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Standard

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**Bamboo structures — Glued
laminated bamboo — Product
specifications**

*Structures en bambou — Bambou lamellé-collé — Spécifications
du produit*

ISO/TC 165

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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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.

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 document 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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This document was prepared by Technical Committee ISO/TC 165, *Timber structures*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Glued laminated bamboo is produced by bonding together several bamboo strips with their fibres parallel to each other. A member with a rectangular or non-rectangular solid cross-section can be produced through this manufacturing process.

The purpose of the requirements in this document is to provide minimum product specifications to achieve adequate in-service performance of glued laminated bamboo building structures.

[Figure 1](#) shows the typical manufacturing steps of glued laminated bamboo. [Figure 1 a\)](#) shows a single bamboo strip (also known as 'lamina') with rectangular cross section ($w_s \times t_s \times l_s$ as shown in [Figure 1 a\)](#) which is typically lengthened by adding bamboo strips using non-structural joints (see [6.1](#)). [Figure 1 b\)](#) shows a multiple layered glued laminated bamboo "board" (having width w_s and height h) component that results from bonding together bamboo strips. The boards are subsequently assembled into glued laminated bamboo components (having width b and height h) as shown in [Figure 1 c\)](#) and [Figures 1 d\)](#). The layup shown in [Figure 1 c\)](#) is the commonly used glued laminated bamboo arrangement. Other arrangements permitted by this document are shown in [Figures 1 d\)](#).

When producing multiple-board glued laminated bamboo, care shall be taken that the splice joints in adjacent boards are staggered by at least the greater of $10w_s$ and $2h$ (see [Figure 2](#)).

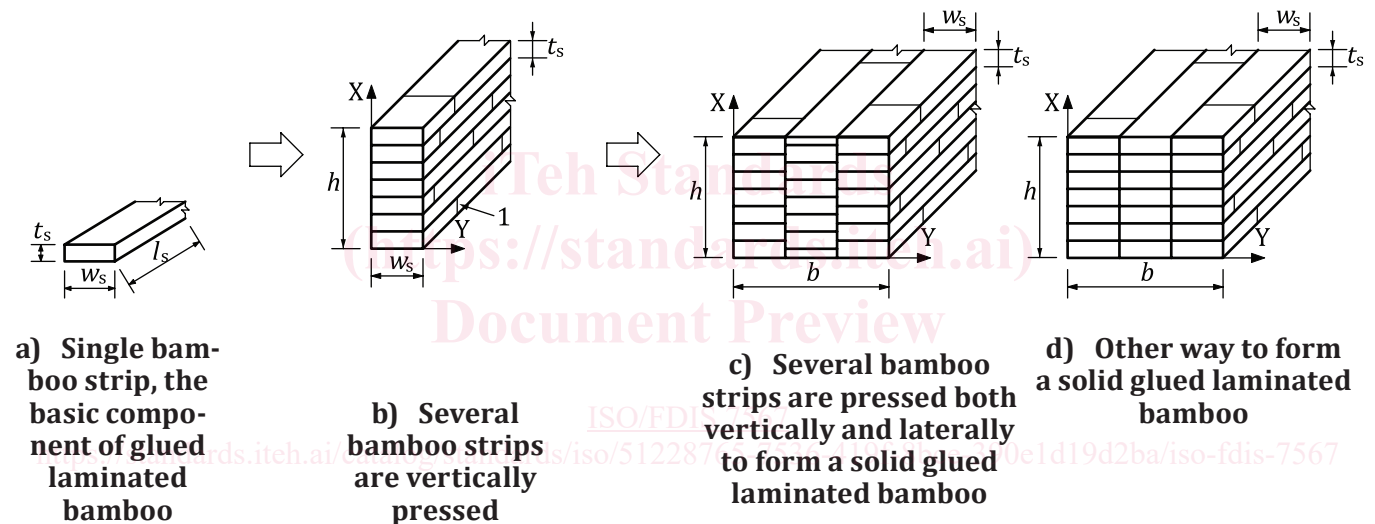


Figure 1 — Key manufacturing process for the products covered by this document

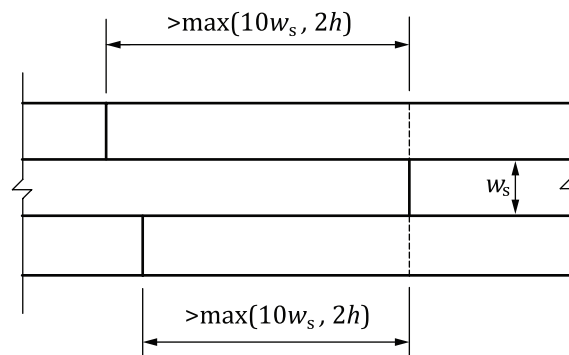


Figure 2 — Requirement for the staggering of splice joints in adjacent boards in the longitudinal direction

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Bamboo structures — Glued laminated bamboo — Product specifications

1 Scope

This document specifies requirements for the components of glued laminated bamboo members intended for structural use.

Although currently most glued laminated bamboo is made from *Phyllostachys edulis* (Moso), this document also applies to other bamboo species (e.g. *Guadua angustifolia*, *Dendrocalamus asper*) if the performance required by this document can be shown to have been 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 5.2).

[Annex C](#) contains informative references for formaldehyde emission.

The requirements will need to be supplemented to take into consideration any relevant special conditions as well as material and/or functional requirements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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*

ISO 21625, *Vocabulary related to bamboo and bamboo products*

ISO 23478, *Bamboo structures — Engineered bamboo products — Test methods for determination of physical and mechanical properties*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21625 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

bamboo failure percentage

At the plane of shear failure, the ratio of failed bamboo material to the total failure surface expressed as a percentage.

3.2

total delamination

sum of delamination lengths of all glue lines around the perimeter of a test piece

3.3

lamination

piece or pieces of bamboo, with or without extension joints forming part of a glued laminated bamboo product

3.4

service class

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

3.4.1

service class 1

characterised by an equilibrium moisture content in the glued laminated bamboo not exceeding 12 %.

Note 1 to entry: Service class 1 is representative of indoor air-conditioned or heated environments in which relative humidity is maintained below 65 %.

3.4.2

service class 2

characterised by an equilibrium moisture content in the glued laminated bamboo not exceeding 20 %.

Note 1 to entry: Service class 2 is representative of indoor unheated or uncooled environments in most locations except those with relative humidity regularly or for prolonged periods exceeding 85 %.

3.4.3

service class 3

characterised by ambient or climatic conditions leading to moisture contents in glued laminated bamboo higher than *service class 2* (3.4.2), such as when a member is fully exposed to the weather

3.5

characteristic value

Value of a material or product property having a prescribed probability of non-exceedance in a hypothetical unlimited test series. The value is expressed in terms of a specified fractile of the assumed statistical distribution of the property expressed with a specified confidence.

3.6

density

characteristic mean density obtained at 75 % confidence limit determined at conditions of equilibrium moisture content of 12 %

3.7

modulus of elasticity

characteristic mean modulus at a 75 % confidence limit obtained from the results of tests using test specimens at an equilibrium moisture content resulting from a temperature of 20 °C and an equilibrium moisture content of 12 %

3.8

strength

modulus of rupture

ultimate strength of beam element tested in flexure determined by first occurrence of tensile rupture or compression failure of extreme fibres. Expressed as a characteristic 5th-percentile value at a 75 % confidence limit.

3.9

moisture content

portion of material weight consisting of water expressed as percentage of oven-dry weight

4 Symbols

w_s	width for the cross-section of the bamboo strip
t_s	thickness for the cross-section of the bamboo strip
l_s	length of the bamboo strip
f_v	shear strength, newtons per square millimetre
A	area, in square millimetres
b	width of cross section, in millimetres
G	shear modulus, in newtons per square millimetre
h	depth of section, in millimetres
ρ	density, in grams per cubic centimetre
$f_{m,k}$	characteristic value of bending strength
$f_{c,k}$	characteristic value of compressive strength parallel to grain, newtons per square millimetre
$f_{t,k}$	characteristic value of tensile strength parallel to grain, newtons per square millimetre
$f_{v,k}$	characteristic value of shear strength parallel to grain, newtons per square millimetre
$f_{c,90,k}$	characteristic value of shear strength perpendicular to grain, newtons per square millimetre
E	modulus of elasticity, newtons per square millimetre

5 Component requirements

5.1 Bamboo strip requirements

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5.1.1 Appearance

Bamboo culms shall be selected to permit the fabrication of straight bamboo splits. The length of bamboo splits shall be adequate to make bamboo strips at least $2\,000 \pm 3$ mm in length and at least $16 \pm 0,1$ mm in width.

The material used for glued laminated bamboo shall be free from physical damage, decay, and insect attack.

There may be variations from element to element, but the total impression of the glued laminated bamboo shall show a homogeneous character.

NOTE Since bamboo is a natural material, colour variations can occur naturally or due to exposure to light over time.

Any part of the material, such as the bamboo outer layer (outer skin) or the bamboo inner layer (inner skin) that hinders preservation, bonding, and finishing shall be removed entirely.

Splinters, cracks, and gaps within a single strip are not permitted.

5.1.2 Maturity

Bamboo shall be used and harvested at species-specific optimal maturity.

NOTE for most suitable species, optimal maturity is in the range of (4 to 7) years.

5.1.3 Density

The dry density of the bamboo strip shall be greater than $0,50 \text{ g/cm}^3$.

5.2 Adhesives

Adhesives shall meet the requirements of ISO 20152-1. Adhesives containing formaldehyde would require special consideration as described in [Annex C](#).

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

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

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

6 Performance requirements

6.1 Extension Joints in laminations

Extension joints to increase the length of bamboo strips can be used. These end extension joints shall not be considered mechanical joints (i.e., they do not transmit force). These joints are only meant to facilitate the manufacture of longer glued laminated bamboo elements. Extension joints shall not align across adjacent strips or adjacent layers of laminated boards. Joints in adjacent strips of a single board ([Figure 3](#)) shall be staggered a distance of at least the greater of $10w_s$ and 200 mm in the lengthwise direction of the strip ([Figure 3](#)).

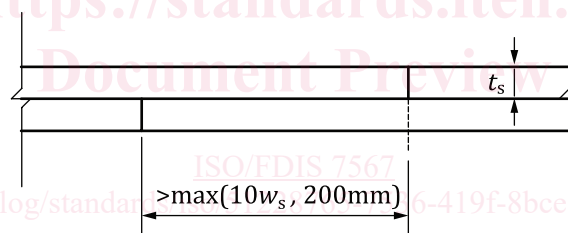


Figure 3 — requirement for the staggering of non-structural splice joints in adjacent strips in the longitudinal direction

6.1.1 Moisture content of bamboo strips

The mean moisture content of a single bamboo strip shall be less than 15 %. The difference of the mean moisture contents of the bamboo strips to be extended shall be less than 2 %.

6.1.2 Extension joints geometry

Examples of extension joints that are currently used in glued laminated bamboo are shown in [Annex D](#).

6.1.3 Extension joint surface and adhesive application

At the time of arrangement, the extension joint shall not be damaged, the extension joint surface shall be clean.

The adhesive shall meet requirements in [5.2](#) and shall be used in accordance with the instructions of the adhesive manufacturer.

The adhesive shall be applied fully and evenly on the extension joint surface.