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Timber structures — Test methods — Determination of the long term behaviour of coated and uncoated dowel-type fasteners

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National foreword

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English Version

Timber structures - Test methods - Determination of the long term behaviour of coated and uncoated dowel-type fasteners

Structures en bois - Méthodes d'essai - Détermination du comportement à long terme des éléments de fixation de type tige, revêtus ou non

Holzbauwerke - Prüfverfahren - Bestimmung des Langzeitverhaltens beschichteter und unbeschichteter stiftförmiger Verbindungsmittel

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European foreword

This document (EN 16784:2016) has been prepared by Technical Committee CEN/TC 124 "Timber Structures", the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by December 2016, and conflicting national standards shall be withdrawn at the latest by December 2016.

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1 Scope

This European Standard specifies a test method for the determination of the long duration withdrawal strength of coated and uncoated dowel-type fasteners in structural timber and timber products and wood based products for structural application.

The method applies to all types of nails, screws and staples.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1382, *Timber Structures — Test methods — Withdrawal capacity of timber fasteners*

EN 26891:1991, *Timber structures — Joints made with mechanical fasteners — General principles for the determination of strength and deformation characteristics (ISO 6891:1983)*

EN ISO 8970, *Timber structures — Testing of joints made with mechanical fasteners — Requirements for wood density (ISO 8970)*

ISO 13061-1, *Physical and mechanical properties of wood — Test methods for small clear wood specimens — Part 1: Determination of moisture content for physical and mechanical tests*

ISO 13061-2, *Physical and mechanical properties of wood — Test methods for small clear wood specimens — Part 2: Determination of density for physical and mechanical tests*

3 Terms and definitions

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

3.1
reference withdrawal strength
mean (50 % fractile) withdrawal strength of the tests carried out in accordance with EN 1382

3.2
load level
percentage of the reference withdrawal strength

4 Symbols and abbreviations

a staple crown width, in millimetres (see Figure 1)

d is the outer thread diameter for screws, the diameter of the smooth plain part of a round nail or for staples the diameter of the wire (transformed to a round cross-section) (see EN 14592)

F_{max} maximum withdrawal load, in newtons

$k_{d,T}$ duration of load factor for withdrawal load

l_p the effective depth of penetration of fastener, in millimetres. For smooth nails and staples this includes the point. For profiled nails and screws only the penetration depth of the profiled part. In the case of partly or completely resin coated fasteners only the depth of penetration of the coated

part.

α_{crn} angle between the direction of a staple crown and the grain direction or the main direction of the timber or wood based products, respectively, in degrees (see Figure 2)

T_f elapsed time to failure in minutes for a certain test specimen

T time to failure

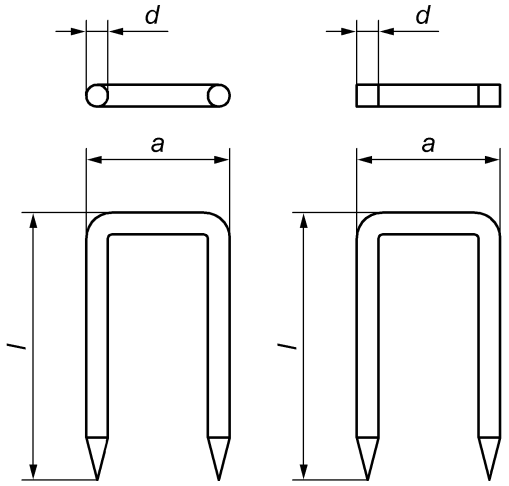


Figure 1 — Staple dimensions

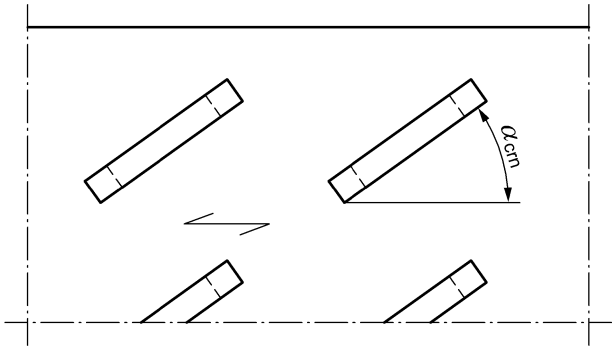


Figure 2 — Angle between the staple direction and the grain direction

5 Sampling

5.1 Timber

The range of density of the test pieces shall be representative of the density of the mechanical class or range of product to which they belong.

The sampling of test pieces shall be done in accordance with EN ISO 8970.

5.2 Fasteners

The technical specification of the nails, screws and staples shall be established.

6 Test method

6.1 General

The moisture content and density of the timber at test shall be determined as specified in ISO 13061-1 and ISO 13061-2 as appropriate.

6.2 Conditioning

The test pieces shall be manufactured with the timber products at an equilibrium moisture content corresponding to (20 ± 2) °C and (80 ± 5) % relative humidity. The material is conditioned when it attains constant mass. Constant mass is considered to be attained when the results of two successive weightings, carried out at an interval of 6 h, do not differ by more than 0,1 % of the mass of the material.

For certain investigations, other moisture conditioning can be appropriate and shall be reported.

NOTE The high moisture content reflects the worst design situation where wet timber is installed that dries out in service.

6.3 Fabrication of the specimens

6.3.1 Fastener axis perpendicular to the grain

The axis of the fastener shall be perpendicular to the timber surface. The insertion of fasteners shall follow normal preparation (e.g. pre-boring) and practice. The position of the fastener is such that no eccentricities occur in transferring the load to the timber.

The width and depth of the test piece in the direction of insertion of the fastener shall be equal and at least lp + 5d for nails and screws (see Figure 3), and for staples at least 10d.

Where the test pieces are of solid timber or glued laminated timber, the fasteners shall be inserted irrespective of the direction of the growth rings. In addition for staples, half of the tests shall be carried out with αcrn = 0° and the other half with αcrn = 90°.

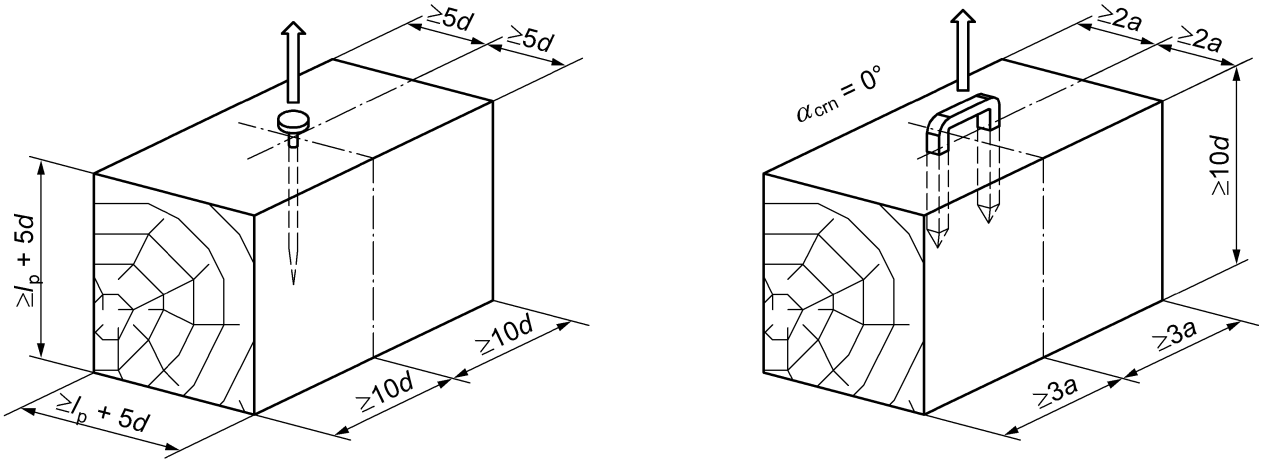


Figure 3 — Withdrawal test pieces - load perpendicular to grain

6.3.2 Fastener axis parallel to the grain

The test piece shall comply with Figure 4. The fastener shall be driven into the end grain to a penetration of between 8d and 20d and shall be positioned in the centre line of the timber specimen as to prevent any eccentricities in the load transfer. A depth of penetration of at least 12d is appropriate to fasteners of d less than 2 mm.

NOTE The range of depth penetration is given so that the depth of penetration used in the test can be decided depending on the withdrawal resistance EN 1382 and the tensile capacity of the fastener.

The cross-sectional dimensions of the test piece shall be equal and at least 10*d* (see Figure 4). For staples, the dimensions parallel and perpendicular to the crown shall be equal and at least 6*a* and 4a, respectively (see Figure 4). The test piece dimension parallel to grain shall be at least 2*l*p + 5*d* for nails and screws, and for staples at least 2*l*p + 3*a*.

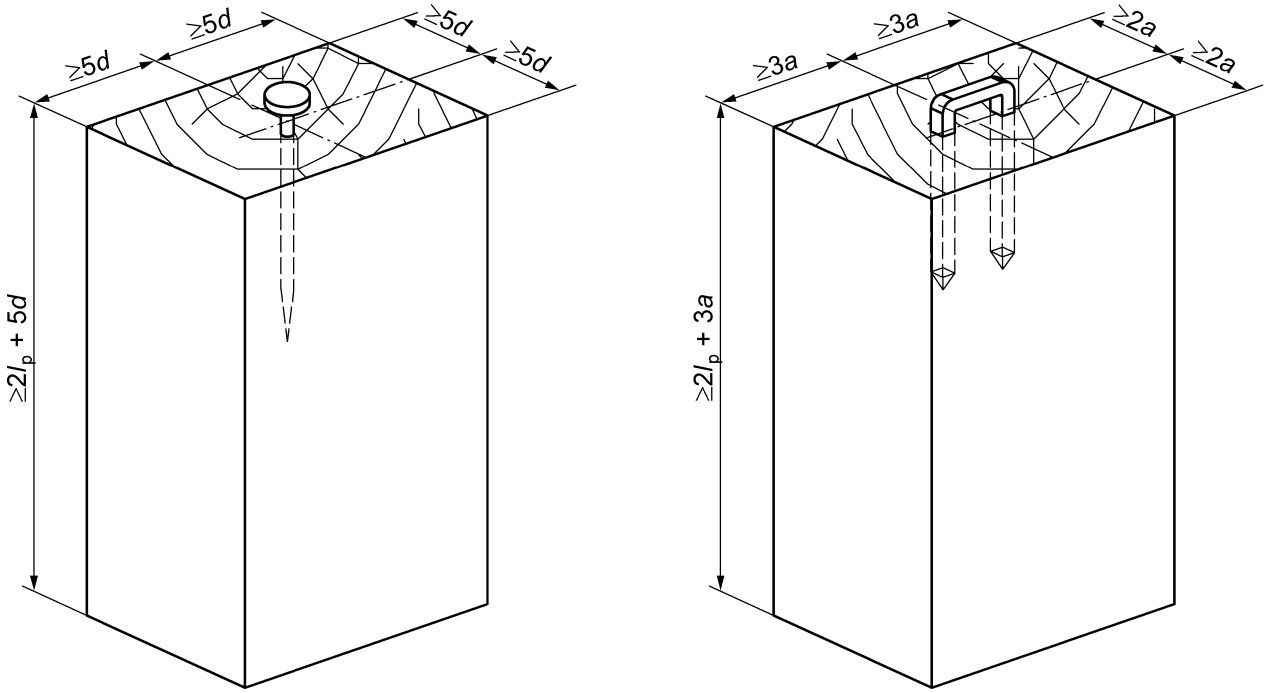


Figure 4 — Withdrawal test pieces - load parallel to grain

6.4 Test procedure

The apparatus used shall be as required in EN 26891:1991, Clause 7.

Tests are carried out in an environment corresponding to (20 ± 2) °C and (65 ± 5) % relative humidity. If these conditions are not maintained during the test, they shall be reported.

Test of thermo plastic adhesive coatings shall be performed at elevated temperatures.

NOTE 1 The design rules in EN 1995-1-1 are valid up to 60 °C.

Determine the depth of the fastener penetration *l*p. Place the test specimen in a device ensuring the application of the withdrawal force along the axis of the fastener or the axes of the staple legs. Any part of the supports that hold the timber test specimen shall be not closer to the axis of the fastener than 3*d* for nails and screws and *a* for staple.

The loading procedure is in accordance with EN 26891 were the load shall be applied with constant increments until the required load level is attained. The required load is held constant until failure or termination of the test. The time to failure or termination of the test shall be recorded.

NOTE 2 Usually the test specimens are mounted in strings in a rig and loaded by dead load. To keep the dead load within limits a level arm can be applied. It is important that the lever arm can function with or without negligible friction at the hinges.

6.5 Testing for duration of withdrawal load

To determine the load duration withdrawal factor at least 10 test specimens are loaded to at least two of the following load levels: 20 %, 30 %, 40 %, 55 %, 60 %, 65 %, 70 %, or 80 % of the reference withdrawal strength.

NOTE Best practice is to choose very different load levels appropriate to the aim of the test.

The reference withdrawal strength is the mean (50 % fractile) of the withdrawal strength established by tests in accordance with EN 1382. For the reference withdrawal strength perpendicular to grain the average of the withdrawal strength in radial and tangential direction is taken. If these tests were carried out with the insertion direction at random with respect to the radial and tangential direction the resulting mean withdrawal strength can directly be taken as reference withdrawal strength.

If test specimens fail during the initial loading, this load level shall be discarded from the investigation.

For all tests, record the time to failure in minutes expressed to the nearest 1% of the elapsed time, T_f.

The tests shall continue until at least 7 test specimens at each load level have failed.

7 Expression of the results

7.1 Load duration factor for withdrawal

The load duration for withdrawal at a given time is defined as the ratio of the load level that results in failure at that time, to the mean reference withdrawal strength.

The load duration factor for withdrawal, $k_{d,T}$ shall be determined by plotting the load level against $\log_{10}$ time (T) to failure.

Calculate the mean time to failure at each load level for those test specimens which have failed.

Calculate the linear regression line treating the load level as the independent variable, to provide Formula (1) of the form:

$$LogT = c - mLL \tag{1}$$

where

c is the intercept on the vertical axis;

m is the slope;

LL is the load level, in percent;

T is the time to failure, in minutes.

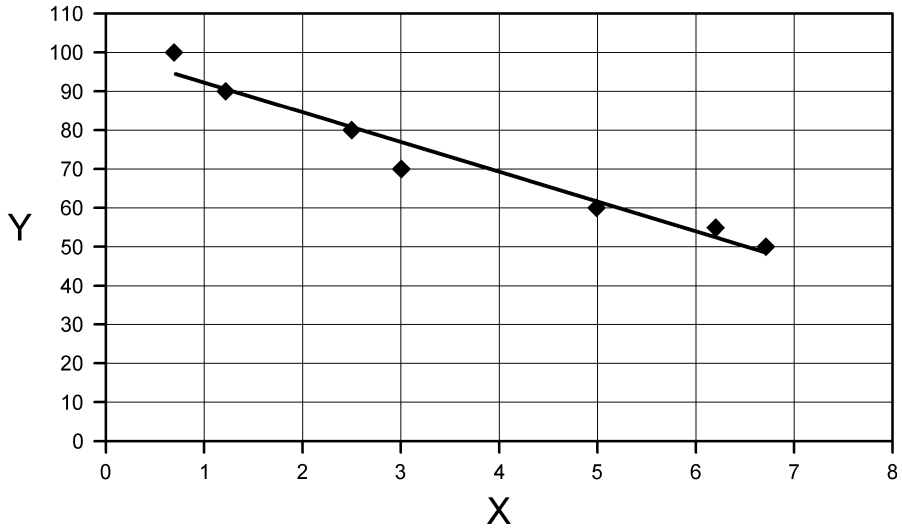
Formula (1) is then rearranged algebraically to give the more traditional form:

$$LL = e - f\log T = k_{d,T} \tag{2}$$

where

$$e = \frac{c}{m}$$
$$f = \frac{1}{m} \tag{3}$$

The extrapolated load level for a particular life is then calculated using Formula (2) and expressed to three significant figures. An example for a ten year life (log T= 6,72) is illustrated in Figure 5.



Key

X is log time

Y is the load level

Figure 5 — Example of a load duration regression curve

The symbol, $k_{d,T}$ shall embrace the time of loading and the service class to which it applies.

NOTE An example of a predicted kd,T value at 10 years calculated from the duration of load testing carried out under service class 1 conditions is as follows:

$k_{d,10y,SC1}$

Where separate tests have been performed parallel and perpendicular to grain direction, separate load duration withdrawal factors shall be calculated.

7.2 Test report

The test report shall contain the following information:

a) a reference to this European Standard;

b) sampling and loading procedure and test set-up;

c) specification of the timber;

d) dimensions, density, moisture content and conditioning for the test;

e) diagram showing the layout of the fasteners and the method of insertion used;

f) angle, αcrn, between staple crown and grain as used in the test;

g) number of test pieces used;

h) specification and number of fasteners tested (type, sizes, material, surface coating or condition and other particulars);

i) procedure to establish the reference withdrawal strength;

j) time to failure, level of applied load in percent, climatic conditions for the test specimens;

k) method of measurement;

l) individual test results, mean values and standard deviations per test series, and description of the mode of failure;

m) statistic model and procedure for the calculation of the load duration withdrawal factor, k_d.

Bibliography

EN 1995-1-1, *Eurocode 5: Design of timber structures — Part 1-1: General — Common rules and rules for buildings*

EN 14592, *Timber structures — Dowel-type fasteners — Requirements*

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