BRITISH STANDARD

BS EN
12512:2001
Incorporating Amendment No. 1

Timber structures — Test methods — Cyclic testing of joints made with mechanical fasteners

The European Standard EN 12512:2001, with the incorporation of amendment A1:2005, has the status of a British Standard

ICS 21.060.01; 91.080.20

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National foreword

This British Standard is the official English language version of EN 12512:2001, including amendment A1:2005.

The start and finish of text introduced or altered by CEN amendment is indicated in the text by tags [A1] ⟨A1]. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by [A1] ⟨A1].

The UK participation in its preparation was entrusted by Technical Committee B/518, Structural timber, to Subcommittee B/518/1, Test methods, which has the responsibility to:

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— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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English version

Timber structures - Test methods - Cyclic testing of joints made with mechanical fasteners
(includes amendment A1:2005)

Structures en bois - Méthodes d'essai - Essais cycliques d'assemblages réalisés par organes mécaniques
(inclut l'amendement A1:2005)

Holzbauwerke - Prüfverfahren - Zyklische Prüfungen von Anschlüssen mit mechanischen Verbindungsmitteln
(enthält Änderung A1:2005)

This European Standard was approved by CEN on 5 October 2001. Amendment No. 1 was approved by CEN on 8 August 2005.

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 124 "Timber structures", the secretariat of which is held by DS.

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of an identical text or by endorsement, at the latest by May 2002, and conflicting national standards shall be withdrawn at the latest by May 2002.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Foreword to amendment A1

This European Standard (EN 12512:2001/A1:2005) has been prepared by Technical Committee CEN/TC 124 “Timber structures”, the secretariat of which is held by SFS.

This Amendment to the European Standard EN 12512:2001 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2006, and conflicting national standards shall be withdrawn at the latest by March 2006.

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Introduction

Developments in the field of load-bearing engineered timber structures in seismic regions require that joints made with mechanical fasteners be tested to obtain information about their ductility, dissipation of energy and impairment of strength under cyclic loading.

This standard lays down general principles, which should be followed in order to achieve comparability of results from investigations carried out in different laboratories.

For different purposes two different testing procedures are considered: a general one, when the determination of the complete cyclic load-slip performance is required (complete procedure), and a particular one when only the determination of the main performances at a pre-determined ductility level is required (short procedure).

1 Scope

This European Standard specifies a test method for determining the ductility, impairment of strength and energy dissipation properties of joints made with mechanical fasteners under cyclic loading.

NOTE This standard is written, for uniformity, in terms of direct axial loads and their effects only. The standard is, however, also appropriate to the determination of the moment resisting properties of joints.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply:

3.1
cyclic load
alternative load in compression and tension

3.2
maximum load
maximum joint load reached during test, F_{max}, see Figure 2

3.3
yield load
load corresponding to the entry into the plastic range. When the load-slip curve presents two well-defined linear parts, the yield values are determined by the intersection between these two lines (see Figure 1 a)). When the load-slip curve does not present two well defined linear parts, the yield values are determined by the intersection of the following two lines: the first line will be determined as that drawn through the point on the load slip curve corresponding to 0,1 F_{max} and the point on the load-slip curve corresponding to 0,4 F_{max}*;* the second line is the tangent having an inclination of 1/6 of the first line (see Figure 1 b))

3.4
ultimate load
joint load corresponding to

a) failure; or

b) 80 % of the maximum load for a slip of less than 30 mm; or

c) a joint slip of 30 mm whichever occurs first in the test, see Figure 2

3.5
yield slip
joint slip corresponding to the yield load, see Figures 1 a) and 1 b)

3.6
ultimate slip
joint slip corresponding to the ultimate load, see Figure 2

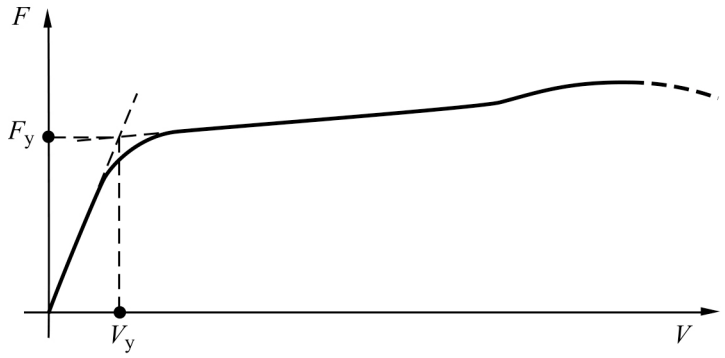
3.7
ductility
ability of the joint to undergo large amplitude slip in the plastic range without a substantial reduction of strength. It is measured by the ratio between ultimate slip and yield slip,

$$D = V_u / V_y \ .$$

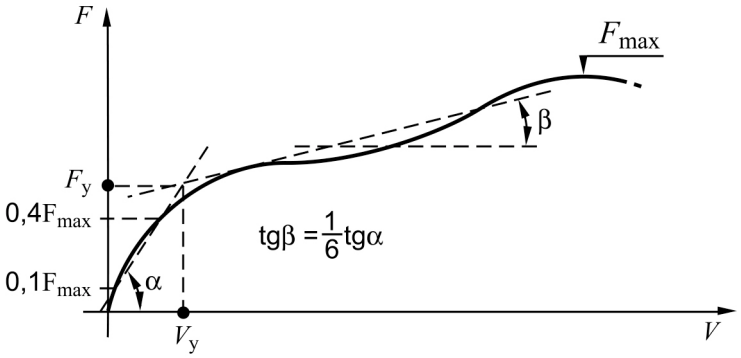
NOTE The above definitions are intended with reference to envelop load-slip cycle loops curves, but they may also be used for monotonic load-slip curves.

3.8
impairment of strength
reduction in the load when attaining a given joint slip from the first to the third cycle of the same amplitude, see Figure 3: The impairment of strength is measured as ΔF where $\Delta F = |\Delta F_c|$ in the compression side and $\Delta F = |\Delta F_t|$ in the tension side

3.9
dissipation of energy
property of a joint which, for the purposes of this European Standard, is measured as the equivalent viscous damping ratio by hysteresis. It is a non-dimensional parameter expressing the hysteresis damping properties of the joint and is measured as the ratio between the dissipated energy in one half cycle and the available potential energy multiplied by 2π, see Figure 4: The equivalent viscous damping ratio is defined as $\nu_{eq} = E_d/(2\pi\ E_p)$



a) Definition of yield values for a load-slip curve with two well-defined linear parts

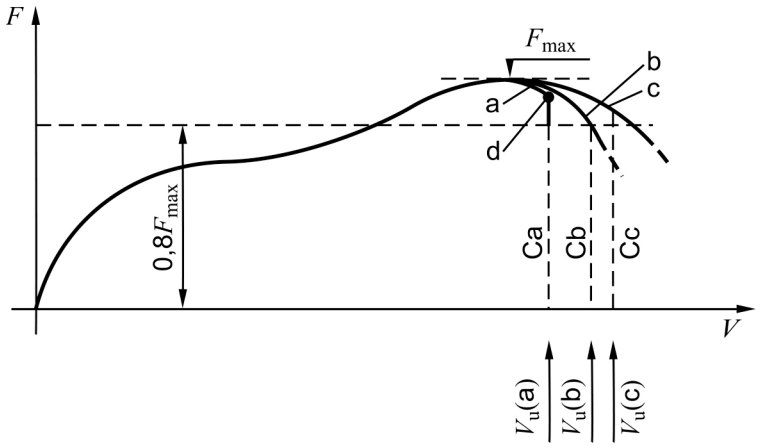


b) Definition of yield values for a load-slip curve without two well-defined linear parts

Key

F	Load
F_{max}	Maximum load
$F_{y,}$	Yield load
V	Slip
$v_{y,}$	Yield slip

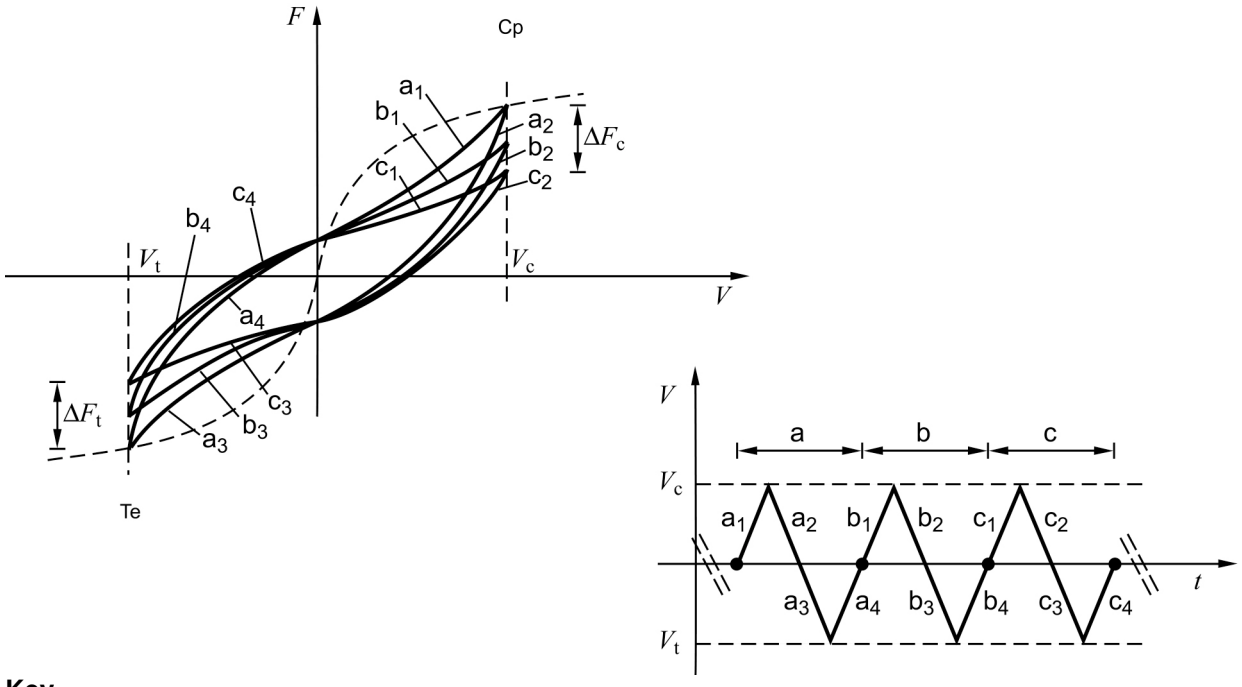
Figure 1 - Definition of yield values for a load-sup curve



Key

F	Load
F_{max}	Maximum load
	failure
C_a	Case a
V	Slip

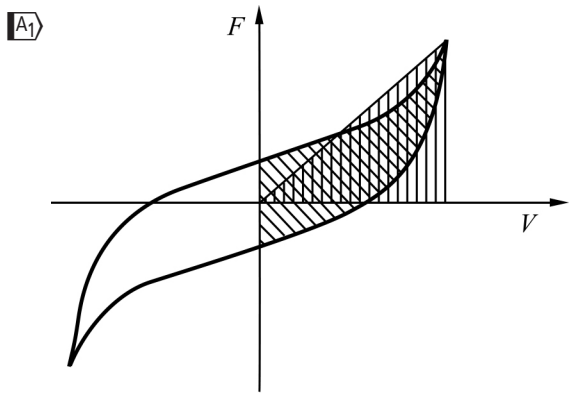
Figure 2 - Definition of ultimate values. υ corresponds to failure slip (case a) or *0,8F*$_{max}$*.* slip (case b) or 30 mm slip (case c)



Key

V	Slip
a, b, c	Cycle
t	Time
c	Compression;
t	Tension

Figure 3 - Definition of impairment of strength



Key

Energy dissipated per half cycle, E_d

Available potential energy, E_P A1

Figure 4 - Definition of equivalent viscous damping ratio for one cycle

4 Symbols

D ductility;

E_d dissipated energy in newtons millimetres;

E_p available potential energy, in newtons millimetres;

F applied load, in newtons;

F_{max} maximum load, in newtons;

F_u ultimate load, in newtons;

F_y yield load, in newtons;

V_u ultimate slip, in millimetres;

V_y yield slip, in millimetres;

$V_{y,est}$ estimated yield slip, in millimetres;

ΔF impairment of the strength, in newtons;

ν_{eq} equivalent viscous damping ratio.

5 Requirements

None.

6 Test methods

6.1 Principles

The ductility, equivalent viscous damping ratio and impairment of the strength of joints are determined under a standardised quasi-static cyclic loading procedure.

6.2 Apparatus

In addition to equipment for measuring the geometry of the test specimens and the moisture content the following shall be available

a) a displacement controlled double effect (tension and compression) testing machine

- with an accuracy on the stroke of ±1 % or better

- with an accuracy on the load of ± 1 % or better.

b) equipment to measure continuously joint slip under load with an accuracy of ± 1 % or better.

6.3 Preparation of the specimens

6.3.1 General

The specimen shall correspond to a joint expected in practice.

6.3.2 Conditioning

The tests shall usually be carried out on specimens, which have been conditioned at the standard environment of (20 ± 2) ºC temperature and (65 ± 5) % relative humidity. Further information is given in EN 26891.

6.3.3 Test laboratory

The test laboratory should usually be maintained at the standard environment, but when other conditions apply, they shall be reported.

6.3.4 Moisture content

The moisture content of the materials shall be determined.

6.4 Procedures

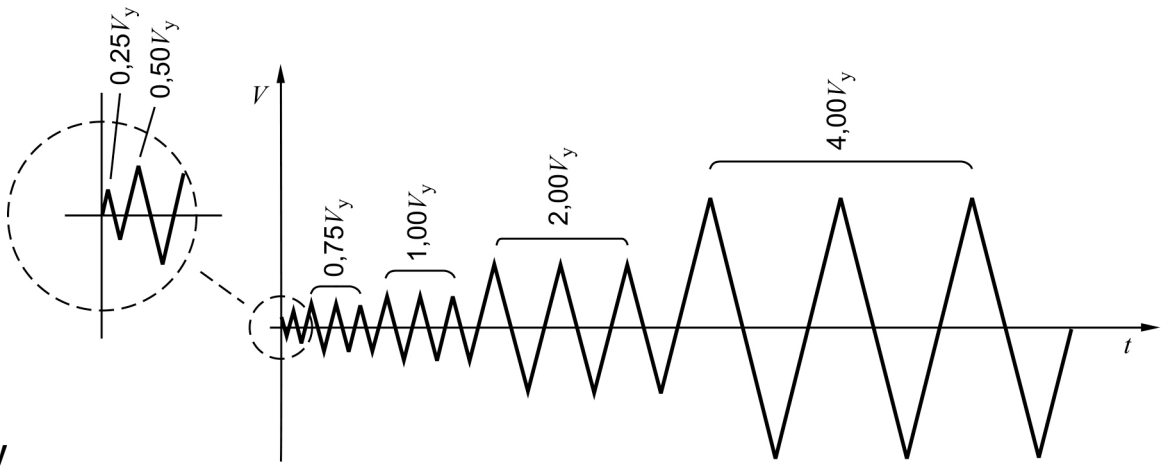
6.4.1 General

The test shall be carried out at a constant rate of slip of between 0,02 mm/s and 0,2 mm/s. Lateral restraint shall be provided to prevent buckling of the specimens.

Load and slip shall be measured continuously.

6.4.2 Complete procedure

To determine the complete load-slip envelope curve the complete loading procedure as shown in Figure 5, shall be used.



Key

V	Slip
t	Time

Figure 5 - Procedure for cyclic testing (complete procedure)

1st cycle:

1) apply the load in compression, until a slip of 25 % of the estimated yield slip $V_{y,est}$ is reached. The value of $V_{y,est}$ may be evaluated by calculation, by experience or by previous monotonic tests according to EN 26891;

2) unload the specimen and reload it in tension to zero-slip;

3) continue to load in tension up to a slip of 25 % of $V_{y,est}$ on the tension side;

4) unload the specimen and reload it in compression to zero-slip.

2nd cycle:

1) continue to load in compression, up to a slip of 50 % of $V_{y,est}$;

2) unload the specimen and reload in tension to zero-slip;

3) continue to load in tension, up to a slip of 50 % of $V_{y,est}$;

4) unload the specimen and reload it in compression to zero-slip.

3rd-4th-5th cycles (set of three cycles):

Repeat 2nd cycle three times but corresponding to 75 % of $V_{y,est}$.

6th-7th-8th cycles (set of three cycles):

Repeat 2nd cycle three times but corresponding $V_{y,est.}$

Following sets of three cycles:

Repeat 2nd cycle three times corresponding to $2V_{y,est}$, $4V_{y,est}$, $6V_{y,est}$, … until failure or a slip of 30 mm is reached.

If $V_y < 0{,}5\ V_{y,est}$, the test shall be repeated.

6.4.3 Short procedure

To determine only the main characteristics ΔF and ν_{eq} at pre-determined ductility D, the following short procedure may be used.

1st cycle:

1) apply the load in compression in a monotonic way until a slip of $V_c = D \cdot V_y$ is achieved, where V_y is the yield slip determined by previous monotonic tests according to EN 26891 or evaluated directly during the test;

2) unload the specimen and reload it in tension to zero-slip;

3) continue to load in tension until a slip $V_t = D \cdot V_y$;

4) unload the specimen and reload it in compression to zero-slip.

2nd cycle:

Repeat the 1st cycle

3rd cycle:

Repeat the 1st cycle.

7 Results

In addition to the load-slip and slip-time diagrams, the following quantities shall be calculated and reported:

For the complete procedure:

a) the impairment of the strength for each set of three cycles at each tested ductility level, both in tension and compression;

b) the damping ratio at each tested ductility level, evaluated from the third cycle of each set of three cycles;

c) the maximum ductility level reached, referring to the envelop load slip curve of the first cycle of each set of three cycles at each tested ductility level, both in compression and tension. Quantities V_u and V_y with the corresponding F_u and F_y (and also F_{max}) shall be reported.

For the short procedure:

a) the impairment of the strength at the pre-determined ductility level, both in tension and compression;

the equivalent viscous damping ratio corresponding to the third cycle, at the pre-determined ductility level.

8 Test reports

The test report shall include:

a) species and density of the timber;

b) type of the fasteners including dimensions and coating;

c) dimensions of the joint members, number of fasteners, arrangement and spacing, details of possible gaps between members;

d) conditioning of timber and test specimens before and after manufacture, moisture content of the timber at manufacture and test, fissures, etc.;

e) position and type of measurement devices;

f) arrangement and type of the load apparatus and control system,

g) the test procedure used (with reference to 6.4) and a statement of any deviations; the loading rate;

h) individual joint test results (with reference to clause 7) and any relevant information about the modes of failure.

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