearest support, expressed in millimetres; see Figure 1
l_2	free length of the fastener, expressed in millimetres; see Figure 1
l_4	length between supports, expressed in millimetres; see Figure 5
l_5	length between the end of fastener and the nearest support, expressed in millimetres; see Figure 5
M_y	yield moment of the fastener, expressed in newton-millimetres
α, α_1, α_2	bending angle, expressed in degrees; see Figure 2
ρ_k	characteristic density of the timber, expressed in kilograms per cubic metre
f_t	tensile strength of the fastener, expressed in newtons per square millimetre

4 Requirements

The fasteners shall be, as far as possible, of the quality allowed by the relevant manufacturing specification.

5 Test method

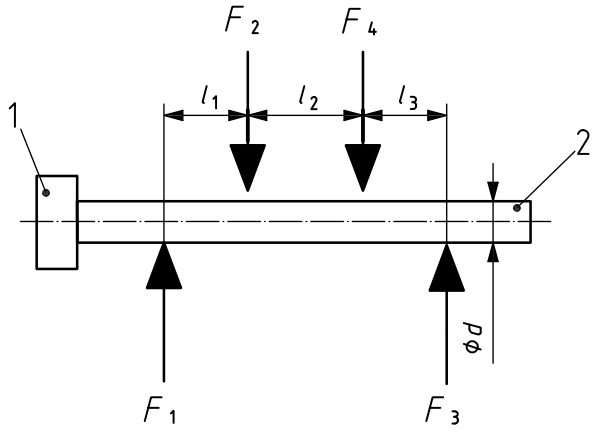
5.1 General

One of the two test methods shall be used: the four-point loading method (method A) or the three-point loading method (method B). The user may choose one of these two methods, whichever is most relevant.

5.2 Method A

5.2.1 Principle

The principle of the test method involves the loading of the fastener under test as shown in Figure 1 in such a manner that the loading points do not move along the fastener and the loads remain normal to the axis of the fastener during the test. The dimensions l_1 and l_3 shall be not less than $2d$. The free length of the fastener, l_2, shall be between d and $3d$.

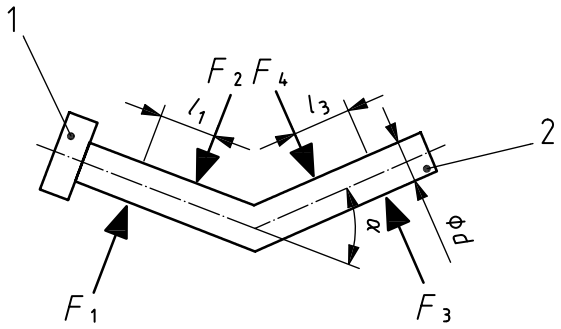


Key

1 fastener head

2 dowel-type fastener

Figure 1 — Fastener loading in method A



Key

1 fastener head

2 dowel-type fastener

Figure 2 — Fastener deformation in method A

5.2.2 Materials

Dowel-type fasteners shall be the same nails, staples, bolts, screws, dowels or the like as those used in the actual construction.

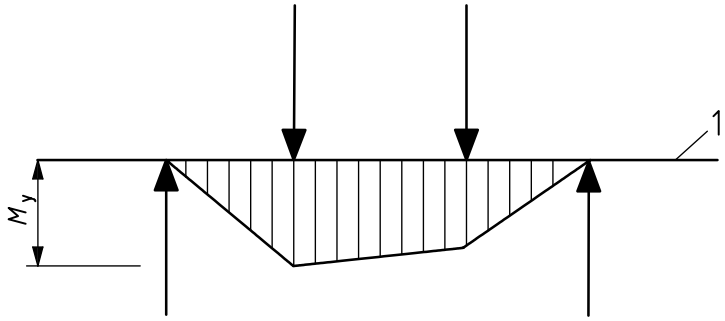
For the fasteners with coatings, the coatings shall be removed before measuring the diameter and carrying out the tests.

5.2.3 Apparatus

5.2.3.1 Testing apparatus, such that the loads F_2 and F_4 (see Figures 1 and 2) do not deviate by more than 5 % from each other.

The bending moment diagram for the resulting yield moment M_y is shown in Figure 3.

NOTE A test apparatus that has been found suitable for this test is shown in Annex A.



Key

1 dowel-type fastener

Figure 3 — Yield moment M_y on the fastener in method A

5.2.4 Preparation of specimen

The fastener shall be tested about its weakest axis.

5.2.5 Loading procedure

The load shall be applied to the fastener as shown in Figure 1, and shall be increased at such a rate that the bending angle defined in 5.2.6 is reached in (10 ± 5) s.

The maximum load shall be determined to an accuracy of 1 %.

Record the loads and the corresponding values of the bending angle.

5.2.6 Bending angle

For nails and staples, the bending angle shall be 45°.

For bolts, screws or dowels used in wood-based products, the bending angle shall be (110/d) degrees.

For bolts, screws or dowels produced from steel material with a tensile strength of at least 1 000 N/mm^2 used in timber and glued laminated timber with a characteristic density of 360 kg/m^3 (based on oven-dry mass and volume), the bending angle is given by Figure 4.

For different tensile strength and/or different characteristic density of timber, the bending angle, α, expressed in degrees, shall be determined as given in Equation (1):

$$\alpha = \alpha_1 \left(\frac{2{,}78\rho_k}{f_t} \right)^{0{,}44} + \alpha_2 \qquad (1)$$

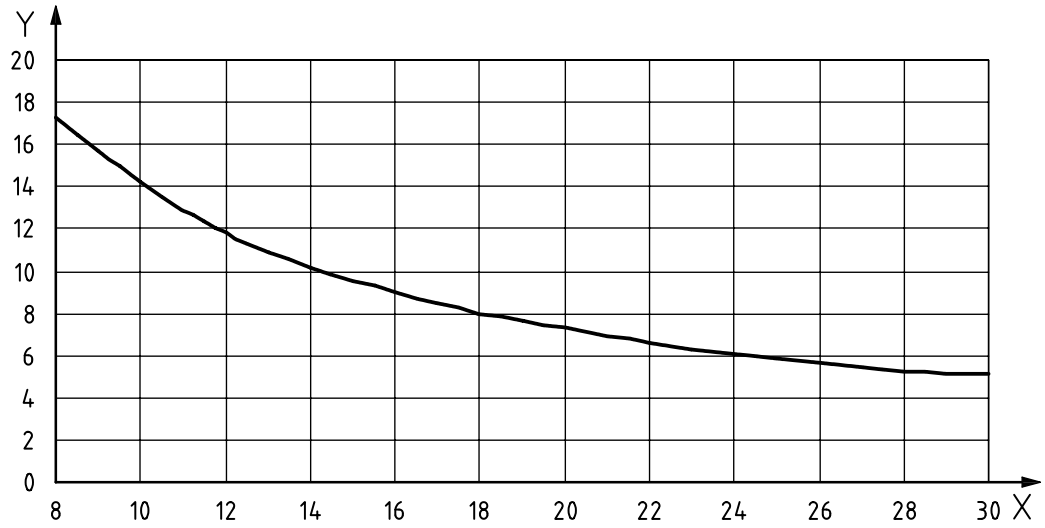
where

α_1 is the bending angle according to Figure 4, expressed in degrees;

α_2 is 10° for nails, staples and screws, and 0° for dowels and bolts;

ρ_k is the characteristic density of the timber, expressed in kilograms per cubic metre;

f_t is the tensile strength of the fastener, expressed in newtons per square millimetre.



Key

X nominal section, d, expressed in millimetres

Y angle, α, expressed in degrees

Figure 4 — Diagram for bending angle versus fastener diameter used for method A

5.2.7 Results

Measure the loads, F_1 and F_3, at the bending angle, α, determined in accordance with 5.2.6.

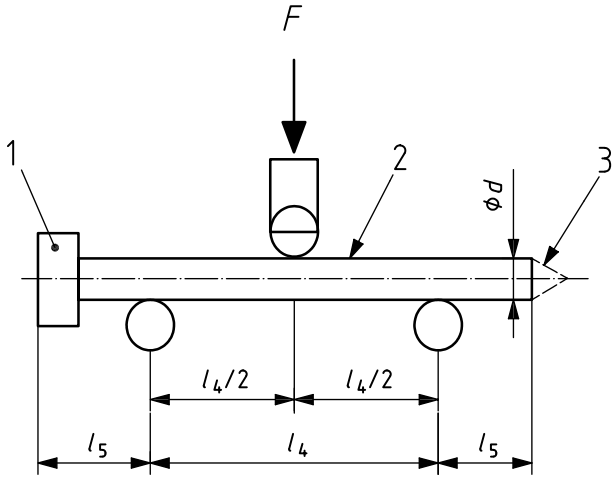
The value of the yield moment, M_y, shall be calculated as the greater of the two expressions ($F_1 \times l_1$) and ($F_3 \times l_3$), and shall be determined to an accuracy of 1 %.

When the test apparatus used is that shown in Annex A, Equation (A.1) or Equation (A.2) shall be used to determine the yield moment in lieu of Equation (1).

5.3 Method B

5.3.1 Principle

The principle of the test method B involves the loading of the fastener under test as shown in Figure 5 in such a manner that the lateral bending load is applied at a constant rate during the test. Dimension l_4 shall be at least $11d$ for nails and staples and $4d$ for bolts. Dimension l_5 shall be not less than $2d$ for nails, staples and bolts. If the fastener is too short to meet this requirement, it shall be tested with the largest possible span and the span and testing circumstances shall be described in the test report.



Key

1 fastener head
2 dowel-type fastener
3 pointed tip for nails and screws

Figure 5 — Fastener loading in method B

5.3.2 Materials

For the fasteners with coatings, the coatings shall be removed before measuring the diameter and carrying out the tests.

5.3.3 Apparatus

5.3.3.1 Testing machine, capable of operation at a constant rate of motion of its movable head and capable of measuring the load with an accuracy of 1 %.

The cylindrical bearing points and loading point shall be any cylindrical metal member capable of supporting and loading the test specimen without deformation, as shown in Figure 5, and having diameter, d, equal to 10 mm.

5.3.4 Preparation of specimen

The fastener shall be tested about its weakest axis.

5.3.5 Loading procedure

The load shall be applied to the fastener as shown in Figure 5, and shall be increased at a constant rate to achieve maximum load in not less than approximately 30 s. The load and deformation shall be continuously monitored. The load shall be measured to an accuracy of 1 % and the deformation shall be measured to an accuracy of 0,03 mm.

The load and deformation curve shall be produced to the point where the yield moment can be calculated from the relationship between load and deformation.

5.3.6 Results

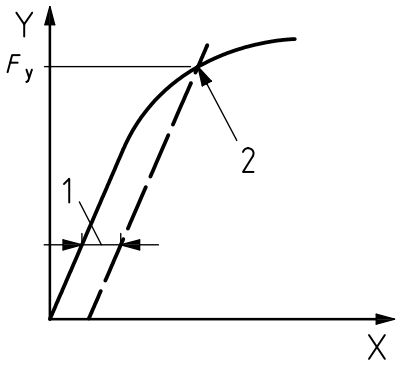
The offset yield point shall be determined by fitting a straight line to the initial linear portion of the load and deformation curve, offsetting the line by a deformation equal to 5 % of the fastener diameter, and selecting the point at which the offset line intersects the load versus deformation curve, as given by Figure 6. The load corresponding to the offset yield point is the yield load and the yield moment, M_y, in Newton millimetres of the fastener is calculated as given by Equation (2):

$$M_y = \frac{F_y l_4}{4} \tag{2}$$

where

F_y is the yield load, expressed in newtons;

l_4 is the length between supports expressed in millimetres.



Key

X deformation, expressed in millimetres

Y load, expressed in newtons

1 5 % of fastener diameter

2 offset yield point

Figure 6 — Typical load versus deformation curve obtained from method B

6 Test report

6.1.1 Method A

The test report for method A shall include the following:

a) name and address of test laboratory;

b) date of test report;

c) reference to this part of ISO 10984;

d) description of the fasteners;

e) description of the test apparatus;

f) rate of loading;

g) location of the free length of the fastener in the test;

h) number of replicate tests;

i) graphs plotting the values of bending angle and load;

j) value of the yield moment.

6.2 Method B

The test report for method B shall include the following:

a) name and address of test laboratory;

b) date of test report;

c) reference to this part of ISO 10984;

d) description of the fasteners;

e) description of the test apparatus;

f) rate of loading;

g) location of the free length of the fastener in the test;

h) number of replicate tests;

i) load versus deformation curve;

j) value of the yield moment.

Annex A
(informative)

Fastener bending apparatus used for method A

A.1 Apparatus

A.1 Fastener bending apparatus, consisting of the following (see Figure A.1).

a) The fastener under test (Figure A.1, key item 1) is held at one end in a loose fitting bushing (key item 2) fixed to an arm (key item 3) that can be rotated about point A.

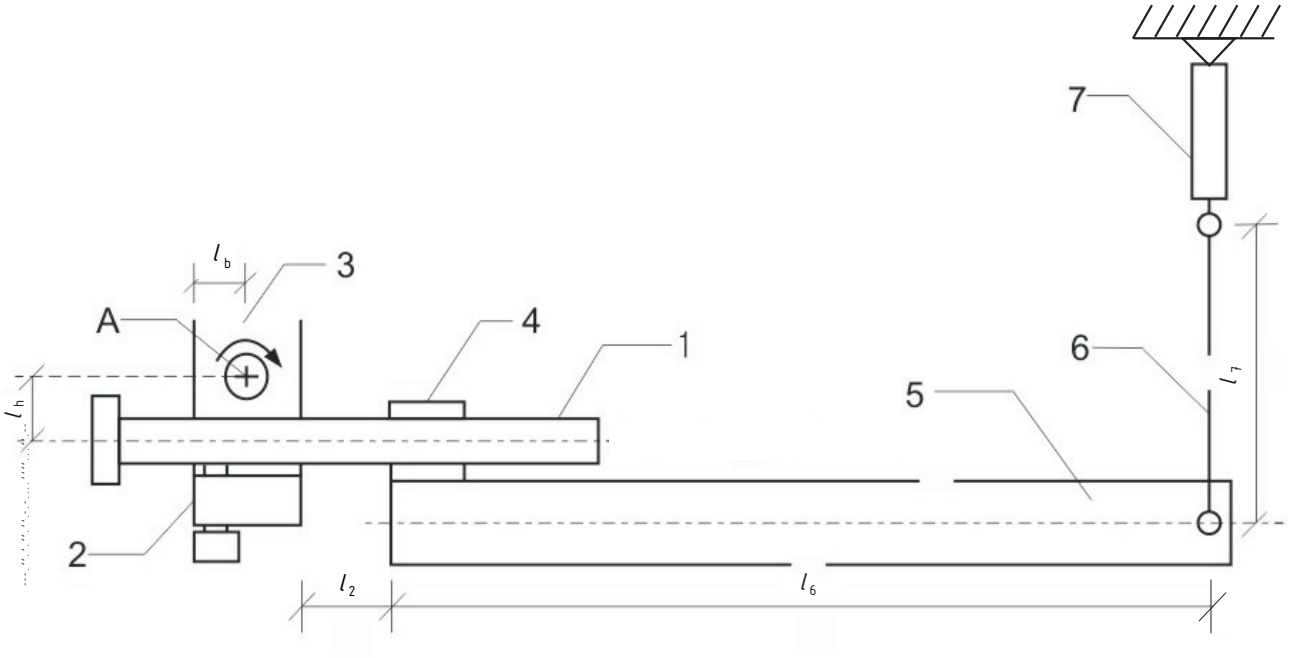
b) The other end of the fastener is put into a loose fitting bushing (key item 4) which is fixed to a lever (key item 5);

c) The lever (key item 5) is suspended on a load gauge (key item 7) by a rod (key item 6) having freely rotating joints at both ends and having its axis perpendicular to the lever.

The dimensions h, from the axis of rotation, point A in Figure A.1, to the axis of the fastener, and b, between the axis of rotation A and the lead edge of arm (3), should be sufficiently small relative to the lengths of the lever, l_6, and of the rod, l_7, that the right angle between the rod and lever does not change by more than 0,1 rad to reach M_y.

The lever should be stiff compared to the fastener.

With the arm (Figure A.1, key item 3) resting on the fastener and the load gauge (key item 7) set to zero the test should be commenced by rotating arm (key item 3) about axis A until the condition of yield within the free length l_2 is reached. The length of bushings (key item 2) and (key item 4) should not differ by more than 5 %.



Key

1 dowel-type fastener under test
2 loose-fitting bushing
3 arm
4 fastener head
5 lever
6 rod
7 load gauge

l_h fastener head
l_b dowel-type fastener

Figure A.1 — Fastener bending apparatus

A.2 Expression of results

The yield moment, M_y, is given as the larger of Equation (A.1) and Equation (A.2):

$$M_y = F_{max} \times l_6 \tag{A.1}$$

$$M_y = F_{max}\left[l_6 + \left(1 - \frac{G_{1ev}}{2F_{max}} \right) \times l_2 \right] \tag{A.2}$$

where

F_{max} is the maximum load on the gauge, expressed in newtons;

G_{1ev} is the self weight of the lever, expressed in newtons;

l_2 is the free length of the fastener, expressed in millimetres;

l_6 is the length of the lever, expressed in millimetres

Bibliography

[1] EN 409, *Timber structures — Test methods — Determination of the yield moment of dowel type fasteners*

[2] ASTM F1575, *Standard Test Method for Determining Bending Yield Moment of Nails*

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