



# SLOVENSKI STANDARD

## SIST EN 16351:2015

01-december-2015

---

### Lesene konstrukcije - Križno lamelirani les - Zahteve

Timber structures - Cross laminated timber - Requirements

Holzbauwerke - Brettsper Holz - Anforderungen

Structures en bois - Bois lamellé croisé - Exigences

Ta slovenski standard je istoveten z: EN 16351:2015

[SIST EN 16351:2015](https://standards.iteh.ai/catalog/standards/sist/2ab66d98-d1e0-44b7-9dac-7ee990f7f124/sist-en-16351-2015)

<https://standards.iteh.ai/catalog/standards/sist/2ab66d98-d1e0-44b7-9dac-7ee990f7f124/sist-en-16351-2015>

#### **ICS:**

79.060.10	Vezan les	Plywood
91.080.20	Lesene konstrukcije	Timber structures

**SIST EN 16351:2015**

**en,fr,de**

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

SIST EN 16351:2015

<https://standards.iteh.ai/catalog/standards/sist/2ab66d98-d1e0-44b7-9dac-7ee990f7f124/sist-en-16351-2015>

EUROPEAN STANDARD  
NORME EUROPÉENNE  
EUROPÄISCHE NORM

**EN 16351**

October 2015

ICS 79.060.10

English Version

**Timber structures - Cross laminated timber -  
Requirements**

Structures en bois - Bois lamellé croisé - Exigences

Holzbauwerke - Brettsperholz - Anforderungen

This European Standard was approved by CEN on 29 August 2015.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

SIST EN 16351:2015

<https://standards.iteh.ai/catalog/standards/sist/2ab66d98-d1e0-44b7-9dac-7ee990f7f124/sist-en-16351-2015>



EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

**CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels**

# Contents

Page

European foreword.....	6
Introduction .....	7
1 Scope .....	8
2 Normative references .....	9
3 Terms and definitions .....	10
4 Symbols.....	14
4.1 Main symbols .....	14
4.2 Subscripts.....	15
5 Components and product characteristics, testing and assessment methods.....	16
5.1 Components characteristics.....	16
5.1.1 Timber to be used in laminations .....	16
5.1.2 Laminations.....	16
5.1.3 Timber layers .....	17
5.1.4 Wood-based panel layers.....	17
5.1.5 Species.....	17
5.1.6 Adhesives for the production of cross laminated timber.....	18
5.2 Characteristics of cross laminated timber .....	20
5.2.1 General.....	20
5.2.2 Geometrical data .....	20
5.2.3 Strength and stiffness properties of cross laminated timber .....	24
5.2.4 Strength and stiffness properties of cross laminated timber with large finger joints.....	25
5.2.5 Bonding strength.....	26
5.2.6 Resistance to fire .....	27
5.2.7 Reaction to fire.....	27
5.2.8 Dimensional stability.....	29
5.2.9 Release of dangerous substances.....	29
5.2.10 Durability .....	30
6 Assessment and Verification of Constancy of Performance (AVCP).....	31
6.1 General.....	31
6.2 Type testing.....	31
6.2.1 General.....	31
6.2.2 Test samples, testing and compliance criteria .....	32
6.2.3 Test reports.....	36
6.2.4 Shared other party results.....	36
6.2.5 Cascading determination of the product type results .....	37
6.3 Factory production control (FPC) .....	38
6.3.1 General.....	38
6.3.2 Requirements .....	39
6.3.3 Product specific requirements.....	45
6.3.4 Initial inspection of factory and of FPC .....	45
6.3.5 Continuous surveillance of FPC.....	46
6.3.6 Procedure for modifications .....	46
7 Marking and labelling.....	46

7.1	General .....	46
7.2	Cross laminated timber .....	47
Annex A	(normative) Release of Formaldehyde .....	48
A.1	General .....	48
A.2	Classification .....	48
A.2.1	Cross laminated timber .....	48
A.2.2	Cross laminated timber with large finger joints .....	49
Annex B	(normative) Additional test methods and requirements for adhesives .....	50
B.1	General .....	50
B.2	Long-term sustained load test at cyclic climate conditions with specimens loaded perpendicular to the glue line for moisture curing one-component polyurethane and emulsion polymer isocyanate adhesives (glass house test) .....	50
B.2.1	General description .....	50
B.2.2	Production of the specimens .....	50
B.2.3	Test procedure and climate conditions .....	51
B.2.4	Requirements .....	52
B.2.5	Test report .....	52
Annex C	(normative) Delamination test of glue lines between layers .....	53
C.1	Principle .....	53
C.2	Apparatus .....	53
C.2.1	Pressure vessel .....	53
C.2.2	Drying duct .....	53
C.2.3	Balance .....	53
C.2.4	Metal wedge and hammer .....	53
C.3	Sampling and preparation of test pieces .....	53
C.4	Procedures .....	54
C.4.1	General .....	54
C.4.2	Measurement and evaluation of delamination .....	54
C.4.3	Test cycle .....	55
C.5	Results .....	55
C.5.1	General .....	55
C.5.2	Total delamination .....	55
C.5.3	Maximum delamination .....	56
C.5.4	Wood failure percentage .....	56
C.6	Test report .....	56
Annex D	(normative) Shear tests .....	57
D.1	Principle .....	57
D.2	Apparatus .....	57
D.2.1	Testing machine .....	57
D.2.2	Shearing tool .....	57
D.3	Test pieces .....	58
D.3.1	General .....	58
D.3.2	Test pieces for edge bonds in timber layers .....	58
D.3.3	Test pieces for glue lines between layers .....	58
D.3.4	Test pieces for testing single glue lines within cross laminated timber .....	60
D.3.5	Sampling of test pieces .....	60
D.3.6	Marking of test pieces .....	61
D.4	Procedure .....	61
D.5	Results .....	61
D.6	Test report .....	62

<b>Annex E (normative) Tests with laminations with or without finger joints (including compliance criteria).....</b>	<b>63</b>
<b>E.1 Sampling.....</b>	<b>63</b>
<b>E.1.1 General.....</b>	<b>63</b>
<b>E.1.2 For type testing.....</b>	<b>63</b>
<b>E.1.3 For factory production control.....</b>	<b>63</b>
<b>E.2 Testing.....</b>	<b>63</b>
<b>E.2.1 General.....</b>	<b>63</b>
<b>E.2.2 Additional requirements for type testing.....</b>	<b>63</b>
<b>E.2.3 Additional requirements for factory production control.....</b>	<b>63</b>
<b>E.3 Compliance criteria of finger joints in laminations.....</b>	<b>64</b>
<b>E.3.1 For type testing.....</b>	<b>64</b>
<b>E.3.2 For factory production control.....</b>	<b>64</b>
<b>E.4 Report of tests with finger joints in laminations.....</b>	<b>64</b>
<b>E.5 Tests with laminations without finger joints.....</b>	<b>65</b>
<b>Annex F (normative) Determination of strength, stiffness and density properties of cross laminated timber .....</b>	<b>66</b>
<b>F.1 Indices.....</b>	<b>66</b>
<b>F.2 General.....</b>	<b>69</b>
<b>F.2.1 Sampling.....</b>	<b>69</b>
<b>F.2.2 Specimens .....</b>	<b>69</b>
<b>F.2.3 Testing.....</b>	<b>69</b>
<b>F.2.4 Analysis of test results.....</b>	<b>70</b>
<b>F.2.5 Test reports.....</b>	<b>70</b>
<b>F.3 Characteristics determined by tests with loads perpendicular to the plane .....</b>	<b>70</b>
<b>F.3.1 Bending test .....</b>	<b>70</b>
<b>F.3.2 (Rolling) shear strength and stiffness derived from bending tests .....</b>	<b>71</b>
<b>F.3.3 (Rolling) shear strength and stiffness derived from shear test (alternative test method) .....</b>	<b>72</b>
<b>F.3.4 Compression perpendicular to the plane.....</b>	<b>74</b>
<b>F.3.5 Large finger joint - Bending test .....</b>	<b>74</b>
<b>F.4 Characteristics determined by tests with in-plane loads .....</b>	<b>75</b>
<b>F.4.1 Bending.....</b>	<b>75</b>
<b>F.4.2 Shear values within a layer – net cross section .....</b>	<b>76</b>
<b>F.4.3 Shear values for glue lines between layers – torsional shear .....</b>	<b>77</b>
<b>F.4.4 Shear stiffness for cross laminated timber in plane by bending test.....</b>	<b>78</b>
<b>F.4.5 Large finger joint - Bending test .....</b>	<b>79</b>
<b>Annex G (normative) Measurement of moisture content.....</b>	<b>80</b>
<b>G.1 General.....</b>	<b>80</b>
<b>G.2 Measurement of moisture content of boards during production.....</b>	<b>80</b>
<b>G.3 Mean moisture content of cross laminated timber made from timber laminations .....</b>	<b>80</b>
<b>Annex H (normative) Separation tests with finger joints in laminations produced with contact-free application of adhesive.....</b>	<b>81</b>
<b>Annex I (normative) Minimum production requirements.....</b>	<b>82</b>
<b>I.1 Personnel .....</b>	<b>82</b>
<b>I.2 Production and storage facilities .....</b>	<b>82</b>
<b>I.2.1 General.....</b>	<b>82</b>
<b>I.2.2 Facilities for drying and storage of timber .....</b>	<b>82</b>
<b>I.2.3 Facilities for processing and storage of adhesives.....</b>	<b>82</b>
<b>I.2.4 Facilities for production and curing.....</b>	<b>82</b>
<b>I.3 Equipment .....</b>	<b>83</b>
<b>I.4 Finger joints in laminations .....</b>	<b>83</b>

I.4.1	Wane and edge damages .....	83
I.4.2	Finger joint geometry .....	84
I.4.3	Knots and local grain deviation .....	84
I.4.4	Moisture content at bonding .....	85
I.4.5	Bonding surface and application of the adhesive .....	85
I.4.6	Time between cutting and adhesive application .....	86
I.4.7	Pressure .....	86
I.4.8	Curing .....	86
I.5	Bonding of laminations and layers .....	87
I.5.1	General .....	87
I.5.2	Moisture content at bonding .....	87
I.5.3	Bonding surfaces and adhesive application .....	87
I.5.4	Cramping .....	87
I.5.5	Glue line thickness .....	87
I.5.6	Curing .....	88
I.6	Cross laminated timber with large finger joints .....	88
I.6.1	Cross laminated timber to be jointed .....	88
I.6.2	Moisture content at bonding .....	88
I.6.3	Finger joint geometry .....	88
I.6.4	Machining of the fingers .....	88
I.6.5	Adhesive, bonding surface and adhesive application .....	88
I.6.6	Cramping .....	89
I.6.7	Glue line thickness .....	89
I.6.8	Curing .....	89
Annex ZA (informative)	Clauses of this European Standard addressing the requirements of the EU Construction Products Regulation .....	90
Bibliography	.....	102

SIST EN 16351:2015  
<https://standards.iteh.ai/catalog/standards/sist/2ab66d98-d1e0-44b7-9dac-7ee990f7f124/sist-en-16351-2015>

**EN 16351:2015 (E)****European foreword**

This document (EN 16351:2015) has been prepared by Technical Committee CEN/TC 124 “Timber structures”, the secretariat of which is held by AFNOR.

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 April 2016, and conflicting national standards shall be withdrawn at the latest by July 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports basic work requirements of Regulation (EU) No 305/2011.

For relationship with the EU Regulations, see informative Annex ZA, which is an integral part of this document.

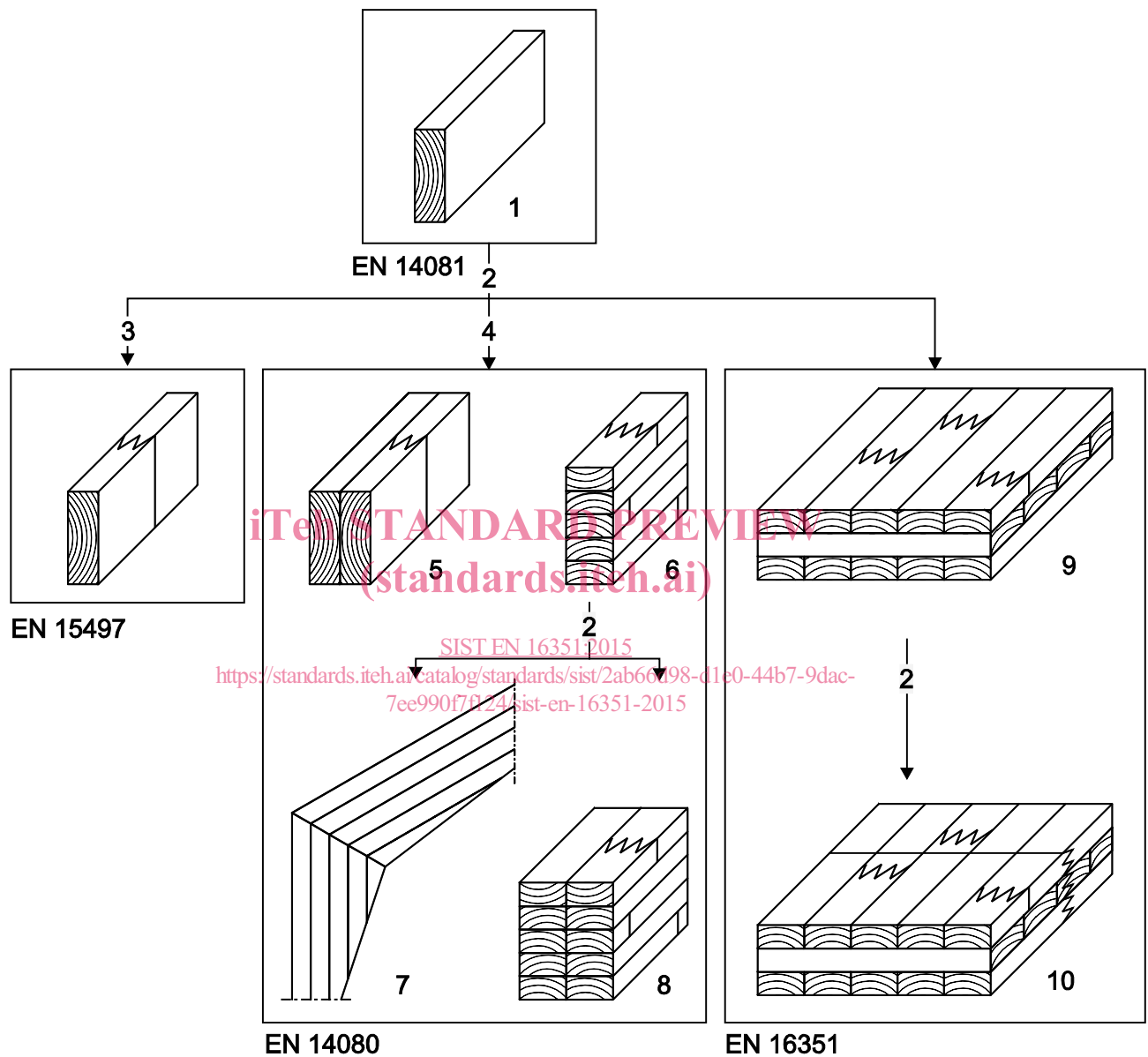
According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

[SIST EN 16351:2015](https://standards.iteh.ai/catalog/standards/sist/2ab66d98-d1e0-44b7-9dac-7ee990f7f124/sist-en-16351-2015)

<https://standards.iteh.ai/catalog/standards/sist/2ab66d98-d1e0-44b7-9dac-7ee990f7f124/sist-en-16351-2015>

## Introduction

Figure 1 shows the relation of European Standards prepared by CEN/TC 124.



### Key

- |   |                                  |    |   |
|---|----------------------------------|----|---|
| 1 | boards                           | 6  | glued laminated timber (glulam)                         |
| 2 | is a component for               | 7  | glulam with large finger joints                         |
| 3 | structural finger jointed timber | 8  | block glued glulam                                      |
| 4 | glued laminated products         | 9  | cross laminated timber (X-Lam)                          |
| 5 | glued solid timber               | 10 | cross laminated timber (X-Lam) with large finger joints |

**Figure 1 — Relation of European Standards prepared by CEN/TC 124**

## 1 Scope

This European Standard sets out provisions regarding the performance characteristics for straight and curved structural cross laminated timber (X-Lam) both without and with large finger joints as a material for the manufacture of structural elements to be used in buildings and bridges.

This European Standard applies to cross laminated timber:

- to be used in service class 1 or 2 according to EN 1995-1-1;
- made of coniferous species and poplar listed in 5.1.5 of this standard;
- built up of at least three orthogonally bonded layers (at least two of them timber layers);
- having, depending on the number of layers, adjacent layers which may be bonded parallel to the grain;
- made of timber layers which are made of strength graded timber according to EN 14081-1;
- made of timber layers having thicknesses between 6 mm and 60 mm (including) taking into account the layup requirements given in this European standard;
- made of timber layers which may be edge bonded or which are not bonded and have spacing less than 6 mm between adjacent laminations;
- which may comprise wood based panels made of structural wood based panels specified in this European standard, fulfilling the requirements for use in service class 2 or 3 according to EN 1995-1-1, having no structural joints between the single panels and having thicknesses between 6 mm and 45 mm (including);
- bonded with adhesives, fulfilling the requirements given in this European standard;
- having overall thicknesses up to 500 mm;
- which is not made from reused timber or wood based panels comprising reused timber.

This European Standard also applies to cross laminated timber with large finger joints:

- made from cross laminated timber pieces having the same cross section and layup;
- made from cross laminated timber pieces having cross sectional thicknesses from 51 mm up to 345 mm (inclusive) and minimum thicknesses of the outermost layers not less than 17 mm.
- made from cross laminated timber pieces solely comprising timber layers;
- made from plane cross laminated timber pieces jointed so that no regular change between the grain directions of the layers occurs;
- with finger joints having a finger length of at least 45 mm and fingers which are visible at the two narrow sides of the components.

This European Standard applies to cross laminated timber treated against biological attack. Cross laminated timber treated with fire retardants is not covered.

It also sets out minimum production requirements and procedures for Assessment and Verification of Constancy of Performance.

## 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.

EN 301:2013, *Adhesives, phenolic and aminoplastic, for load-bearing timber structures — Classification and performance requirements*

EN 302-1, *Adhesives for load-bearing timber structures — Test methods — Part 1: Determination of longitudinal tensile shear strength*

EN 302-2:2013, *Adhesives for load-bearing timber structures — Test methods — Part 2: Determination of resistance to delamination*

EN 302-3:2013, *Adhesives for load-bearing timber structures — Test methods — Part 3: Determination of the effect of acid damage to wood fibres by temperature and humidity cycling on the transverse tensile strength*

EN 302-4, *Adhesives for load-bearing timber structures — Test methods — Part 4: Determination of the effects of wood shrinkage on the shear strength*

EN 302-6, *Adhesives for load-bearing timber structures — Test methods — Part 6: Determination of the minimum pressing time under referenced conditions*

EN 338, *Structural timber - Strength classes*

EN 350-1, *Durability of wood and wood-based products — Natural durability of solid wood — Part 1: Guide to the principles of testing and classification of the natural durability of wood*

EN 350-2, *Durability of wood and wood-based products — Natural durability of solid wood — Part 2: Guide to natural durability and treatability of selected wood species of importance in Europe*

EN 408, *Timber structures — Structural timber and glued laminated timber — Determination of some physical and mechanical properties*

EN 717-1, *Wood-based panels — Determination of formaldehyde release — Part 1: Formaldehyde emission by the chamber method*

EN 789:2004, *Timber structures — Test methods — Determination of mechanical properties of wood based panels*

EN 1995-1-1, *Eurocode 5: Design of timber structures — Part 1-1: General — Common rules and rules for buildings*

EN 13183-1, *Moisture content of a piece of sawn timber — Part 1: Determination by oven dry method*

EN 13183-2, *Moisture content of a piece of sawn timber — Part 2: Estimation by electrical resistance method*

EN 13183-3, *Moisture content of a piece of sawn timber — Part 3: Estimation by capacitance method*

EN 13238, *Reaction to fire tests for building products — Conditioning procedures and general rules for selection of substrates*

**EN 16351:2015 (E)**

EN 13501-1, *Fire classification of construction products and building elements — Part 1: Classification using data from reaction to fire tests*

EN 13823, *Reaction to fire tests for building products — Building products excluding floorings exposed to the thermal attack by a single burning item*

EN 13986, *Wood-based panels for use in construction — Characteristics, evaluation of conformity and marking*

EN 14081-1:2005+A1:2011, *Timber structures — Strength graded structural timber with rectangular cross section — Part 1: General requirements*

EN 14358, *Timber structures — Calculation of characteristic 5-percentile values and acceptance criteria for a sample*

EN 14374, *Timber structures — Structural laminated veneer lumber — Requirements*

EN 15228:2009, *Structural timber — Structural timber preservative treated against biological attack*

EN 15416-3, *Adhesives for load bearing timber structures other than phenolic and aminoplastic — Test methods — Part 3: Creep deformation test at cyclic climate conditions with specimens loaded in bending shear*

EN 15416-5, *Adhesives for load bearing timber structures other than phenolic and aminoplastic — Test methods — Part 5: Determination of conventional pressing time*

EN 15425:2008, *Adhesives — One component polyurethane for load bearing timber structures — Classification and performance requirements*

(standards.iteh.ai)  
<https://standards.iteh.ai/catalog/standards/sist/2ab66d98-d1e0-44b7-9dac-7ee990f7f124/sist-en-16351-2015>

### 3 Terms and definitions

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

#### 3.1

##### **actual size**

measured size of a cross laminated timber at a related measured/estimated moisture content

#### 3.2

##### **bonding strength**

structural effectiveness of adhesives between timber pieces when subjected to stresses

#### 3.3

##### **corrected size**

size of a cross laminated timber corrected by calculation from its actual size to its size at the reference moisture content

**3.4****cross laminated timber****X-Lam**

structural timber consisting of at least three layers of which a minimum of three are orthogonally bonded, which always comprise timber layers and may also comprise wood-based panel layers

Note 1 to entry: See also 5.2.2.7.

Note 2 to entry: Cross laminated timber in accordance with EN 16351 and multilayer solid wood panels in accordance with EN 13353 may have the same layup but the timber to be used in laminations is strength graded according to EN 14081-1 and the adhesives are tested according to 5.1.6 of this European Standard.

**3.5****curved cross laminated timber**

cross laminated timber having a precamber greater than 1% of the respective span

**3.6****edge bonds**

bonds between adjacent laminations within a timber layer

**3.7****edge bonded layer**

timber layer comprising structural edge bonds

**3.8****finger angle**

inclination  $\alpha$  of each side of the fingers of a finger joint

Note 1 to entry: See Figure 2.

[SIST EN 16351:2015](https://standards.iteh.ai/catalog/standards/sist/2ab66d98-d1e0-44b7-9dac-7ee990f7f124/sist-en-16351-2015)

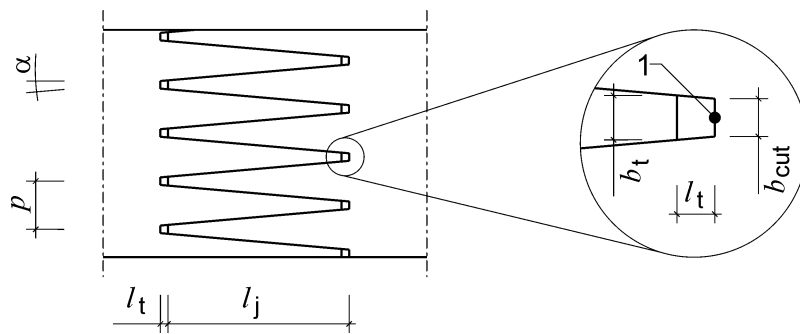
<https://standards.iteh.ai/catalog/standards/sist/2ab66d98-d1e0-44b7-9dac-7ee990f7f124/sist-en-16351-2015>

**3.9****finger joint**

interlocking end joint formed by machining a number of similar, tapered, symmetrical fingers in the ends of timber components using a finger joint cutter and then bonded together

Note 1 to entry: In this European Standard the term finger joint is used for finger joints in laminations whereas finger joints between cross laminated timber are defined as large finger joints (see 3.13).

**iTeh STANDARD PREVIEW**  
(standards.iteh.ai)

**Key**

$l_j$	finger length
$p$	pitch
$\alpha$	finger angle
$l_t$	tip gap
$b_{cut}$	tip width of the cutter
$b_t$	tip width
1	slot base

**Figure 2 — Typical profile of a finger joint****3.10****finger length**

distance  $l_j$  between the finger base and the tip of the finger, measured along the centre line of the finger

Note 1 to entry: See Figure 2.

**3.11****finished thickness**

thickness after planing

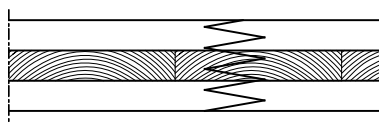
**3.12****laminations**

structural timber boards, finger jointed unless the length of a single board matches the lamination length, being part of timber layers in cross laminated timber

**3.13****large finger joint**

finger joint through the full cross sectional area of two cross laminated timber pieces

Note 1 to entry: See Figure 3.

**Figure 3 — Cross laminated timber with large finger joints**

**3.14****layup**

cross sectional arrangement of timber layers or wood-based panel layers in which each layer may be made of different species and may have different strength classes, manufacturer specific strength classes or technical classes

**3.15****manufacturer specific strength class**

set of characteristic strength, stiffness and density properties not tabulated in a standard

**3.16****maximum delamination length**

largest delamination length in any single glue line measured around the circumference of the test piece

**3.17****mean moisture content**

mean value of the moisture content of cross laminated timber calculated from at least two measurements

Note 1 to entry: See G.3.

**3.18****minimum mean density**

required density at reference moisture content, estimated as the weighted mean of the mean densities of the layers, if necessary

Note 1 to entry: Minimum mean density is used for the classification of the reaction to fire.

**3.19****pitch**

distance between centres of adjacent finger tips

Note 1 to entry: See Figure 2.

**3.20****ratio of resin to hardener**

proportion of resin to hardener by mass with the resin set at 100 parts

**3.21****reduction factor**

ratio between tip width and pitch

Note 1 to entry: See Figure 2.

**3.22****reference moisture content**

moisture content at which target sizes are established

**3.23****relative tip gap**

ratio between tip gap and finger length

Note 1 to entry: See Figure 2.