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Bamboo structures — Engineered bamboo products — Test methods for determination of mechanical properties using small size specimens

Structures en bambou — Produits en bambou reconstitués — Méthodes d'essai pour la détermination des propriétés mécaniques à partir d'éprouvettes de petites tailles

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
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This document was prepared by Technical Committee ISO/TC *165*, *Timber structures*.

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Introduction

Engineered bamboo products are processed bamboo-based composites designed for structural applications, including bamboo scrimber and glued laminated bamboo. For each type of engineered bamboo product, it is necessary to measure mechanical properties. This document is intended to provide manufacturers, regulatory agencies, and end-users with a means to evaluate the mechanical properties of engineered bamboo products intended for structural applications using small size specimens.

This document is an internationally-agreed reference standard for the measurement of mechanical properties of engineered bamboo products as defined in 3.1 and 3.2. Other standards related to the measurement of material properties may be deemed to comply with this document, provided that the adjustments necessary to establish equivalency between this and other standards are applied appropriately.

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Bamboo structures — Engineered bamboo products — Test methods for determination of mechanical properties using small size specimens

1 Scope

This document specifies test methods, using small size specimens, suitable for determining the following mechanical properties of engineered bamboo products: tensile strength parallel-to-fibre; tensile modulus parallel-to-fibre; compressive strength parallel-to-fibre; tensile strength perpendicular-to-fibre; tensile modulus perpendicular-to-fibre; compressive strength perpendicular-to-fibre; compressive modulus perpendicular-to-fibre; shear strength parallel-to-fibre and shear modulus parallel-to-fibre.

NOTE This document provides an alternative test method to ISO 23478.

This document specifies test procedures for currently manufactured products as defined in 3.1 and 3.2 to evaluate material properties. The methods specified in this document are applicable to small size test specimens. The methods required to determine characteristic values, design values, or allowable values of the mechanical properties for a population are out of the scope of this document. Materials that do not conform to the definitions of bamboo scrimber or glued-laminated bamboo are beyond the scope of this specification.

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

ASTM D2915, *Sampling and data-analysis for structural wood and wood-based products*

3 Terms and definitions

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

3.1
bamboo scrimber
panel or lumber made of compressed bamboo fibre bundle strips or compressed bamboo fibre bundle sheet which has three mutually perpendicular axes

Note 1 to entry: The three axes are shown in Figure 1.

Note 2 to entry: Bamboo scrimber can be approximately deemed as orthotropic material; hence it has two mutually orthogonal minor axes in the plane perpendicular to major axis. Unless otherwise stated, the properties of two minor axes can be ideally considered have same properties because the differences between them are trivial for structural use.

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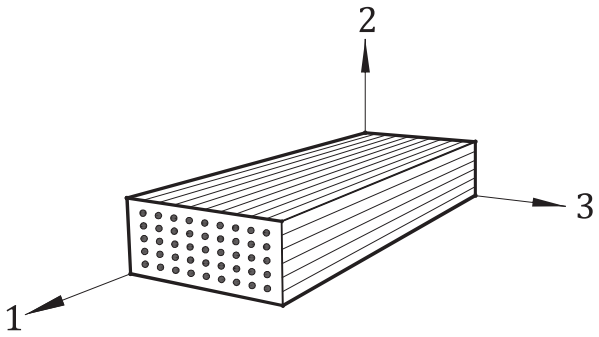
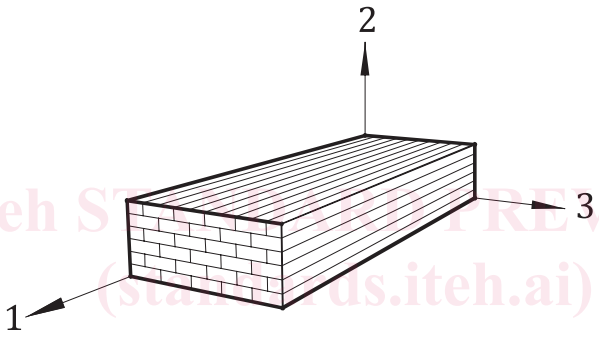


Key

1 along the direction of the bamboo fibres

2, 3 two mutually orthogonal directions in a plane that is perpendicular to axis-1

Figure 1 — Example of bamboo scrimber



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Key

1 along the direction of the bamboo fibres

2, 3 two mutually orthogonal directions in a plane that is perpendicular to axis-1

Figure 2 — Example of glued laminated bamboo

3.2
glued laminated bamboo
structural member formed by bonding together bamboo strips with their fibre orientation essentially parallel which has three mutually perpendicular axes

Note 1 to entry: The three axes are shown in Figure 2.

3.3
grade
population of engineered bamboo products with defined design properties

4 Symbols

A_c	area of the cross section of the compressive specimen, in mm^2
b	width of critical section located at the reduced cross section, in mm
d_1	coupon width between notches of the V-notched rail shear test specimen, in mm
E_0	modulus of elasticity parallel to the fibre, in N/mm^2

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$E_{c,0}$	modulus of elasticity in compression parallel to the fibre, in N/mm^2
$E_{t,0}$	modulus of elasticity in tension parallel to the fibre, in N/mm^2
Et,90	modulus of elasticity in tension perpendicular to the fibre, in N/mm^2
F	load, in N
$F_{c,0,u}$	compressive load parallel to the fibre at failure, in N
$F_{c,90,u}$	compressive load perpendicular to the fibre at failure, in N
$F_{s,u}$	shear load at failure, in N
$F_{t,0,u}$	tensile load parallel to the fibre at failure, in N
$F_{t,90,u}$	tensile load perpendicular to the fibre at failure, in N
$f_{c,0}$	compressive strength parallel to the fibre, in N/mm^2
$f_{s,0}$	shear strength parallel to the fibre, in N/mm^2
$f_{t,0}$	tensile strength parallel to the fibre, in N/mm^2
$f_{t,90}$	tensile strength perpendicular to the fibre, in N/mm^2
$f_{s,90}$	shear strength perpendicular to the fibre, in N/mm^2
G	shear modulus, in N/mm^2
G_0	shear modulus parallel to the fibre, in N/mm^2
G_{90}	shear modulus perpendicular to the fibre, in N/mm^2
h	overall coupon thickness of the V-notched rail shear test specimen, in mm
t	thickness of critical section located at the reduced cross section, in mm
$\Delta F_{c,0}$	incremental compressive load parallel to the fibre, in N
$\Delta F_{t,0}$	incremental tensile load parallel to the fibre, in N
$\Delta F_{t,90}$	incremental tensile load perpendicular to the fibre, in N
$\Delta F_{s,0}$	incremental shear load parallel to the fibre, in N
$\Delta F_{s,90}$	incremental shear load perpendicular to the fibre, in N
$\Delta\sigma$	incremental stress, in MPa
$\Delta\sigma_{c,0}$	$\Delta\sigma_{c,0} = \Delta F_{c,0} / bt$, incremental compressive stress parallel to the fibre, in MPa
$\Delta\sigma_{t,0}$	$\Delta\sigma_{t,0} = \Delta F_{t,0} / bt$, incremental tensile stress parallel to the fibre, in MPa
$\Delta\sigma_{t,90}$	$\Delta\sigma_{t,90} = \Delta F_{t,90} / bt$, incremental tensile stress perpendicular to the fibre, in MPa
$\Delta\varepsilon$	incremental strain
$\Delta\varepsilon_{c,0}$	incremental compressive strain parallel to the fibre
$\Delta\varepsilon_{t,0}$	incremental tensile stain parallel to the fibre

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$\Delta\varepsilon_{t,90}$ incremental tensile stain perpendicular to the fibre

$\Delta\varepsilon_{+45}$ incremental stain over a gauge length at +45 direction

$\Delta\varepsilon_{-45}$ incremental stain over a gauge length at -45 direction

5 Reference population

The population from which the test sample was obtained shall be fully described. The description shall reference all of the attributes that may affect evaluated properties or restrict constituent materials to the grouping. The description shall include but is not limited to:

a) species or species grouping, population boundary;

b) age of the bamboo feedstock when harvested;

c) designation of the product;

d) size or size range of the product;

e) moisture condition of the product;

f) preservative treatment of the product;

j) period in which the product was manufactured.

The reference population shall be a grouping from which a representative sample can be drawn to test specimens to characterize the required properties.

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6 Sampling

The sampling shall be appropriate to the purpose of the testing and the nature of the reference population. The sampling method shall be documented. The documentation shall include details of the steps taken to ensure that each of the variants listed in the population as described in Clause 5 is included in the representative sample.

Unless otherwise stated, test specimens shall be selected from random locations within a piece of engineered bamboo product. Specimens cut from pre-defined locations (center of a piece of engineered bamboo product, or a randomly selected end within a piece or a section free of defects or imperfections) may be deemed to comply with this requirement provided this does not produce any bias in measured properties.

Each test specimen for a given size, grade or property shall be cut from a different piece of engineered bamboo product and more than one type of test specimen may be cut from each piece. Sampling of the test materials shall be done in accordance with applicable sections on Statistical Methodology of ASTM D2915.

Materials with larger assumed or assigned population coefficients of variation, C_V, of the tested properties should have a larger sample size. It is possible to use the expected confidence limit to estimate the sample size based on the expected reduction of the characteristic property calculated from the test data.

7 Conditioning of test specimens

Test specimens shall be conditioned to an equilibrium moisture content resulting from a temperature of (23 ± 3) °C and relative humidity of (65 ± 5) %. A test piece is considered to be conditioned when it attains constant mass. Constant mass is deemed to have been attained when the results of two successive weighings, carried out at intervals of not less than 6 h, do not differ by more than 1 %.

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8 Test conditions

Unless otherwise specified in the description of the reference population, the reference moisture content at the time of testing shall be consistent with conditioning at a temperature of 23 °C (±3 °C) and 65 % (±5 %) relative humidity.

At the time of testing, the moisture content, the temperature, and the time-to-failure of the specimen shall be recorded.

If tests results are to be used in the same environmental conditions in which testing took place, or if the laboratory is unable to follow the standard, storage, conditioning and testing under ambient temperature and relative humidity is permitted. The values of the temperature (±3 °C) and the relative humidity (±5 %) for the laboratory shall be recorded in the test report in addition to the moisture content determined for individual specimens.

9 Density and moisture content

9.1 Density

Measurement of density of a test specimen shall be in accordance with the method specified in ISO 23478.

9.2 Moisture content

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Measurement of moisture content of a test specimen shall be in accordance with the method specified in ISO 23478.

10 Measurement of mechanical properties

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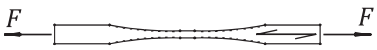
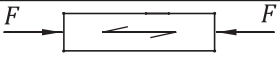
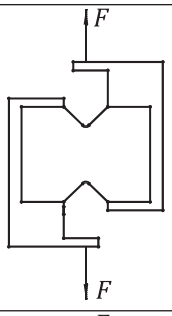
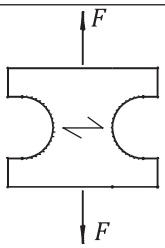
Mechanical properties shall be determined via tests by using small size specimens. Table 1 lists the mechanical properties covered by this standard.

Table 1 — Mechanical properties covered by this document

Tensile strength parallel-to-fibre		10.1
Tensile modulus parallel-to-fibre		10.1
Compressive strength parallel-to-fibre		10.2
Shear strength parallel-to-fibre		10.3
Shear modulus parallel-to-fibre		10.3
Tensile strength perpendicular-to-fibre		10.4
Tensile modulus perpendicular-to-fibre		10.4

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