INTERNATIONAL STANDARD

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Timber structures — Solid timber finger-jointing — Production requirements

Structures en bois — Aboutages à entures multiples de bois massif — Exigences de fabrication

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Contents

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 10983 was prepared by Technical Committee ISO/TC 165, *Timber structures.*

Annexes A and B of this International Standard are for information only.

Introduction

This International Standard is based on European Standard EN 385:1995, *Finger-jointed structural timber — Performance requirements and minimum production requirements,* but has been modified for international use. In particular, the requirements for external control of production by an external independent organization have been omitted, as this is regarded as the responsibility of national regulatory bodies and not a matter for inclusion in an International Standard. However, TC 165 is not prepared to recommend the use of finger joints in structural timber components where the manufacturing process is not described by a works' quality manual for the following reasons.

a) Structural properties can only be assigned to a finger joint which is clearly defined. Such definition requires a clear statement, within the works' quality manual, which details the raw material inputs (wood and adhesive) and the manufacturing process.

b) Processes which are not written in a works' quality manual and promulgated to the personnel responsible for manufacturing the finger joint are unlikely, over lengthy periods of time, to be manufactured consistently.

Other principles built into the development of this International Standard are as follows.

— This International Standard applies only to the finger-joint production and makes reference only to the maintenance of finger-joint strength. Finger joints are found in both glulam laminations and finger joints and finger-jointed timber used directly for structural applications. No attempt is made in this International Standard to relate compliance testing to the properties of either glulam or finger-jointed timber.

— Type testing is undertaken to establish characteristic strengths and thence target strengths for compliance (daily quality control) testing. The precise test configurations are not specified in this International Standard, which permits the use of a wide variety test equipment. However, it is a requirement that the same equipment and configuration used for type testing also be used for compliance testing. Both bend and tension tests are provided for compliance testing.

Timber structures — Solid timber finger-jointing — Production requirements

1 Scope

This International Standard specifies requirements for bonded finger joints and minimum requirements for the manufacture of cut, interlocking, bonded finger joints in structural timber members.

Although most finger joints are produced in coniferous species, this International Standard also applies to broad-leaved species where information is available to enable them to be satisfactorily bonded.

It does not cover impressed (die-formed) joints. In the case of glued laminated timber it applies only to individual laminations. Large finger joints in glued laminated timber are not covered by this International Standard.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, this publication do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

EN 301, *Adhesives for load bearing timber structures — Phenolic and amino-plastic — Classification and performance requirements*.

3 Terms and definitions

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

3.1
finger joint
self-locating end joint formed by machining a number of similar, tapered, symmetrical fingers in the ends of timber members which are then bonded together

See Figure 1.

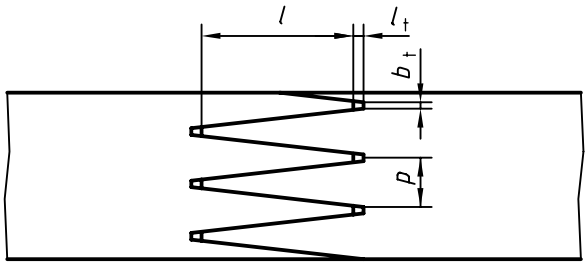


Figure 1 — Typical profile of finger joint showing finger length l, pitch p, tip width b_t, and tip gap l_t

3.2
finger length
distance between the finger base and the tip of the finger, measured along the centreline of the finger

3.3
pitch
centre-to-centre distance between fingers

3.4
production batch
joints, all of which have the same profile, are manufactured from the same species of timber, have the same nominal cross-section, are bonded with the same adhesive and are made during a continuous run on one production line

3.5
service class 1
service class characterized by a moisture content of the material corresponding to a temperature of 20 °C and a relative humidity of the surrounding air exceeding 65 % only for a few weeks per year

NOTE In service class 1, the average equilibrium moisture content in most timbers does not exceed 12 %.

3.6
service class 2
service class characterized by a moisture content of the material corresponding to a temperature of 20 °C and a relative humidity of the surrounding air exceeding 85 % only for a few weeks per year

NOTE In service class 2, the average equilibrium moisture content in most timbers does not exceed 20 %.

3.7
service class 3
service class characterized by climatic conditions leading to higher moisture contents than service class 2

3.8
tip gap
distance between finger tip and slot base in a bonded finger joint

3.9
tip width
distance between finger faces, measured at the tip of the finger

4 Symbols

b width of cross-section, in millimetres

b_t tip width, in millimetres

f_m finger-joint bending strength, in megapascals

$f_{m,k}$ finger-joint characteristic bending strength, in megapascals

$f_{m,15}$ 5^{th} percentile finger-joint bending strength of last 15 specimens tested, in megapascals

$f_{m,dc,k}$ finger-joint bending strength declared by the manufacturer, in megapascals

$f_{m,target}$ target finger-joint bending strength to be met in compliance testing, in megapascals

f_t finger-joint tension strength, in megapascals

$f_{t,k}$ finger-joint characteristic tension strength, in megapascals

$f_{t,15}$ 5^{th} percentile finger-joint tension strength of last 15 specimens tested, in megapascals

$f_{t,dc,k}$ finger-joint tension strength declared by the manufacturer, in megapascals

$f_{t,target}$ target finger-joint tension strength to be met in compliance testing, in megapascals

h depth of cross-section, in millimetres

k_{15} statistical factor, see 7.1.4

l finger length, in millimetres

l_t tip gap, in millimetres

m mean value

p pitch, in millimetres

s standard deviation

5 Requirements

5.1 General

The cutting and the bonding operations of finger joints shall result in reliable and durable bonds of the required strength.

These general requirements shall be considered satisfied if both the requirements in this clause and the minimum production requirements in clause 6 are fulfilled.

5.2 Timber

5.2.1 Species

Sufficient information on the timber species shall be available to enable the timber to be satisfactorily bonded.

5.2.2 Growth and processing characteristics

The incidence of growth and processing characteristics such as knots, fissures, grain disturbance, wane and damage in the timber shall not exceed the limits described in the work's quality manual.

5.3 Adhesives

The adhesive shall enable joints of such strength and durability to be produced such that the integrity of the bond is maintained throughout the intended lifetime of the structure.

For structures in service class 3, the adhesive used shall be of type I and shall meet the requirements for this type given in EN 301. For structures in service class 1 or 2, an adhesive of type II in accordance with EN 301 can be used, provided the temperature of the member in the structure remains below 50 °C.

NOTE 1 The adhesive should be chosen considering the climatic conditions in service, the timber species, the preservative used (if any) and the production methods.

NOTE 2 Such strength and durability can be achieved by a polycondensation adhesive of the phenolic or aminoplastic type as defined in EN 301.

5.4 Characteristic strength

5.4.1 General

The characteristic strength in bending or tension shall be determined by type testing in accordance with clause 8. The method of compliance testing (bending or tension) shall be at the discretion of the manufacturer.

5.4.2 Characteristic strength in bending

Where bend testing is used for compliance testing, the characteristic bending strength of the finger joints, $f_{m,k}$, shall be determined by type testing and statistical analysis as described in 8.5. The declared characteristic bending strength shall meet the requirement:

$$f_{m,dc,k} \leqslant f_{m,k}$$

A manufacturer may declare a characteristic bending strength lower than $f_{m,k}$.

5.4.3 Characteristic strength in tension

Where tension testing is used for compliance testing, the characteristic tension strength of the finger joints, $f_{t,k}$, shall be determined by type testing and statistical analysis as described in 8.5. The declared characteristic tension strength shall meet the requirement:

$$f_{t,dc,k} \leqslant f_{t,k}$$

A manufacturer may declare a characteristic tension strength lower than $f_{t,k}$..

6 Manufacturing requirements

6.1 Production conditions

The premises shall meet the requirements of air temperature and relative humidity to ensure a satisfactory production environment. Necessary machinery and equipment for the production process shall be available.

6.2 Timber

The moisture content shall be measured either by the oven-drying method or by the use of a regularly calibrated moisture meter.

At assembly, the timber at the joint shall have a moisture content and temperature within the range specified by the adhesive manufacturer.

6.3 Adhesive application

The application method shall ensure that all finger surfaces in the assembled joint are covered with the adhesive.

NOTE This requirement may be assumed to be met if the adhesive is squeezed-out on all four surfaces of the joint when the end pressure is applied.

6.4 Assembly and end pressure

6.4.1 Assembly

Joints shall be bonded as soon as possible, and not later than 24 h, after cutting. Between cutting and assembly, care shall be taken to keep the cut surfaces of the fingers clean. The members shall not be stored in conditions likely to lead to distortion.

The advice of the adhesive manufacturers shall be sought and observed with respect to the following:

a) mixing;

b) use of fillers;

c) preheating of the timber (by high frequency, infrared or other methods);

d) application;

e) open and closed assembly times;

f) curing;

g) temperature of the air and the timber before and during curing.

6.4.2 End pressure

The application of end pressure shall be adequate to enable the jointed timber to be moved with reasonable care to the curing stage prior to any subsequent machining. Initial curing of the adhesive shall be completed before further processing, unless it is proved that the finger joints will have sufficient and reliable strength to allow this.

6.5 Preservative and fire retardant treatment

The advice of the preservative and adhesive manufacturer shall be sought and followed with regard to the compatibility of any proposed treatment.

7 Quality control

7.1 Factory production control

7.1.1 General

To ensure that the produced finger joints conform to this International Standard, the manufacturer shall establish and maintain documented internal factory production control.

The documented factory production control shall be efficiently implemented by means of procedures and instructions.

If all finger joints are proof-loaded according to a harmonized technical specification, then the sampling and testing may be omitted.

7.1.2 Sampling of finger joints

7.1.2.1 A representative sample of finger joints shall be drawn at random from each work shift and each production line.

7.1.2.2 At least three sample joints shall be taken for testing from the production of each shift, as far as possible evenly distributed in time and timber sizes over the shift. At least one specimen shall be drawn from each production batch.

7.1.2.3 The specimens shall contain a finger joint at mid-length.

7.1.3 Compliance testing of finger joints

7.1.3.1 Where possible, the whole jointed cross-section shall be tested. However, test specimens not covering the full cross-section of the jointed timber may be used provided that two specimens, each covering at least one-third of the cross-section, are tested. In bend tests, these specimens shall include the edges of the original cross-section and these edges shall be on the tension side of the specimen in the bending test. Only the lower test result shall be considered.

7.1.3.2 Compliance testing of finger joints shall be conducted at the same time after manufacture as used to determine the characteristic strength during type testing.

As far as is practicable, the moisture condition of the timber at the time of manufacture shall be maintained. The surface finish of the specimens at test shall be the same as that of the jointed timber normally supplied by the manufacturer.

NOTE After manufacture, adhesives continue to gain strength with time. Ideally, type and compliance testing should be undertaken following similar curing times.

7.1.3.3 The test for compliance shall be made by load application which subjects the joint to either bending or tension loading. Suitable procedures are given in annex A and annex B respectively.

7.1.3.4 For the finger joints tested, a test report containing the following information shall be registered and signed by the person responsible for the testing:

a) date of production;

b) date of testing;

c) timber species;

d) timber grade;

e) preservative treatment;

f) type of resin and hardener;

g) width and thickness of the timber;

h) test load at failure;

i) bending or tension strength;

j) description of the failure mode (wood failure percentage).

7.1.4 Compliance requirements

7.1.4.1 General

The manufacturer shall test finger joints for compliance using either bend- or tension-testing in accordance with 7.1.4.1 or 7.1.4.2. The choice of test method is at the manufacturer's discretion.

7.1.4.2 Bend testing

Where bend testing has been chosen for compliance testing, the shift's production is acceptable if either one of the following conditions is met:

a) The bending strength f_m of each single joint tested, is equal to or larger than the target bending strength of the finger joint $f_{m,target}$:

$$f_m \geqslant f_{m,target}$$

b) The 5th percentile bending strength $f_{m,15}$ of the last 15 finger joints tested from the same production line is equal to or larger than the target bending strength of the finger joints joint $f_{m,target}$:

$$f_{m,15} \geqslant f_{m,target}$$

Using a log-normal probability function $f_{m,15}$ may be calculated from

$$f_{m,15} = k_{15}\, m(f_m)$$

where

$m(f_m)$ is the mean value of the last 15 test results;

k_{15} is a statistical factor which depends on the coefficient of variation for the sample, see Table 1. Factor k_{15} may be calculated using $k_{15} = 0{,}99e^{-1{,}85V}$;

$f_{m,target}$ is the target bending strength derived from $0{,}9\, f_{m,k} \leqslant f_{m,target} \leqslant f_{m,k}$.

Table 1 — Factor k_{15}

Coefficient of variation	0,10	0,15	0,20	0,25	0,30
k_{15}	0,84	0,77	0,70	0,64	0,58

The coefficient of variation shall be based on the 15 test specimens and shall be taken as not less than 0,1.

7.1.4.3 Tension testing

Where tension testing has been chosen for compliance testing, the shift's production is acceptable if either one of the following conditions is met:

a) The tension strength f_t of each single joint tested, is larger than or equal to the target tension strength of the finger joint $f_{t,target}$:

$f_t \geq f_{t,target}$

b) The 5th percentile tension strength $f_{t,15}$ of the last 15 finger joints tested from the same production line, is larger than or equal to the target tension strength of the finger-joints joint $f_{t,target}$:

$f_{t,15} \geq f_{t,target}$

Using a log-normal probability function $f_{t,15}$ may be calculated from

$$f_{t,15} = k_{15} m(f_t)$$

where

$m(f_t)$ is the mean value of the last 15 test results;

k_{15} is a statistical factor which depends on the coefficient of variation for the sample; see Table 1;

$f_{t,target}$ is the target tension strength derived from $0,9\, f_{t,k} \leq f_{t,target} \leq f_{t,k}$.

The coefficient of variation shall be based on the 15 test specimens and shall be taken as not less than 0,1.

7.2 Organization of factory production control

7.2.1 Responsibility and authority

The responsibility, authority and the interrelation of all personnel who manage, perform and verify work affecting quality shall be defined, particularly for personnel who need the organizational freedom and authority to

a) initiate action to prevent the occurrence of non-conformity of finger joints;

b) identify and record any quality problems with finger joints.

7.2.2 Factory production control

At every factory unit, the manufacturer shall appoint a person who shall have appropriate authority, knowledge and experience of the production of finger joints to be responsible for conducting and supervising factory production control procedures and ensuring that the requirements given in this International Standard are implemented and maintained.

7.2.3 Review

The production control system adopted to satisfy the requirements of this International Standard shall be reviewed at appropriate intervals by the manufacturer's management to ensure its continuing suitability and effectiveness. Records of such reviews shall be maintained.

7.3 Documentation of the quality control system

7.3.1 The manufacturer's documentation, procedures and instructions shall be relevant to the production and process control of the finger joints, and shall be adequately described in a works' quality manual, covering:

a) quality aims and organizational structure, responsibilities and powers of the management with regard to conformity of the finger joints;

b) procedures for specifying and verifying the quality of the timber and the adhesive;

c) manufacturing, production control and other techniques, processes and systematic actions to be used;

d) inspections and tests that will be carried out before, during and after manufacture, and the frequency with which they are to be carried out.

NOTE The documentation for the finger-joint tests may be recorded and kept separately.

7.3.2 All documentation shall be registered so that the raw materials and production conditions for the finger joints are traceable, at least to the production week and year.

7.4 Inspection and testing

7.4.1 General

All necessary facilities, equipment and personnel shall be available to carry out the necessary inspections and tests. This requirement may also be fulfilled if, by means of a contract, the manufacturer or his agent involves a subcontractor having the necessary facilities, equipment and personnel The manufacturer shall control, calibrate and maintain inspection, measuring and test equipment, whether owned by the manufacturer or on hire, to demonstrate the conformity of the finger joints to the specified requirements of this International Standard. Equipment shall be used in a manner which ensures that measurement tolerances are known and are consistent with the required measurement capability.

7.4.2 Action in case of non-conformity

If there is reason to doubt the quality of any production operation or of the raw materials used, the internal quality control shall be increased and intensified.

7.4.3 Quality surveillance of non-conforming finger joints

If the quality of a finger joint is unsatisfactory as assessed by the compliance requirements, the manufacturer shall at once take the necessary steps to rectify the non-compliance. Production involving the non-conforming finger joints shall be set aside and marked accordingly and its associated test data discarded. When it is considered that the non-compliances have been rectified, the characteristic strength shall meet the compliance requirements of 7.1.4.

8 Type testing — Initial determination of joint strength

8.1 General

During the running-in period of a new finger-jointing line, or in the case of significant changes in an existing line (including changes of profile) specimens shall be tested in either bending or tension as chosen by the manufacturer. The cross-sections of the specimens shall be equal to the maximum which the manufacturer intends to finger-join.

8.2 Materials

For every joint type involving differences in timber species, joint geometry, adhesive, any part of the processing or preservative and flame-retardant treatment, at least 30 jointed specimens shall be tested in accordance with annex A (bend testing) or annex B (tension testing).

Where failure of a specimen can be related to a defect in the timber, the test results for that specimen may be excluded in the assessment. If such exclusions leave fewer than 30 valid results, then tests on further specimens shall be carried out to give at least 30 valid results.

8.3 Preparation of specimens

Sample joints shall be drawn from and represent normal production. The timber densities shall be representative of the species and grade concerned.

At the time the sample joints are manufactured, the timber shall be at the moisture content at which production joints would normally be made. Testing shall be conducted at a time after manufacture selected by the manufacturer. The surface finish of the specimens at test shall be typical of the jointed timber normally supplied by the manufacturer.

8.4 Procedure

The testing comprises edge-wise bending, flat-wise bending or tension as selected by the manufacturer. The bending strength of the finger joints shall be determined in accordance with annex A and the tension strength in accordance with annex B.

8.5 Characteristic strength

The characteristic bending or tension strength, $f_{m,k}$ or $f_{t,k}$ as appropriate, defined as the lower fifth percentile strength, shall be determined by an appropriate statistical method.

Annex A
(informative)

Finger-joint bending strength

A.1 Scope

This annex presents an example of an in-factory finger-joint bending test for production control testing of finger joints.

A.2 Principle

The finger joint is tested in three- or four-point bending on the flat or on edge in a testing machine, and the bending stress at failure (modulus of rupture) is calculated. The test specimen shall contain at least one finger joint in the region of maximum bending moment.

A.3 Apparatus

A.3.1 Testing machine, of adequate capacity and capable of measuring loads to an accuracy of 2 %.

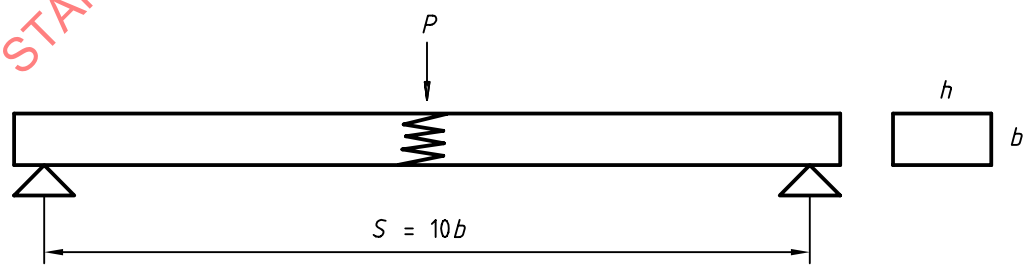
A.4 Preparation of specimens

A.4.1 General

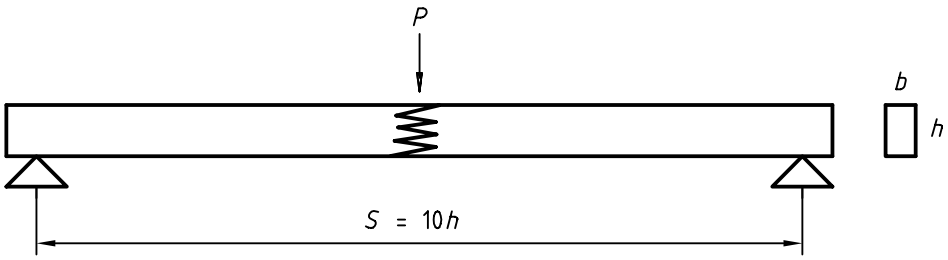
Test specimens shall contain finger joints which are representative of the materials and processes used in manufacture. The specimen length and test configuration is unspecified for this in-factory test, but the length-to-depth ratio shall be not less than 10; see Figure A.1. The same specimen length, test configuration and orientation (flat-wise or edge-wise) shall be used for both the compliance testing, 7.1.3, and type testing, clause 8.

A.4.2 Finger joints

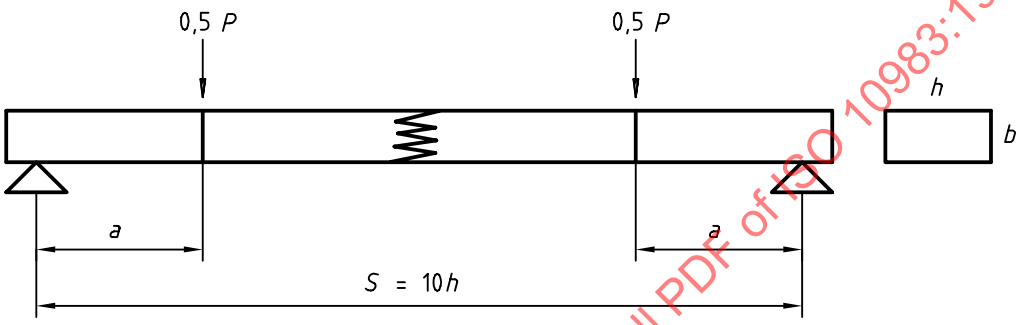
Finger joints shall be tested at the completion of the finger jointing and any finishing operations.



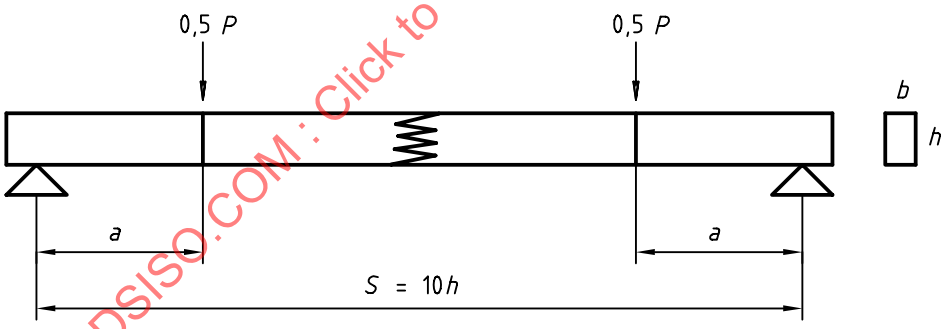
$$f_m = \frac{1{,}5PS}{hb^2}$$



$$f_m = \frac{1{,}5PS}{h^2 b}$$



$$f_m = \frac{3Pa}{b^2 h}$$



$$f_m = \frac{3Pa}{h^2 b}$$

NOTE Because the different configurations result in different strength values, the test method chosen shall remain consistent.

Figure A.1 — Permissible test configurations for quality control testing of finger joints in bending

A.5 Test method

Loading shall be applied at a rate such that failure takes place at a time between 5 s and 120 s.