INTERNATIONAL STANDARD

ISO 12578

Second edition
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Timber structures — Glued laminated timber — Component performance requirements

Structures en bois — Bois lamellé-collé — Performance des composants et exigences

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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The committee responsible for this document is ISO/TC 165, *Timber structures*.

This second edition cancels and replaces the first edition (ISO 12578:2008), which has been technically revised.

Introduction

Glued laminated timber is obtained by bonding together a number of laminations having their grain essentially parallel. In this way, a member with rectangular solid cross-section can be produced. Other non-rectangular shapes can also be produced.

The purpose of the requirements in this International Standard is to provide minimum performance requirements to ensure the in-service performance of the glued laminated timber. The requirements will need to be supplemented to take into consideration special conditions, materials or functional requirements.

Timber structures — Glued laminated timber — Component performance requirements

1 Scope

This International Standard specifies requirements for the components of glued laminated timber members for structural use.

This International Standard is applicable to products with a finished lamination thickness of not more than 50 mm.

Although most glued laminated timber is made from coniferous species, this International Standard also applies to broad leaf species if the tests specified in this International Standard show that a satisfactory glue bond can be achieved.

The basic requirements apply to structural members of all service classes; however, special precautions are necessary for service class 3, for example, the use of weather resistant adhesives (see 5.3).

This International Standard does not apply to the determination of strength and stiffness characteristics. Annex B contains informative materials for formaldehyde emission.

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.

ISO 9709, *Structural timber — Visual strength grading — Basic principles*

ISO 13912, *Structural timber — Machine strength grading — Basic principles*

ISO 10983:2014, *Timber — Finger joints — Minimum production requirements and testing methods*

ISO 8375:—[1)], *Timber structures — Glued laminated timber — Test methods for determination of physical and mechanical properties*

ISO 12579, *Timber structures — Glued laminated timber — Method of test for shear strength of glue lines*

ISO 12580, *Timber structures — Glued laminated timber — Methods of test for glue-line delamination*

ISO 20152-1, *Timber structures — Bond performance of adhesives — Part 1: Basic requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12579, ISO 12580, ISO 20152-1 and the following apply.

3.1
glued laminated timber
glulam
structural member formed by bonding together timber *laminations* (3.7) with their grain running essentially parallel to the member's longitudinal axis

1) To be published. (Revision of ISO 8375:2009)

3.2
horizontal glulam
glued laminated timber (3.1) with the wide faces of the *laminations* (3.7) perpendicular to the direction of the larger cross-sectional dimension

Note 1 to entry: See Figure 1.

Note 2 to entry: This International Standard does not cover vertical glulam.

3.3
service class
group designation characterized by the moisture content of the members corresponding to the temperature and relative humidity of the surrounding air

3.3.1
service class 1
group designation characterized by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air exceeding 65 % for a few weeks per year

Note 1 to entry: In service class 1, the average equilibrium moisture content of most softwoods does not exceed 12 %.

[SOURCE: ISO 20152-1:2010, 3.1]

3.3.2
service class 2
group designation characterized by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air exceeding 85 % for a few weeks per year

Note 1 to entry: In service class 2, the average equilibrium moisture content of most softwoods does not exceed 20 %. Such conditions include resistance to the effects of moisture on structural performance due to construction delays or other conditions of similar severity.

[SOURCE: ISO 20152-1:2010, 3.2]

3.3.3
service class 3
group designation characterized by climatic conditions leading to moisture contents higher than *service class 2* (3.3.2), such as when a member is fully exposed to the weather

[SOURCE: ISO 20152-1:2010, 3.3]

3.4
maximum delamination percentage
maximum delamination length of one glue line in the test piece, measured on both end-grain surfaces of the test specimen multiplied by 100 and divided by the total length of glue lines on the two end-grain surfaces of each test piece for a single glue line in a test piece

Note 1 to entry: As defined in ISO 12580:2007, 8.3.

3.5
total delamination percentage
delamination length of all glue lines on the two end-grain surfaces in the test piece multiplied by 100 and divided by two times the length of one glue line

Note 1 to entry: As defined in ISO 12580:2007, 8.2.

3.6
wood failure percentage
percentage of the wood failure area in relation to the total sheared area

[SOURCE: ISO 12579:2007, 3.5]

3.7
lamination
piece or pieces of timber of not more than 50 mm in thickness, with or without end joints forming part of a glulam member

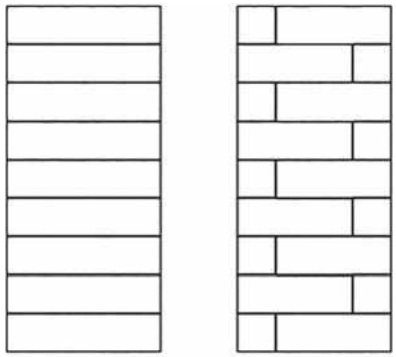

Figure 1 — Glue lines in cross-sections showing the normal position of the glue lines

3.8
declared strengths
<values or properties> mean strength, $\bar{f}_{x,dc}$, and characteristic strength, $f_{x,dc,k}$, of end joints strengths chosen by the manufacturer and used as a basis for determining compliance with the end joint strength requirements of this International Standard

Note 1 to entry: All values can be either bending (m) or tension (t) strength depending on which method of compliance testing is chosen.

Note 2 to entry: For established production facilities, the declared strengths may be determined using historical data and appropriate statistical methods.

3.9
qualification
process of assessing, through physical testing and statistical processing of test data, if the output from a combination of tools, materials and people engaged in producing glued laminated timber products meets the requirements of this International Standard

4 Symbols

$\bar{f}_x$	mean end joint strength determined by qualification testing and statistical processing (mPa)
$f_{x,k}$	characteristic end joint strength determined by qualification tests and statistical processing (mPa)
$\bar{f}_{x,dc}$	required mean strength of the end joints (mPa)
f_v	shear strength (mPa)
x	subscript indicating bending (m) or tension (t)
dc	declared properties

5 Component requirements

5.1 General

The grading of the timber shall result in reliable strength and stiffness properties in the laminations. The bonding operations shall result in reliable and durable bonds in end joints and between laminations.

5.2 Timber

The timber shall be graded in conformity with either ISO 9709 or ISO 13912. The strength and stiffness properties of the glued laminated timber shall be established in accordance with ISO 8375.

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.

The adhesive shall be chosen considering the conditions during construction and in service including climate, moisture conditions, exposure to elevated temperature, the timber species, the preservative used (if any) and the production methods.

Adhesives shall meet the requirements of ISO 20152-1.

NOTE Additional requirements for adhesives may be specified by national standards or governing codes.

5.4 End joints in laminations

5.4.1 Qualification requirements

Mean declared strength, $\overline{f}_{x,dc}$, and characteristic declared strength, $f_{x,dc,k}$, of end joints shall be selected by the manufacturer after qualification testing using one of the methods described in ISO 10983:2014, 6.5. Alternatively, the values may be obtained from historical records where these are available. Declared values of this strength shall satisfy the following:

— mean declared strength, $\overline{f}_{x,dc} \leq \overline{f}_{x,k}$;

— characteristic declared strength, $f_{x,dc,k} \leq f_{x,k}$.

5.4.2 Verification of on-going production

End joints shall comply with the requirements of ISO 10983:2014, 6.6. In interpreting ISO 10983:2014, 6.6, the declared values may be used in lieu of the corresponding $\overline{f}_x$ and $f_{x,k}$ values.

5.5 Glue line integrity and strength

5.5.1 The glue line integrity shall be based on testing of the glue line in a full cross-sectional specimen, cut from the manufactured glulam member.

The specimens shall be representative of the manufacturing process and any pre-gluing chemical treatment of the laminations. For all service classes, bond strength shall be determined using block shear tests according to ISO 12579. Delamination tests shall be performed based on service class as specified in 5.5.2.

5.5.2 For structures of service class 3, delamination tests shall be made according to methods A, B or a combination of D and E of ISO 12580.

For structures of service class 2, delamination tests shall be performed according to methods A, B, C or a combination of D and E of ISO 12580.

For quality control, the test methods are specified in 7.1.3.2.

5.5.3 Depending on the method and number of cycles as required in ISO 12580, the total delamination percentage of each cross-sectional specimen shall be less than the values given in Table 1.

Table 1 — Maximum delamination

Service class	Delamination method ISO 12580	Delamination — % after cycle 1	Delamination — % after cycle 2
3	A	5	10
3	B	5	10
3	D[b] E[b]	— —	5 5
2	A[a]	5	10
2	B[a]	5	10
2	C	5	—
2	D[b] E[b]	5 5	— —

[a] Methods A and B are not required for service class 2; but if they are used, the same delamination requirements as for service class 3 apply.

[b] It is necessary that methods D and E be used together.

For all delamination methods, the maximum delamination percentage of any single glueline shall be less than or equal to 20 %.

NOTE As an alternative to 5.5.3, the provisions of EN 14080:2013, 5.5.5.2.2 are applicable.

5.5.4 Each test result from the block shear tests of each cross-sectional specimen performed in accordance with ISO 12579 shall comply with the following requirements with regard to the shear strength and wood failure percentage.

The average glue line shear strength shall be no less than 90 % of the shear strength of the unbonded wood of the same species. The average shear strength of all glue lines in a cross-section shall be at least 6,0 MPa. For coniferous wood, poplar and broad leaf species with a specific gravity of 0,5 or less, a shear strength of 4,0 MPa for all glue lines in a cross-section shall be regarded as acceptable if the wood failure percentage is 100.

The average wood failure percentage for all glue lines in a cross-section and any individual value shall exceed the minimum wood failure percentages stated in Table 2.

Table 2 — Minimum wood failure percentages (WFP) related to the required shear strength, f_V

	Average			Individual values		
Shear strength f_V in N/mm²	6	8	$f_V \geq 11$	$4 \leq f_V < 6$	6	$f_V \geq 10$
Minimum wood failure percentage, %[a]	90	72	45	100	74	20

Linear interpolation shall be used.

[a] For average values, the minimum wood percentage is: $144 - (9 f_v)$. For the individual values, the minimum wood failure percentage for the shear strength $f_v \geq 6$ N/mm² is: $153{,}3 - (13{,}3 f_v)$.

6 Manufacturing requirements

6.1 General

The manufacturer shall produce reliable glulam. Production conditions that are usually necessary are given in Annex A.

6.2 Adhesives

The adhesives shall comply with the requirements of 5.3.

6.3 Timber

The timber species, moisture content and lamination dimensions shall be suitable for glulam production. Commonly used species, moisture content and lamination dimensions are given in Annex A.

7 Qualification

The compliance of glued laminated timber products with the requirements of this International Standard and with the declared values or classes shall be demonstrated by qualification testing in compliance with Clause 5 and Clause 6, followed by quality control specified in Clause 8 and Clause 9.

NOTE Additional requirements for qualification may be specified by national standards or governing codes, such as EN 14080:2013, 6.2.

8 Factory production internal quality control

8.1 General

To ensure that the glulam members produced conform with this International Standard, the manufacturer shall establish and maintain documented internal factory production quality control. The effectiveness of the production control shall be assessed in accordance with 8.2 and 8.3.

NOTE Additional requirements for quality control may be specified by national standards or governing codes, such as EN 14080:2013, 6.3.

8.2 End joints

From each work shift and each production batch, a representative sample of end joints shall be selected and tested in accordance with ISO 10983. End joints shall meet the requirements of 5.4.

When bending or tension proof loading of end joints is used as an in-line quality assurance measure to augment physical testing, it shall be assured that the proof load level used does not cause incipient damage to the end joint.

8.3 Glue line integrity

8.3.1 The glue lines shall be tested in a full cross-sectional specimen, which is to be cut from a cured glulam member produced during each working shift.

For each shift in which gluing is carried out, one full cross-sectional specimen shall be taken based on the lesser of every press load or every 10 m^3 of production.

If all tests for a three-month period satisfy the requirements, the number of samples may be reduced to not less than half the number prescribed above. At any time, if a sample fails to meet the requirements, corrective action shall be taken and sampling shall return to the frequency described above.

8.3.2 The results of the testing for glue line integrity shall be documented as described in ISO 12580 and ISO 12579 for delamination and block shear, respectively.

8.3.3 For products that are required to be certified in accordance with national standards or governing codes, these sampling requirements should be approved by the product certification body.

8.4 Gluing record

A gluing record shall be kept containing the following:

a) the date and identification of production;

b) the species;

c) the timber quality/grade;

d) the dimensions of the member;

e) the moisture content of the timber;

f) the time at start of adhesive application;

g) the time after adhesive application to before start of clamping;

h) the time at start and end of clamping process;

i) the clamping pressure;

j) the type of adhesive;

k) the adhesive spread (g/m^2);

l) the temperature of the air in timber storage, end jointing room, gluing and clamping area shall be recorded.

The gluing record shall be signed by the nominated responsible member of staff.

9 Quality system

The manufacturing process shall be in accordance with appropriate code and regulatory requirements.

Annex A
(informative)

Personnel, facilities, manufacture and quality control

A.1 Personnel

The staff should have the necessary skills for the production of glulam and the grading of timber.

A.2 Facilities

A.2.1 Premises

A.2.1.1 The premises should be suitable for all phases of the production, taking into consideration the requirements given in this International Standard.

Special consideration should be given to

a) the size of the members, and

b) air temperature.

A.2.1.2 If the temperature and relative humidity of the air is critical to gluing, then the appropriate temperature and relative humidity needs to be maintained throughout the gluing and curing cycle.

A.2.1.3 Drying and storage facilities of sufficient capacity should be available to enable the required moisture content and temperature to be achieved.

A.2.1.4 Where pre-dried timber is used, storage facilities should be available to maintain the required moisture content of the timber.

A.2.1.5 Unless resin and hardener are pumped directly from storage tanks and mixed automatically during application, there should be a separate room for the preparation of the adhesive (mixing resin and hardener).

There should be suitable resin and hardener storage facilities and an area for cleaning the adhesive equipment. For single component adhesives, these references to resin and hardener are not applicable.

The resin and hardener storage should be arranged so that the “first in-first out” principle is maintained.

A.2.2 Equipment

Equipment and personnel should be available

a) to monitor continuously the temperature of the air in storage, production and curing areas,

b) to measure the moisture content of the timber and to check the calibration of moisture meters,

c) for machine and visual grading where these operations are carried out by the producer,

d) to make finger joints in the laminations with sufficient and reliable strength to meet end use requirements,

e) to measure lamination thickness,

f) to provide surfaces fulfilling the requirements of the thickness tolerances and surfaces quality (usually a lamination planer),

g) for weighing and mixing resin and hardener in the required proportions,

h) for the uniform application of the required quantity of adhesive,

i) to obtain the required glue line pressure and temperature during curing of the adhesive,

j) to test the strength of end joints in the laminations, and

k) to test the integrity of the glue lines.

A.3 Manufacture

A.3.1 Laminations

A.3.1.1 When laminations are end-jointed by finger joints, these joints should be produced in conformance with ISO 10983.

A.3.1.2 The individual laminations should be end-jointed to the final length before planing if re-surfacing of the laminations prior to face bonding is required.

During the end-jointing operation, the temperature of the timber should not be less than that required to assure an adequate bond.

A.3.1.3 In order to reduce cupping, laminations with a width larger than 200 mm may be grooved.

In each lamination, one groove is permitted in the middle part of the cross-section, with a maximum width of 4 mm and a maximum depth of one third of the lamination thickness.

A.3.1.4 Where a lamination for horizontal glulam consists of two or more boards positioned side by side and the edges are not bonded, the edge joints in adjacent laminations should be staggered laterally by at least the lamination thickness.

For members to be used in service class 3, the outer laminations on each face should be edge bonded.

A.3.1.5 The laminations should be planed or similarly finished before face bonding.

The planing should be carried out within a time period before the face bonding operations that will assure adequate bonding. With species that are difficult to bond, for example, having a high resin content, or where the laminations have been treated with preservatives, planing should be carried out within 8 h of bonding or within such time that can be shown to result in an adequate bond.

A.3.1.6 The maximum permitted deviation from the average thickness within a lamination length of 1 m is 0,2 mm for gap filling adhesives and 0,1 mm for non-gap filling adhesives.

The difference in thickness over the cross-sectional width of the lamination should be less than 0,15 % of the width and in no case should it exceed 0,3 mm.

A.3.1.7 At assembly, the moisture content in every lamination of non-treated timber should be in the range of 8 % to 15 %.

This range in acceptable moisture content may vary for treated timber.

A.3.1.8 The finished thickness of any lamination should not exceed 50 mm.

For curved members, the maximum thickness is also governed by the radius, *r*, of curvature and the characteristic bending strength of the finger joints. The finished thickness, *t*, should comply with Formula (A.1):

$$t \leq \frac{r}{250}\left(1+\frac{f_{x,k}}{80}\right) \tag{A.1}$$

where $f_{x,k}$, as determined in 5.4, is expressed in megapascals.

As an alternative, an *r*/*t* ratio of 100 for southern pine and hardwoods and an *r*/*t* ratio of 125 for other softwoods may be used.

A.3.1.9 At the time of bonding, the surfaces of laminations should be clean.

A.3.2 Bonding

A.3.2.1 The adhesive spread should be uniform and at the spread rate recommended by the adhesive manufacturer.

A.3.3 Clamping

A.3.3.1 The clamping arrangement should ensure a uniform pressure over the glue line.

A.3.3.2 The pressure should be those recommended in the adhesive manufacturer's instructions.

In the absence of manufacturer's recommendations, values given in Table A.2 may be used. For curved members, higher clamping pressures should be applied and in such a way that the laminations can slide over each other in the lengthwise direction to avoid open glue lines.

Table A.2 — Recommended clamping pressures

Lamination thickness, *t*, in mm	Finished thickness, $t \leq 35$	$35 < t \leq 50$
Pressure in N/mm^2	0,6 to 1,2	0,8 to 1,2 with grooves 1,0 to 1,2 without grooves

A.3.3.3 Sufficient pressure should be maintained during clamping.

Tightening-up should be carried out as necessary and, in all cases, immediately after clamping.

A.3.4 Curing and conditioning

A.3.4.1 The adhesive manufacturer's instructions should be followed.

The temperature during curing should be within the temperature range prescribed by the adhesive manufacturer.

A.3.4.2 If it is necessary to raise the temperature during clamping, the time from initial clamping to the start of the temperature raising should not exceed 8 h.

A.3.4.3 Glulam members should not be loaded, other than by incidental loading that may be induced during handling, or exposed to temperatures below 15 °C until the adhesive has cured completely.

These recommendations should be followed for at least 72 h after the end of clamping for phenolic based adhesives and 24 h for amino plastic adhesives. For other adhesive types, applicable handling recommendations should be established,

A.4 Organization of factory production control

A.4.1 Responsibility and authority

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

a) initiate action to prevent the occurrence of non-conformity of glulam, and

b) identify and record any quality problems with glulam.

A.4.2 Delegated by the manufacturer

At every factory unit, the manufacturer should appoint a person who should have appropriate authority, knowledge and experience of the production of glulam 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.

A.4.3 Inspection by the manufacturer

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

A.5 Documentation of the quality control system

A.5.1 The manufacturer's documentation, procedures and instructions should be relevant to the production and process control of the glulam, and should be adequately described in a work's manual, covering

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

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, and

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 of the end joint tests, the gluing record and the glue line tests are typically recorded and kept separately.

A.5.2 All documentation shall be registered so that raw materials and production conditions for each glulam member are traceable, at least to the production week and year.

A.5.3 All documentation shall be kept for a period in keeping with national statutory requirements.

A.6 Species

Any species may be used where it can be demonstrated they meet the requirements of this International Standard.

Annex B
(informative)

Formaldehyde emission

Adhesives containing formaldehyde are used in some cases for the production of glued laminated timber products. Glued laminated timber products, therefore, may release formaldehyde, but these values are known to be small.

Adhesive manufacturers should provide the documentation on the release of formaldehyde, if any, to the manufacturer of the glued laminated timber products. It is the responsibility of the manufacturer of glued laminated timber products to determine and declare the release of formaldehyde for their product and whether it satisfies the requirements of the appropriate national standards or governing codes.

Bibliography

[1] ISO 12122-1, *Timber structures — Determination of characteristic values — Part 1: Basic requirements*

[2] ANSI A190.1, *Structural Glued Laminated Timber*

[3] EN 15425, *Adhesives — One component polyurethane, for load bearing timber structures — Classification and performance requirements*

[4] EN 14080:2013, *Timber structures — Glued laminated timber and glued solid timber — Requirements*

[5] JAS 235, *Standard for Structural Glued Laminated Timber*

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